

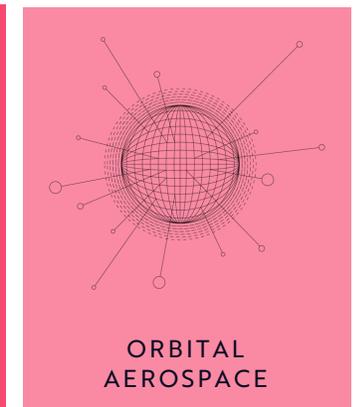
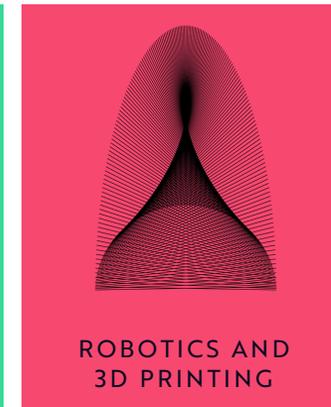
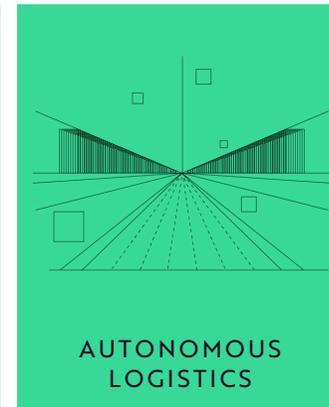
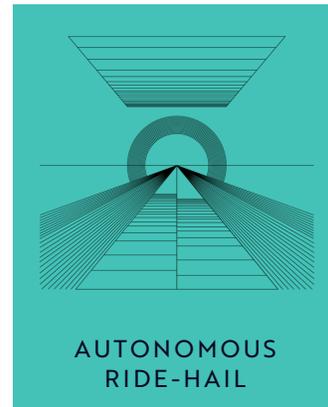
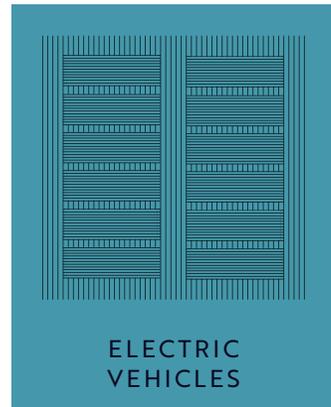
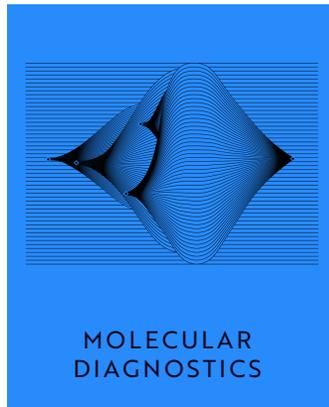
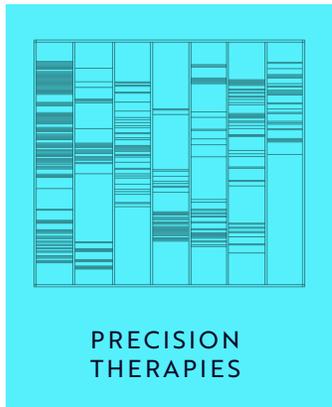
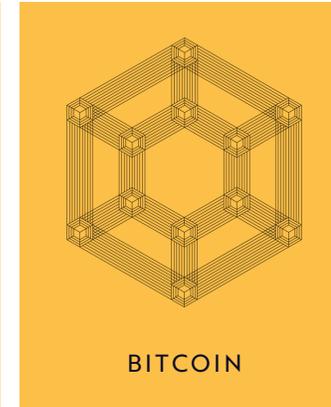
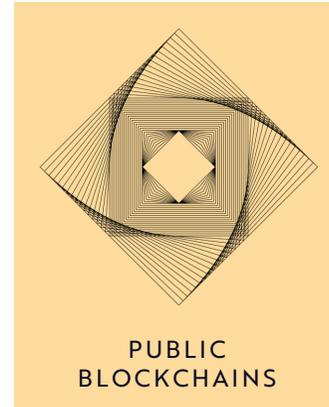
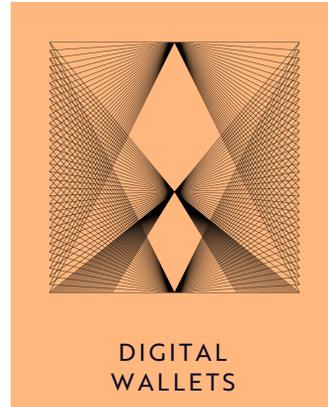
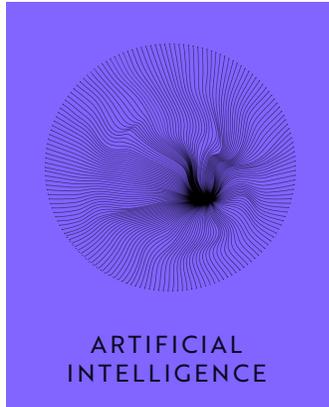
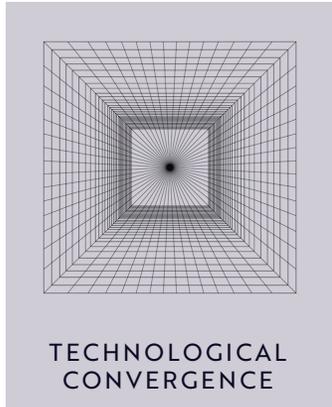
BIG IDEAS 2023



January 31, 2023

ARK Investment Management LLC

www.ark-invest.com



For Informational Purposes Only

ARK Investment Management LLC. This is not a recommendation in relation to any named particular securities/cryptocurrencies and no warranty or guarantee is provided. Any references to particular securities/cryptocurrencies are for illustrative purposes only. There is no assurance that the Adviser will make any investments with the same or similar characteristics as any investment presented. The reader should not assume that an investment identified was or will be profitable. PAST PERFORMANCE IS NOT INDICATIVE OF FUTURE PERFORMANCE, FUTURE RETURNS ARE NOT GUARANTEED.



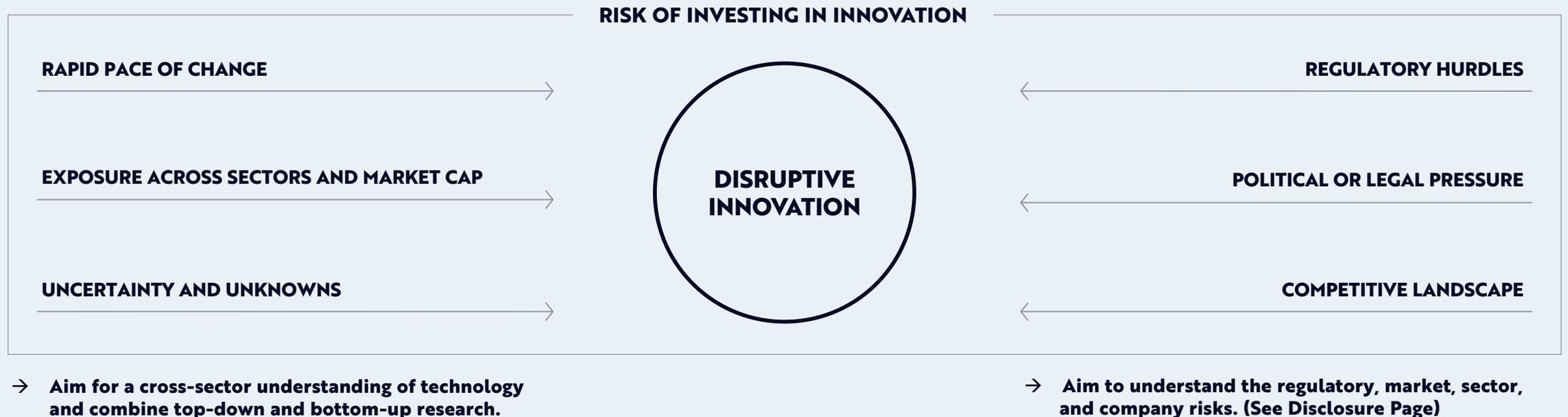
Resolute Investment Managers (“Resolute”) is a compensated promoter for ARK Investment Management LLC (“ARK Invest”) and is not a current client of ARK Invest or investor in ARK Invest’s funds. Resolute has entered an agreement with ARK Invest whereby ARK Invest has agreed to pay Resolute a fee in exchange for Resolute referring potential advisory clients/investors (including you) to ARK Invest. Resolute may refer clients/investors to a third-party platform where ARK Invest’s strategies are available, but Resolute is not promoting those platforms and receives no compensation from them. For its services to ARK Invest, Resolute will receive 25% of the advisory fees received by ARK Invest for referred clients/investors for so long as they remain under ARK Invest’s management. The advisory fees charged to you will not be affected by the fees paid to Resolute, because Resolute’s compensation will be paid solely from ARK Invest’s investment management fee and will not result in any additional charge to you. Receipt of compensation influences Resolute’s referral of prospective clients/investors to ARK Invest. Resolute is not providing investment advice or recommending an investment in ARK Invest’s products to you.



Risks of Investing in Innovation

Please note: Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. ARK aims to educate investors and seeks to size the potential investment opportunity, noting that risks and uncertainties may impact our projections and research models. Investors should use the content presented for informational purposes only, and be aware of market risk, disruptive innovation risk, regulatory risk, and risks related to certain innovation areas.

Please read risk disclosure carefully.





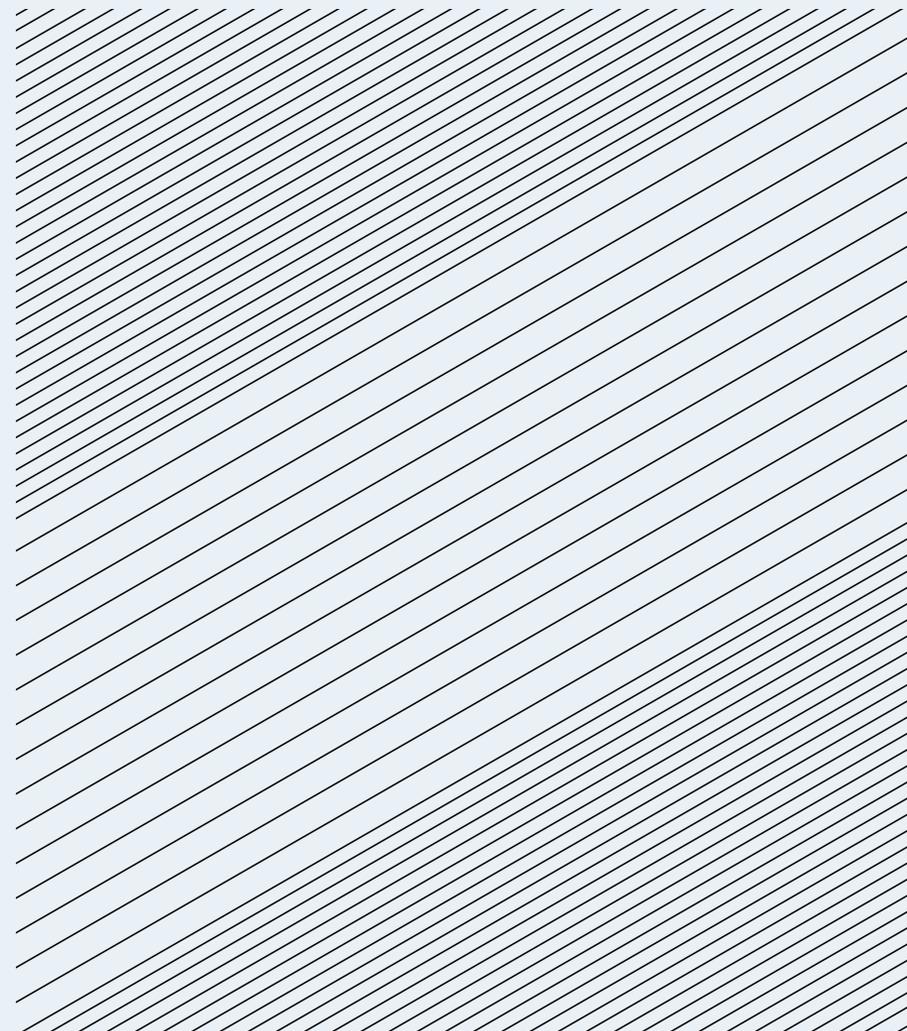
Big Ideas 2023

Innovation is Taking Off

ARK aims to deliver long-term capital appreciation by investing in the leaders, enablers, and beneficiaries of disruptive innovation. We believe every investor should have a strategic allocation to innovation, not only to access potential exponential growth opportunities typically absent from broad-based indices, but also to hedge against the increasing risk that incumbents will be disrupted.

To enlighten investors on the long-term impact of innovation, we began publishing Big Ideas in 2017. This annual research report seeks to highlight the technological breakthroughs evolving today and creating the potential for super-exponential growth tomorrow.

We believe that innovation is taking off now, corroborating our original research and boosting our confidence that ARK's strategies are on the right side of change. We hope you enjoy Big Ideas 2023!





Technological Convergence	05
----------------------------------	-----------

Artificial Intelligence	16
--------------------------------	-----------

Digital Consumers	21
--------------------------	-----------

Digital Wallets	24
------------------------	-----------

Public Blockchains	30
---------------------------	-----------

Bitcoin	37
----------------	-----------

Precision Therapies	45
----------------------------	-----------

Molecular Cancer Diagnostics	54
-------------------------------------	-----------

Electric Vehicles	62
--------------------------	-----------

Autonomous Ride-Hail	67
-----------------------------	-----------

Autonomous Logistics	73
-----------------------------	-----------

Robotics and 3D Printing	77
---------------------------------	-----------

Orbital Aerospace	86
--------------------------	-----------

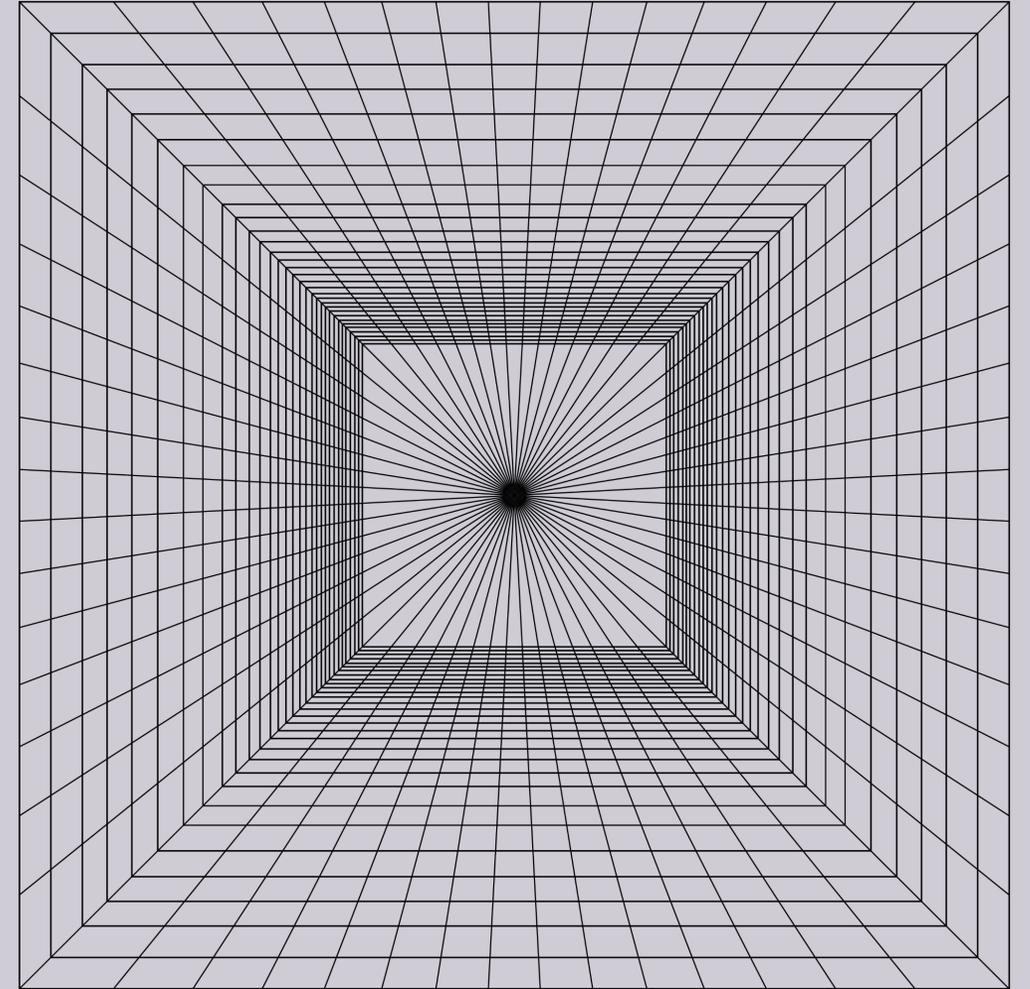
Technological Convergence

Creating The Potential For Super-Exponential¹ Growth

According to ARK's research, five innovation platforms are converging to create unprecedented growth trajectories.

Artificial Intelligence (AI) is the most important catalyst, its velocity cascading through all other technologies.

Research by Brett Winton, Chief Futurist & ARK Venture Investment Committee Member



Sources: ARK Investment Management LLC, 2023. As of year end 2022.. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

[1] "Super-exponential" just means more than exponential, so a function is super-exponential if it grows faster than any exponential function.



Five Converging Innovation Platforms Define This Technological Era

Public Blockchains

The financial ecosystem is likely to reconfigure to accommodate the rise of **Cryptocurrencies** and **Smart Contracts**. These technologies increase transparency, reduce the influence of capital and regulatory controls, and collapse contract execution costs. In such a world, **Digital Wallets** will become increasingly necessary as more assets become money-like, and corporations and consumers adapt to the new financial infrastructure. Corporate structures themselves may be called into question.

Artificial Intelligence

Computational systems and software that evolve with data can solve intractable problems, automate knowledge work, and accelerate technology's integration into every economic sector. The adoption of **Neural Networks** should prove more momentous than the introduction of the internet and create 10s of trillion dollars of value. At scale these systems will require unprecedented computational resources, and AI-specific compute hardware should dominate the **Next Gen Cloud** datacenters that train and operate AI models. The potential for end-users is clear: a constellation of AI-driven **Intelligent Devices** that pervade people's lives, changing the way that they spend, work, and play. The adoption of artificial intelligence should transform every sector, impact every business, and catalyze every innovation platform.

Multiomic Sequencing

The cost to gather, sequence, and understand digital biological data is falling precipitously. **Multiomic Technologies** provide research scientists, therapeutic organizations and health platforms with unprecedented access to DNA, RNA, protein, and digital health data. Cancer care should transform with pan-cancer blood tests. Multiomic data should feed into novel **Precision Therapies** using emerging gene editing techniques that target and cure rare diseases and chronic conditions. Multiomics should unlock entirely new **Programmable Biology** capabilities, including the design and synthesis of novel biological constructs with applications across industries, particularly agriculture and food production.

Energy Storage

Declining costs of **Advanced Battery Technology** should cause an explosion in form factors, enabling **Autonomous Mobility** systems that collapse the cost of getting people and things from place to place. Electric drivetrain cost declines should unlock micro-mobility and aerial systems, including flying taxis, enabling business models that transform the landscape of cities. Autonomy should reduce the cost of taxi, delivery, and surveillance by an order of magnitude, enabling frictionless transport that will increase the velocity of e-commerce and make individual car ownership the exception rather than the rule. These innovations combined with large-scale stationary batteries should cause a transformation in energy, substituting electricity for liquid fuel and pushing generation infrastructure towards the edge of the network.

Robotics

Catalyzed by artificial intelligence, **Adaptive Robots** can operate alongside humans and navigate legacy infrastructure, changing the way products are made and sold. **3D Printing** should contribute to the digitization of manufacturing, increasing not only the performance and precision of end-use parts but also the resilience of supply chains. Meanwhile, the world's fastest robots, **Reusable Rockets**, should continue to reduce the cost of launching satellite constellations and enable uninterrupted connectivity. A nascent innovation platform, robotics could collapse the cost of distance with hypersonic travel, the cost of manufacturing complexity with 3D printers, and the cost of production with AI-guided robots.



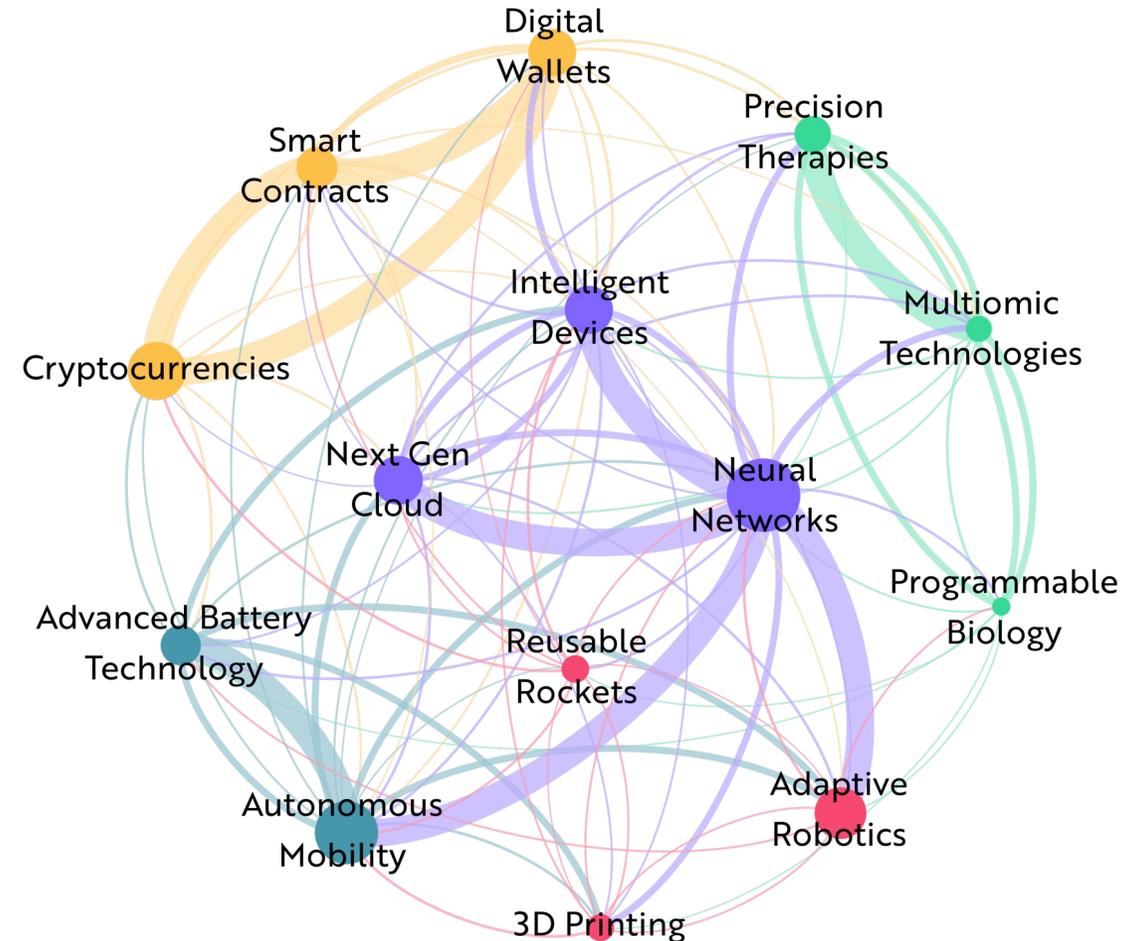
Convergence

The converging innovation platforms involve 14 investable technologies undergoing steep cost declines, impacting multiple sectors, and serving as launching pads for more innovation.

ARK's Convergence Scoring Framework And Network Graph:

- Technology scores are a function of their potential to generate super-exponential growth as they catalyze other technologies.
- The thickest lines correspond to expectations for an order of magnitude increase in another technology's potential.
- Edges are directional. Neural networks should catalyze autonomous mobility (thick purple line), for example, and the data generated by autonomous mobility systems should improve neural network capability (thin teal line).
- Node size corresponds to estimate of 2030 enterprise value¹ attributable to the technology on a logarithmic (log) scale.²
- The innovation platform taxonomy emerges organically from this network graph.

Node size: Each node, or dot, is sized to represent the estimated 2030 Market Capitalization
 Edge size: Each edge, or connecting line is sized to represent the estimated 2030 catalyzing impact
 Edge color coded to the catalyzing technology, or, which technology will have greater impact on another



Sources: ARK Investment Management LLC, 2023. Information provided on this slide is based on ARK's research and views and subject to change. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

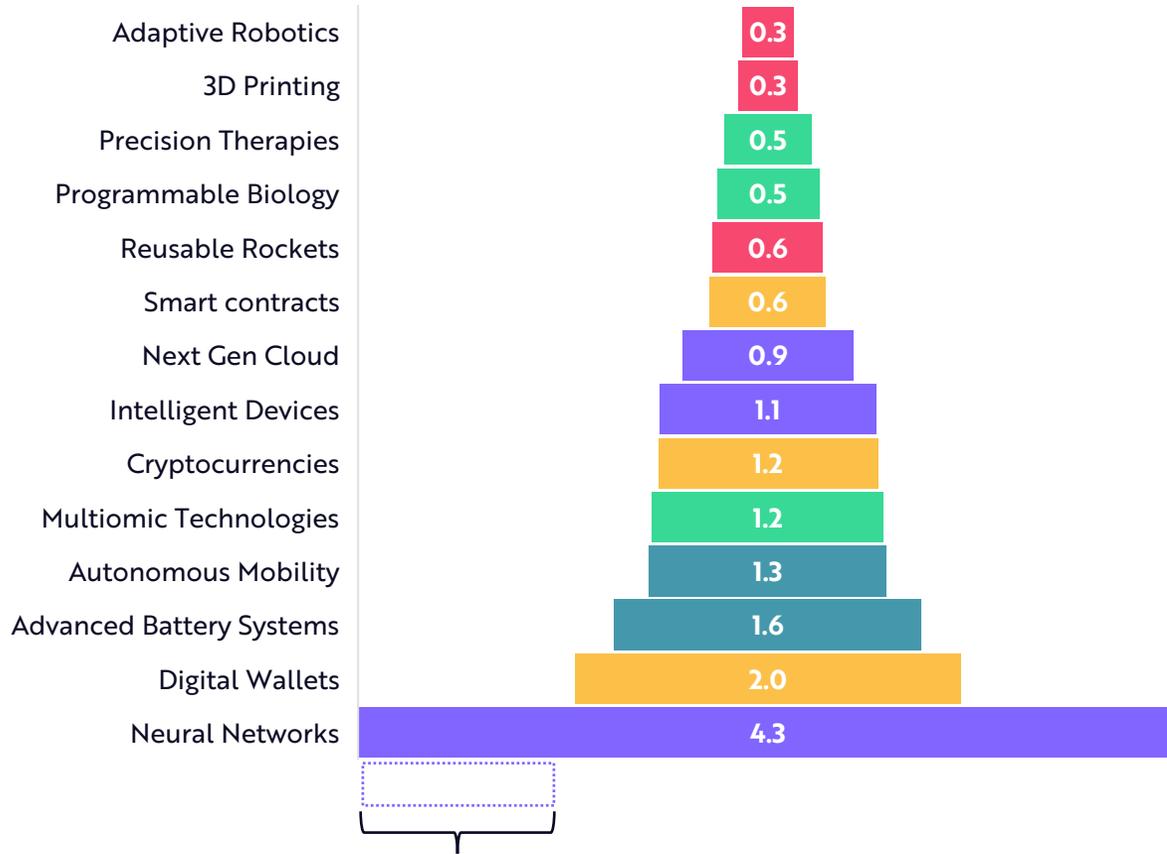
[1] Enterprise value (EV) measures a company's total value, often used as a more comprehensive alternative to equity market capitalization.

[2] A logarithmic scale is a way of displaying numerical data over a very wide range of values in a compact way.

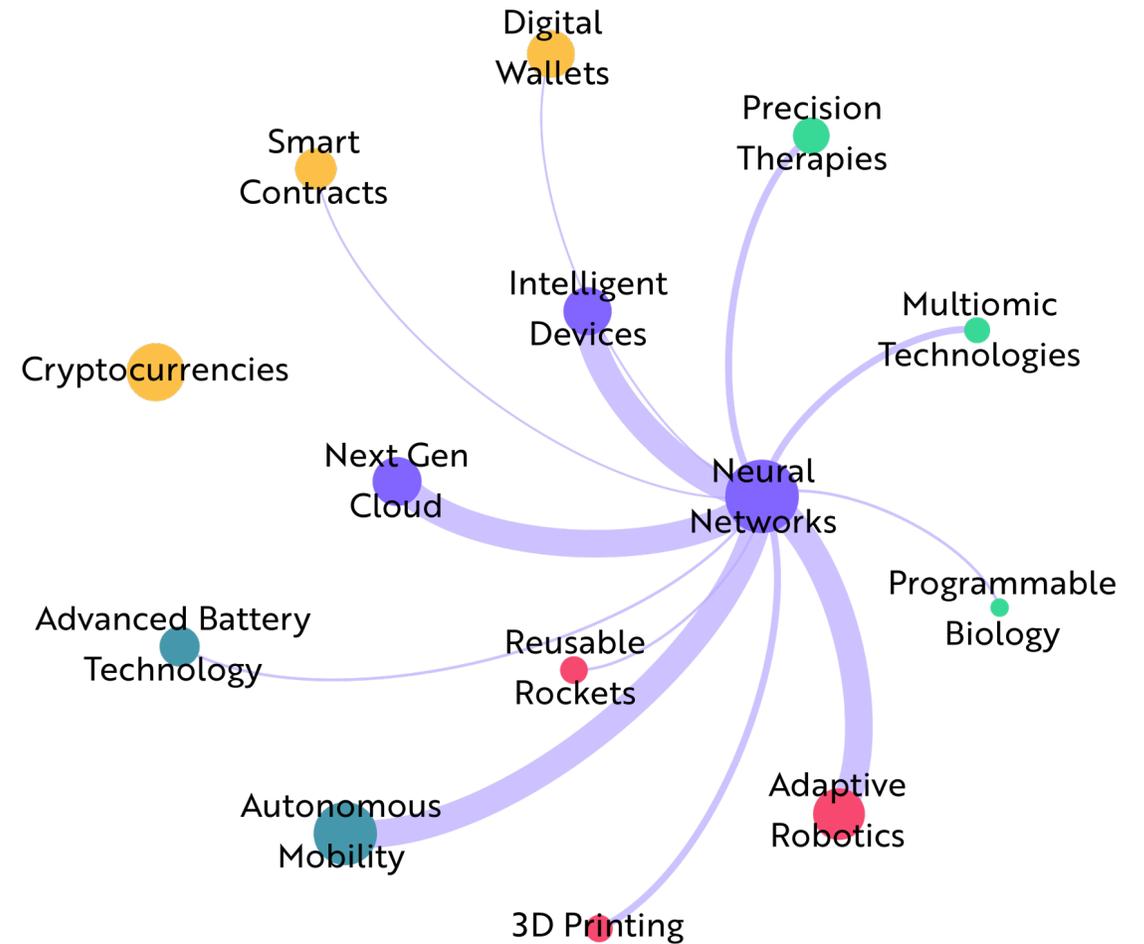


We Believe Neural Networks Could Be The Most Important Catalyst

Relative Importance as a Catalyst



Represents an order of magnitude increase in the commercial potential of another technology.

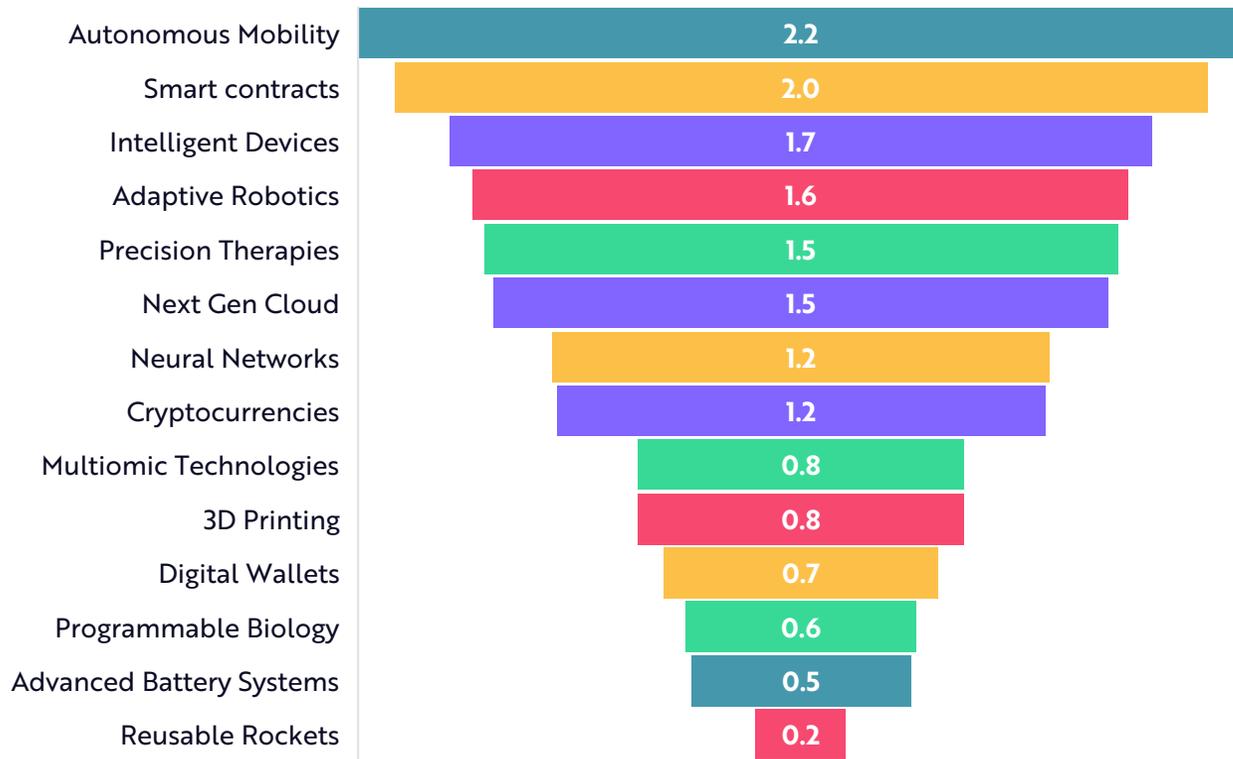


Sources: ARK Investment Management LLC, 2023. ARK’s convergence scoring framework measures the scale of impact that advances in one technology are likely to have on the potential market value of another. “Relative importance as a catalyst” measures the sum of convergence scores for each technology. Scoring is tuned such that a score of 1 corresponds to the potential to increase another technology’s market value by an order of magnitude. Scores are subject to ARK’s views and research and are subject to change. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

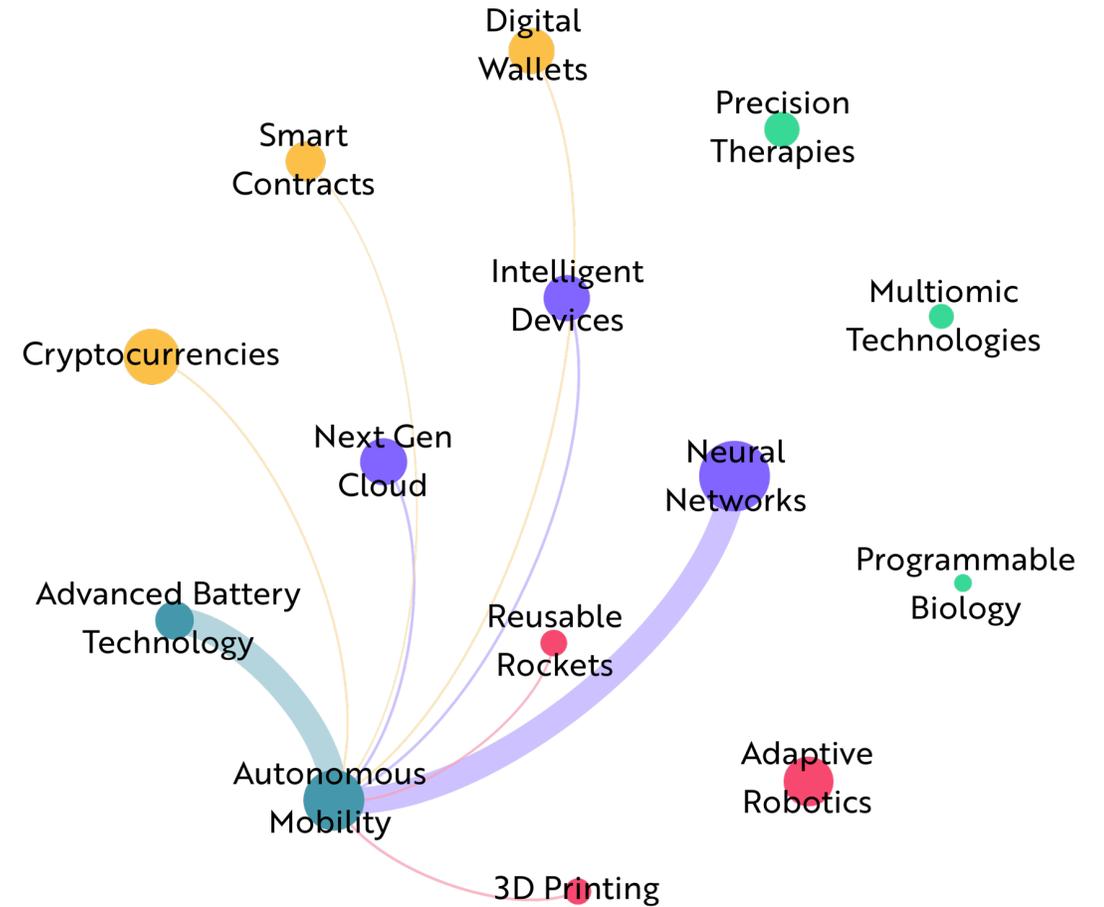


Autonomous Mobility Epitomizes The Convergence Among Technologies

Relative Sensitivity to Other Catalysts



Log of potential increase in addressable market based on other technological advances.

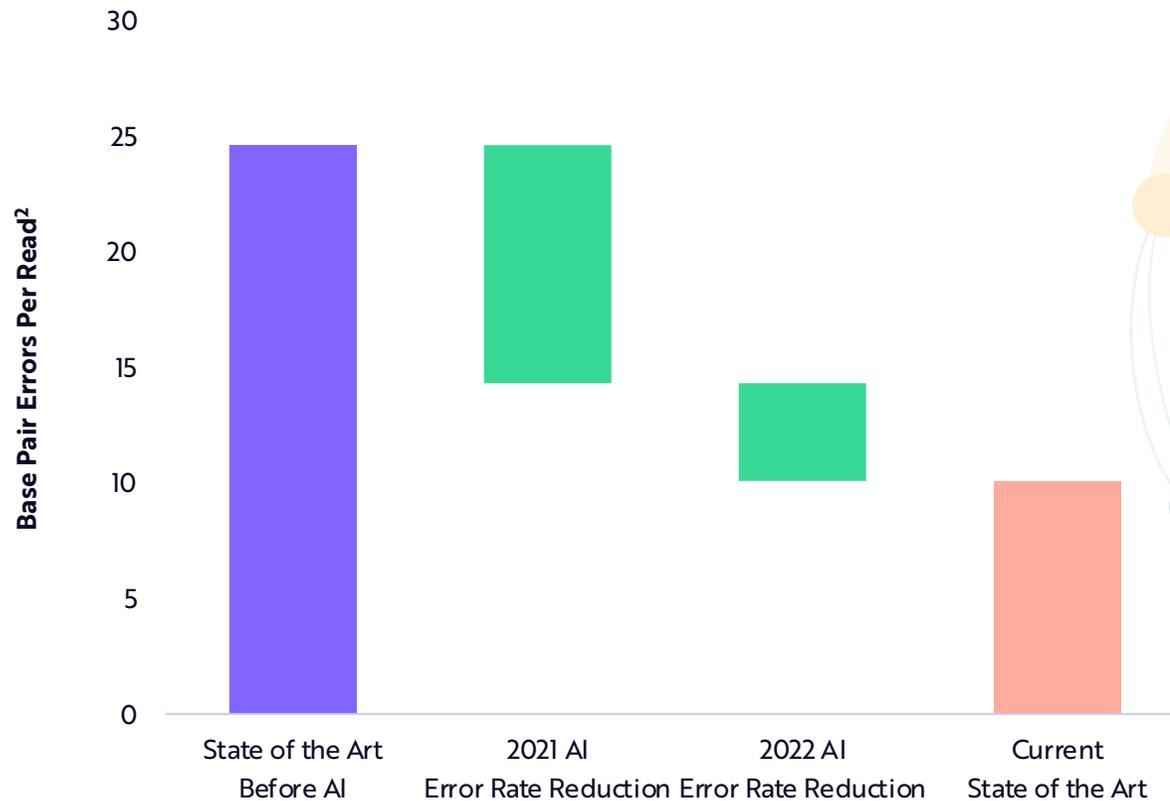


Sources: ARK Investment Management LLC, 2023. ARK’s convergence scoring framework measures the scale of impact that advances in one technology are likely to have on the potential market value of another. “Relative sensitivity to other catalysts” measures the inbound sum of convergence scores for each technology. Scoring is tuned such that a score of 1 corresponds to an order of magnitude potential increase in the technology’s market value. Scores are subject to ARK’s views and research and are subject to change. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

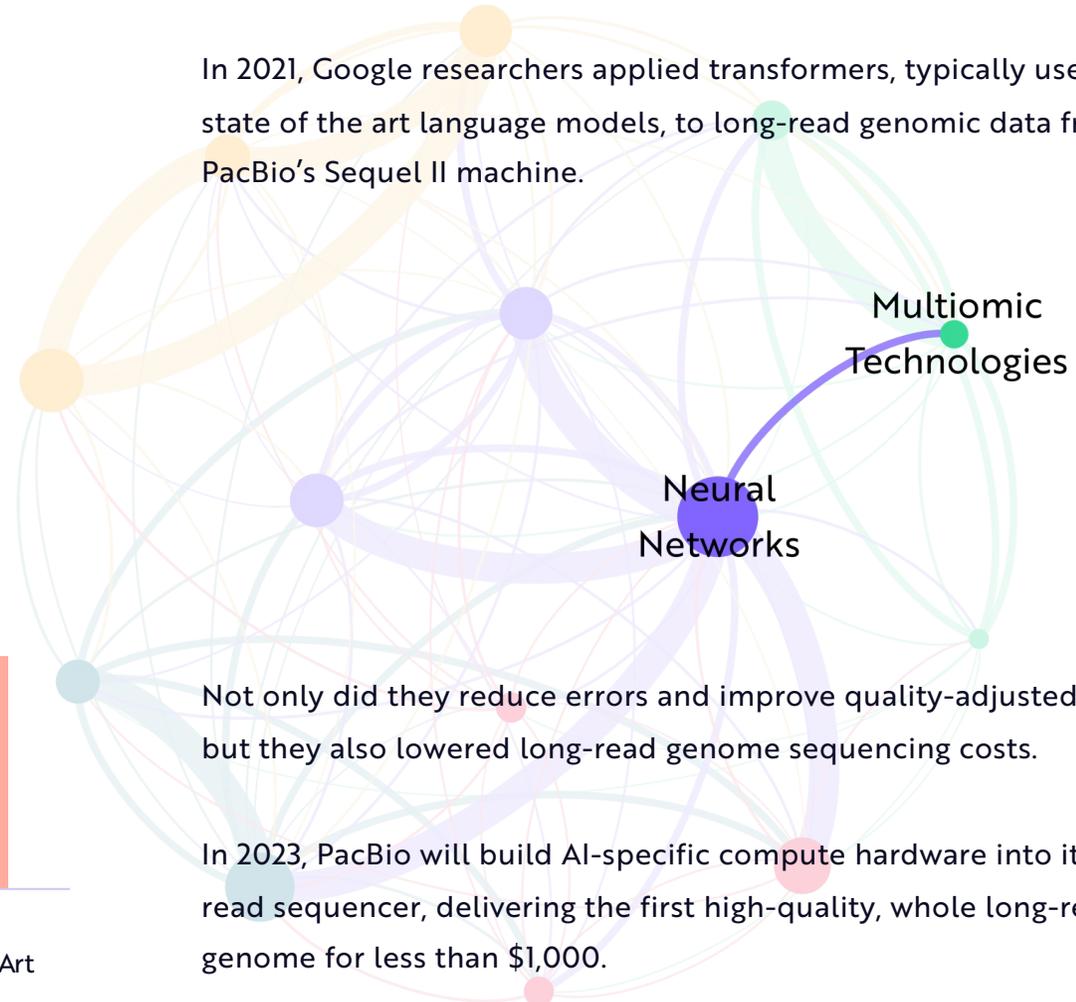


Deep Neural Networks Enable More Accurate Long-Read DNA Sequencing¹

Neural Networks Lower Long-Read DNA Sequencing Error Rates by 59%



In 2021, Google researchers applied transformers, typically used for state of the art language models, to long-read genomic data from PacBio’s Sequel II machine.



Not only did they reduce errors and improve quality-adjusted yields, but they also lowered long-read genome sequencing costs.

In 2023, PacBio will build AI-specific compute hardware into its long-read sequencer, delivering the first high-quality, whole long-read genome for less than \$1,000.

[1] DNA Sequencing is the process of determining the nucleic acid sequence – the order of nucleotides in DNA. It includes any method or technology that is used to determine the order of the four bases: adenine, guanine, cytosine, and thymine. Long-Read DNA Sequencing involves reading sequences of between 10,000 and 100,000 base pairs in one go (although much longer reads have also been reported), without the need to cut up and amplify DNA samples.

[2] A DNA read error occurs when a sequence assembler changes one DNA base for a different base.

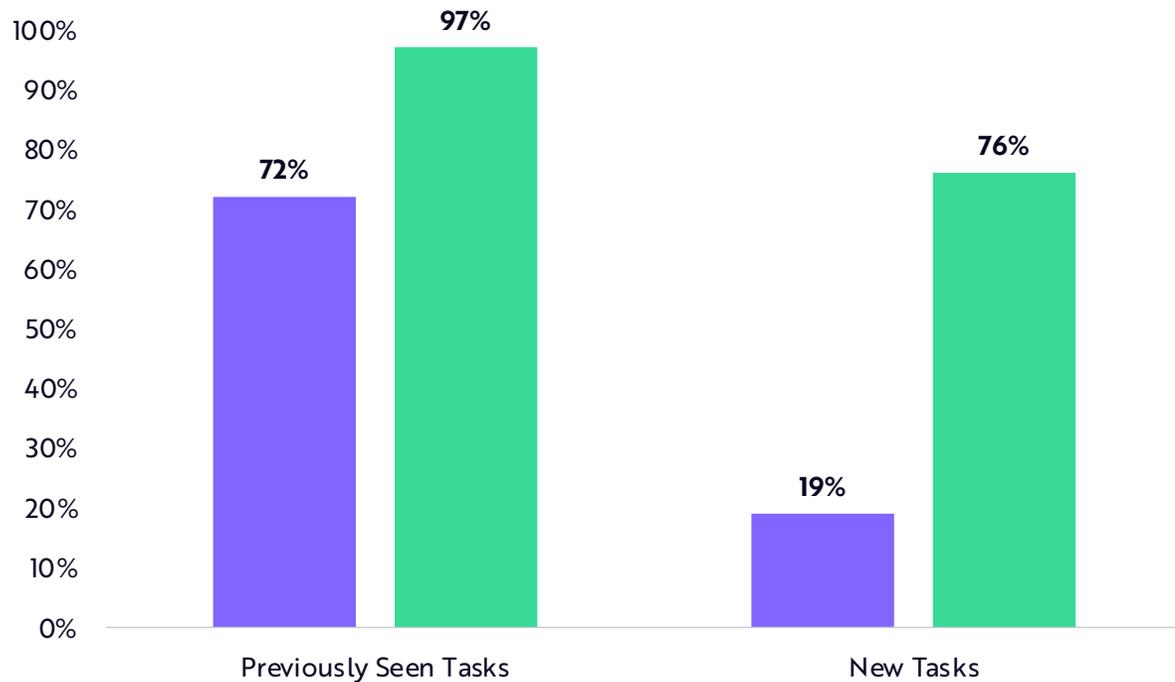
Sources: ARK Investment Management LLC, 2023. Baid, G. et al. 2022; Carroll, A. 2022; Lopez, L. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Robots Learn From Experience Thanks To Advances In AI Language Models

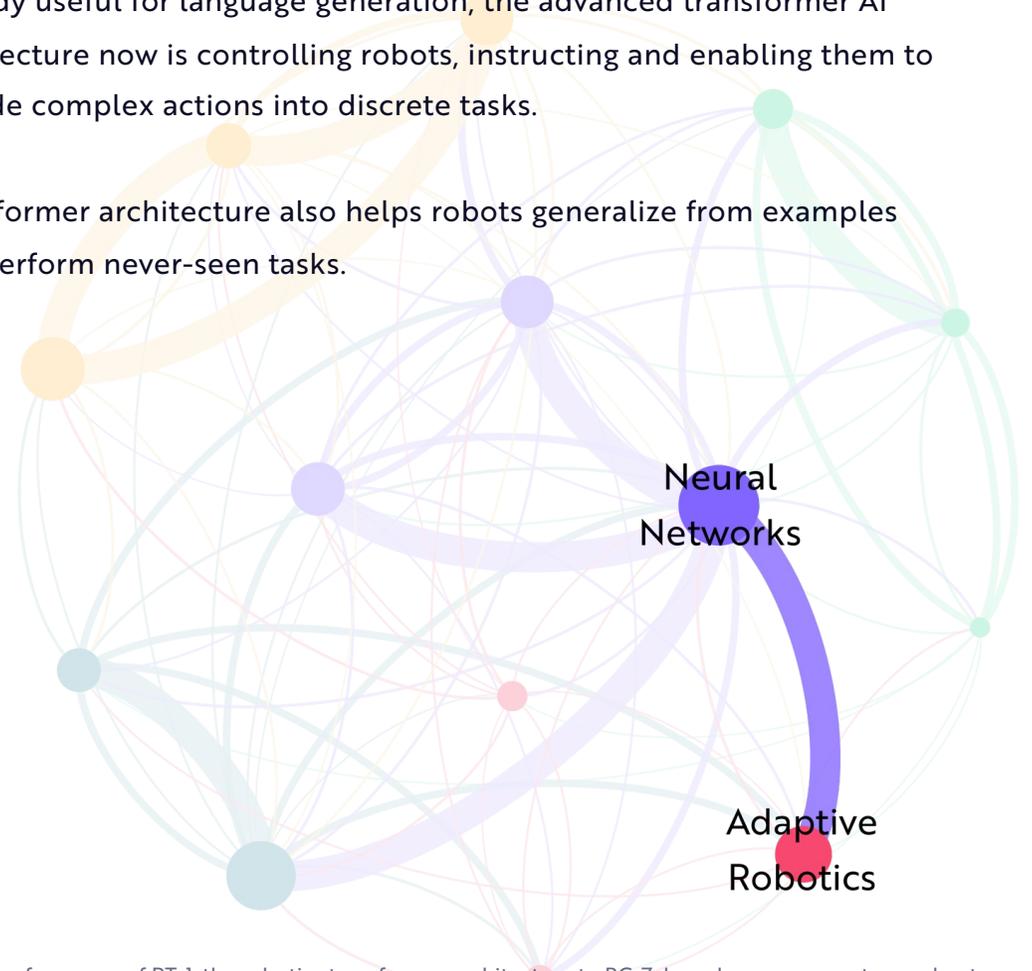
General Task Completion Success Rate

- Robot without AI language model architecture (2021)
- Robot with AI language model architecture (2022)



Already useful for language generation, the advanced transformer AI architecture now is controlling robots, instructing and enabling them to encode complex actions into discrete tasks.

Transformer architecture also helps robots generalize from examples and perform never-seen tasks.

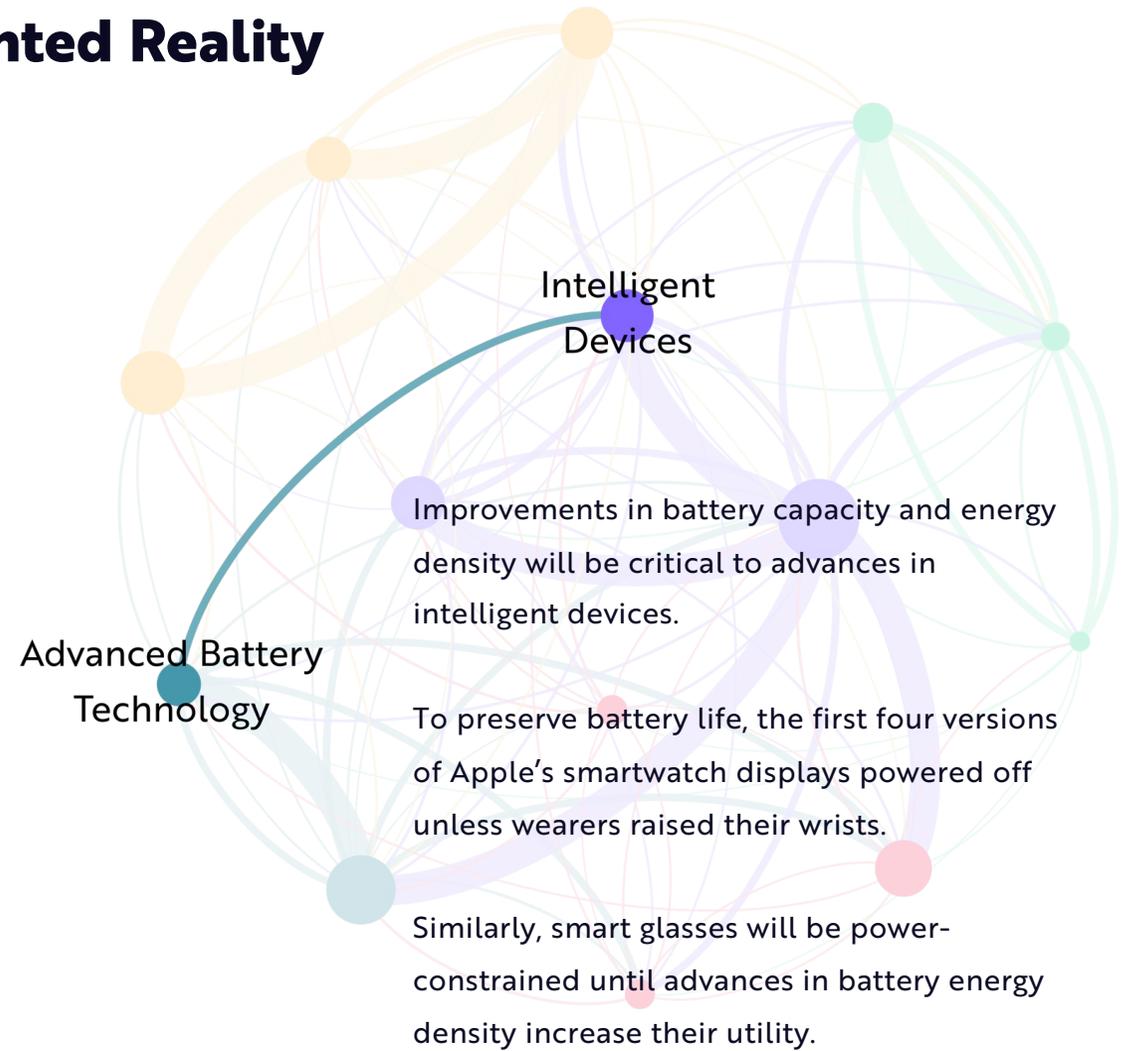
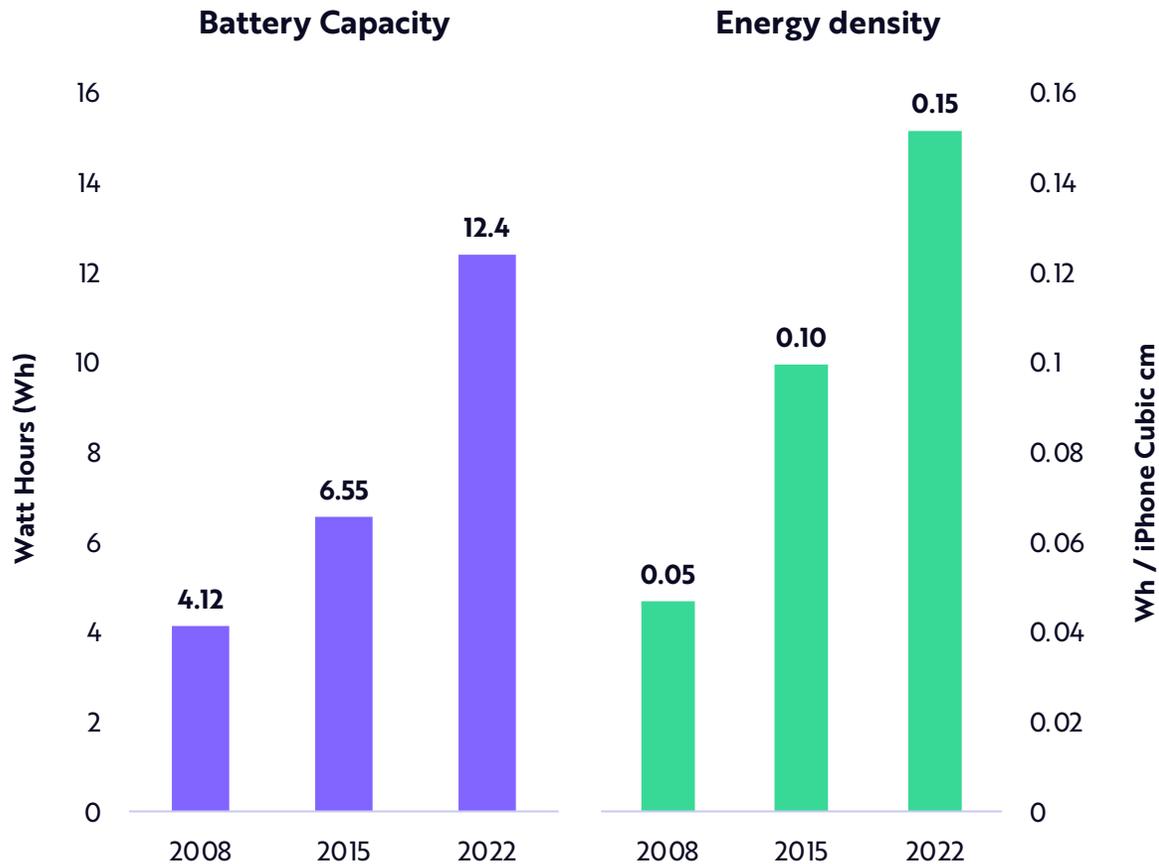


Sources: ARK Investment Management LLC, 2023. Gopalakrishnan, K. et al. 2022; Brohan, A. et al. 2022; Jang, E. et al. 2022. Compares performance of RT-1, the robotics transformer architecture to BC-Z, based on a recurrent neural net architecture. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Battery Advances Will Be Critical To Augmented Reality

iPhone Battery Evolution

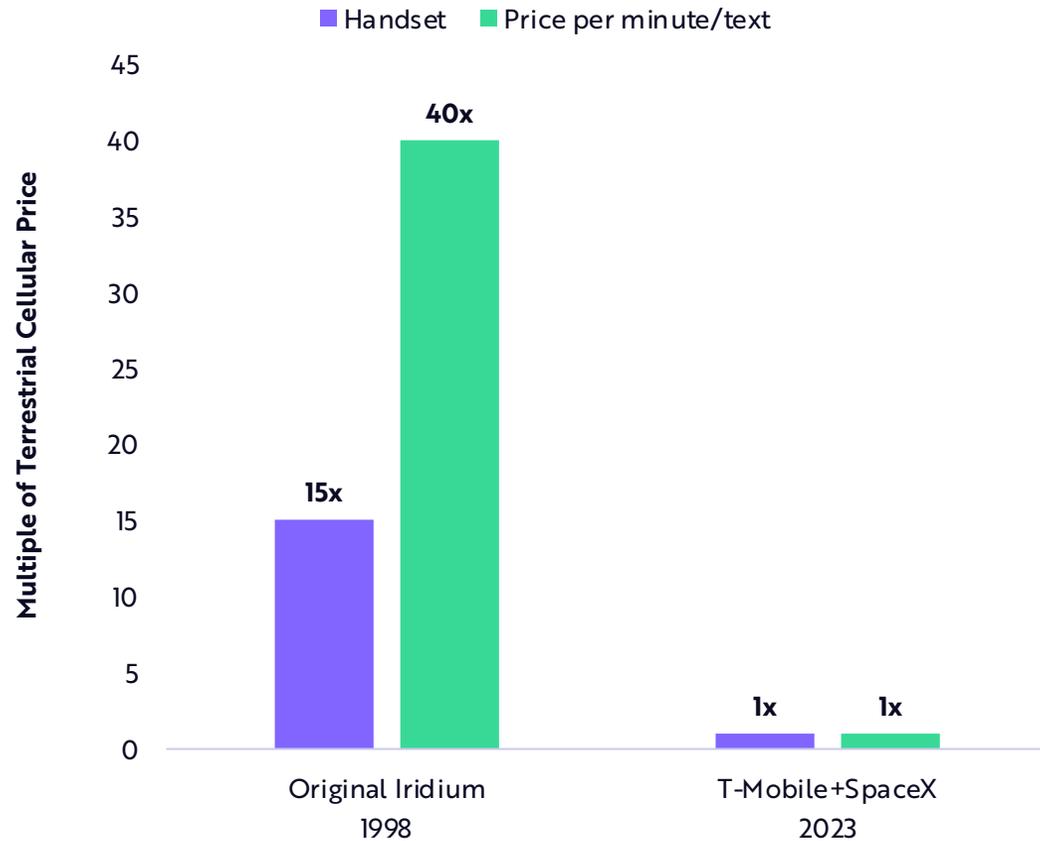


Sources: ARK Investment Management LLC, 2023. Apple, data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Reusable Rockets Deliver Satellite Power To Traditional Smartphones

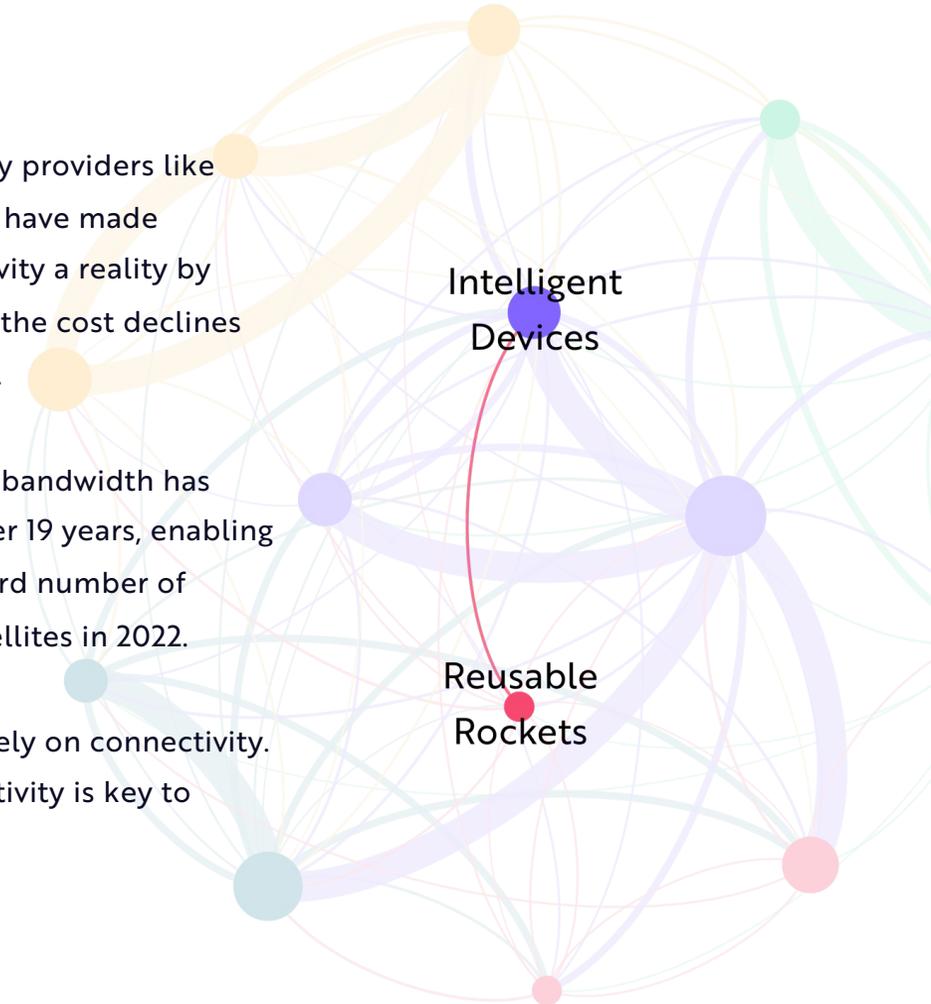
Satellite Price Premium to Terrestrial Cellular



Satellite connectivity providers like Iridium and Starlink have made worldwide connectivity a reality by taking advantage of the cost declines in re-usable rockets.

The cost of satellite bandwidth has fallen 7,500-fold over 19 years, enabling the launch of a record number of communication satellites in 2022.

Intelligent devices rely on connectivity. Inexpensive connectivity is key to universal access.



Sources: ARK Investment Management LLC, 2023. Gregson, R. 1999; Glasner, J. 1999; Hasenstab, B. 1998. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

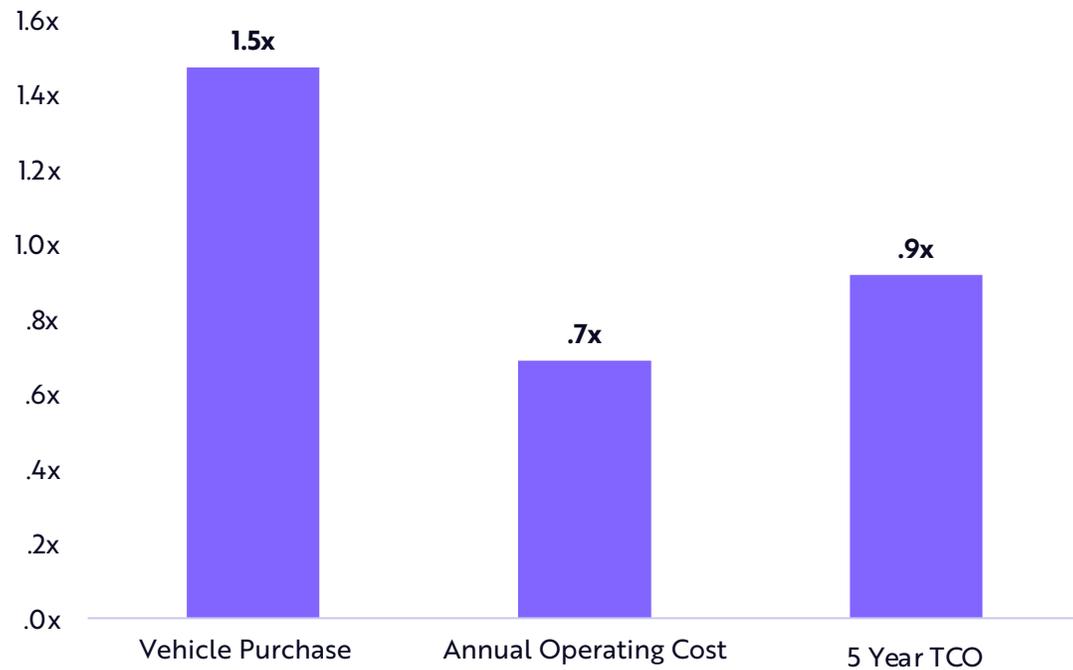


Disruptive Innovations Complicate The Meaning Of Economic Statistics

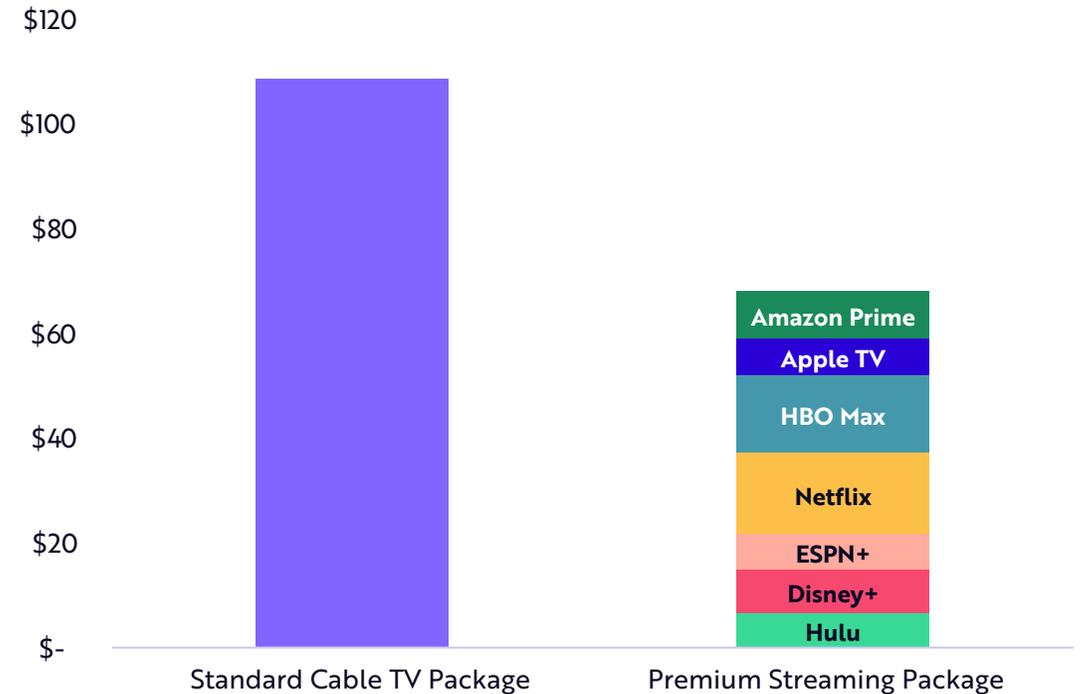
Consumers paying up for an electric vehicle are lowering future costs for better performing vehicles at a lower total cost of ownership (TCO). An EV purchase today leads to lower “output” in the future.

Cutting the cord from a cable package and shifting to streaming services could hurt economic measures but boost the value of entertainment.

**Tesla Model 3 Versus Toyota Camry
Cost Differential**



Monthly Cost for Video Entertainment



Sources: ARK Investment Management LLC, 2023. Edmunds.com, Inc., data as of 01/27/23; Afonso, C. 2022. Cost of ownership as measured over 5 years at 15,000 miles per year. Assumes IRA tax credit. Assumes same depreciation rate for Model 3 versus Camry. Assumes EV maintenance costs at 45% of internal combustion. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Artificial Intelligence

Creating The Assembly Line For Knowledge Workers¹

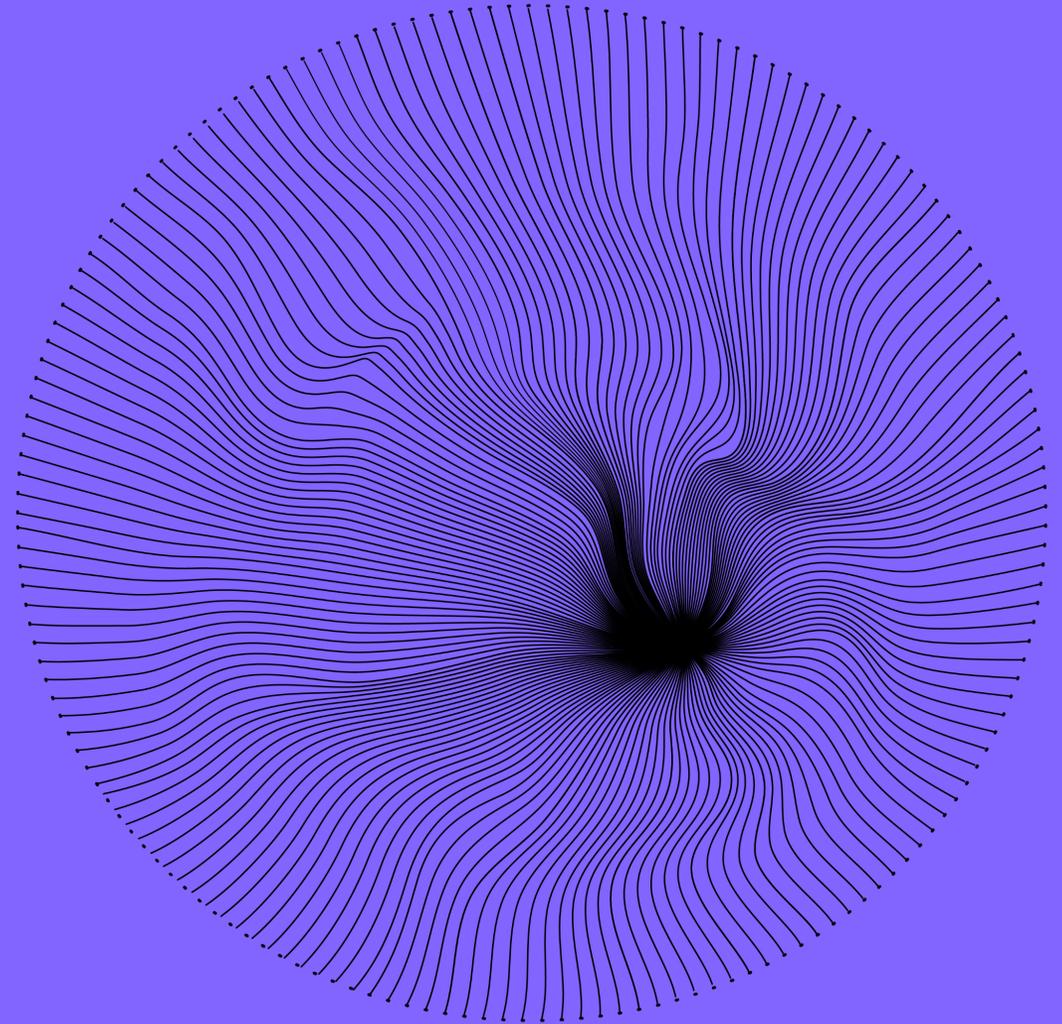
Generative AI made waves this year, from DALL-E-2² to ChatGPT.³ These tools are improving the productivity of knowledge workers—~2x in the case of AI coding assistants.

AI training cost declines continued at an annual rate of 70%, the cost to train a large language model to GPT-3 level performance collapsing from \$4.6 million in 2020 to \$450,000 in 2022.

Research by William Summerlin, Co-Lead, ARK Venture & Analyst
Frank Downing, Director of Research, Next Generation Internet

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

[1] Knowledge workers are workers whose main capital is knowledge. Examples include programmers, physicians, pharmacists, architects, engineers, scientists, design thinkers, public accountants, lawyers, editors, and academics, whose job is to "think for a living". [2] DALL-E 2 is a new AI system that can create realistic images and art from a description in natural language. [3] ChatGPT is a chatbot (or "bot") powered by artificial intelligence (AI). You can have a conversation with it, prompt it to write essays, create recipes, make medical diagnoses, mimic famous authors, and code software. ChatGPT was developed by OpenAI and launched in November 2022.



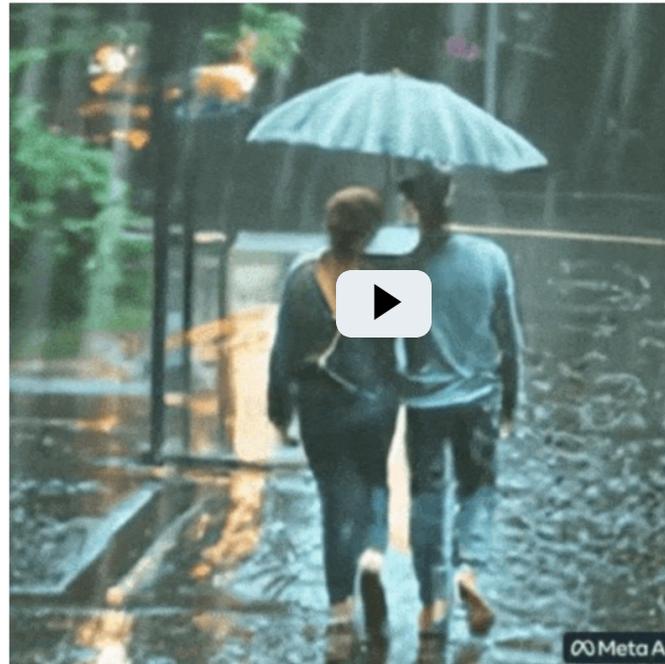


2022 Was The Year Of Generative AI

Prompted by a short text, generative AI models can produce images, code, text, audio, and video. In less than one year, dozens of generative AI projects created models that progressed from grainy images to high-quality 3D models and videos.



DALL-E 2: "An astronaut riding a horse"
Publicly available September 2022



Meta Make-A-Video
Announced September 2022



Open-Source Stable Diffusion 2.0:
Released November 2022

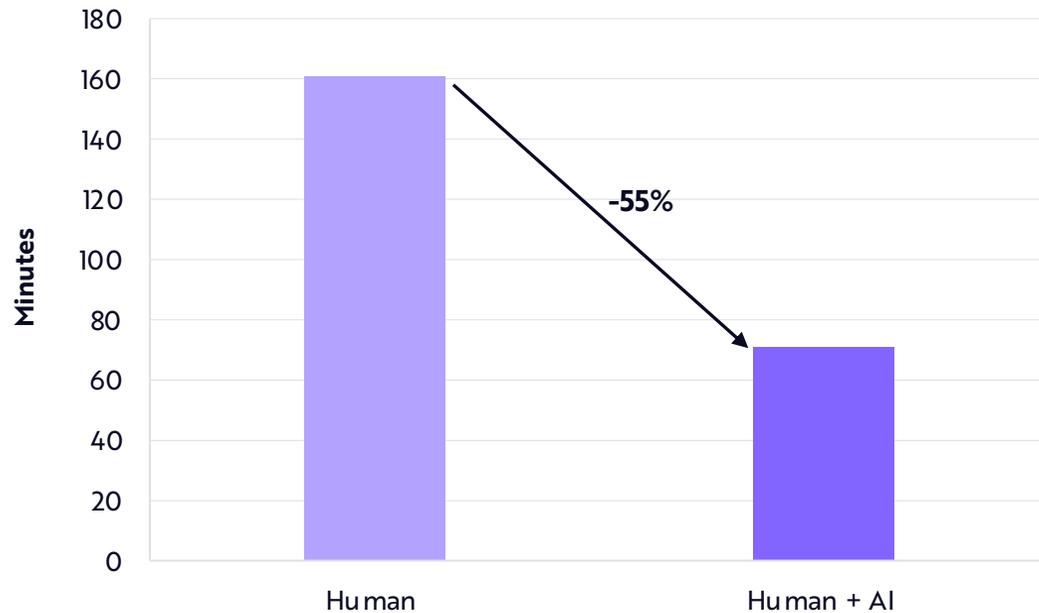


AI Is Increasing The Productivity Of Knowledge Workers

Coding Assistants

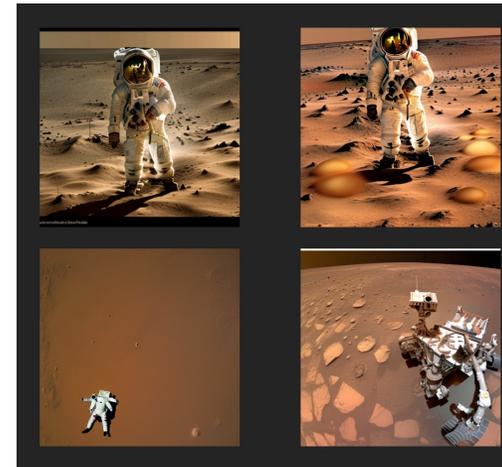
Software engineers completed a coding task in less than half the time with AI coding assistant GitHub Copilot.

Time to Complete Coding Tasks: 2022*



Generative Image Models

According to our research, AI can create a graphic design for just \$0.08** in minutes – a *di minimis* cost compared to \$150 for human labor.



Human	
Cost	\$150
Time	5 Hours
↓	
Generative AI	
Cost	\$0.08
Time	< 1 Minute

*Based on data from GitHub. **Generative AI models translated “ a picture of an astronaut on Mars” into multiple images in just a few seconds. Sources: ARK Investment Management LLC, 2023. Kalliamvakou, E. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

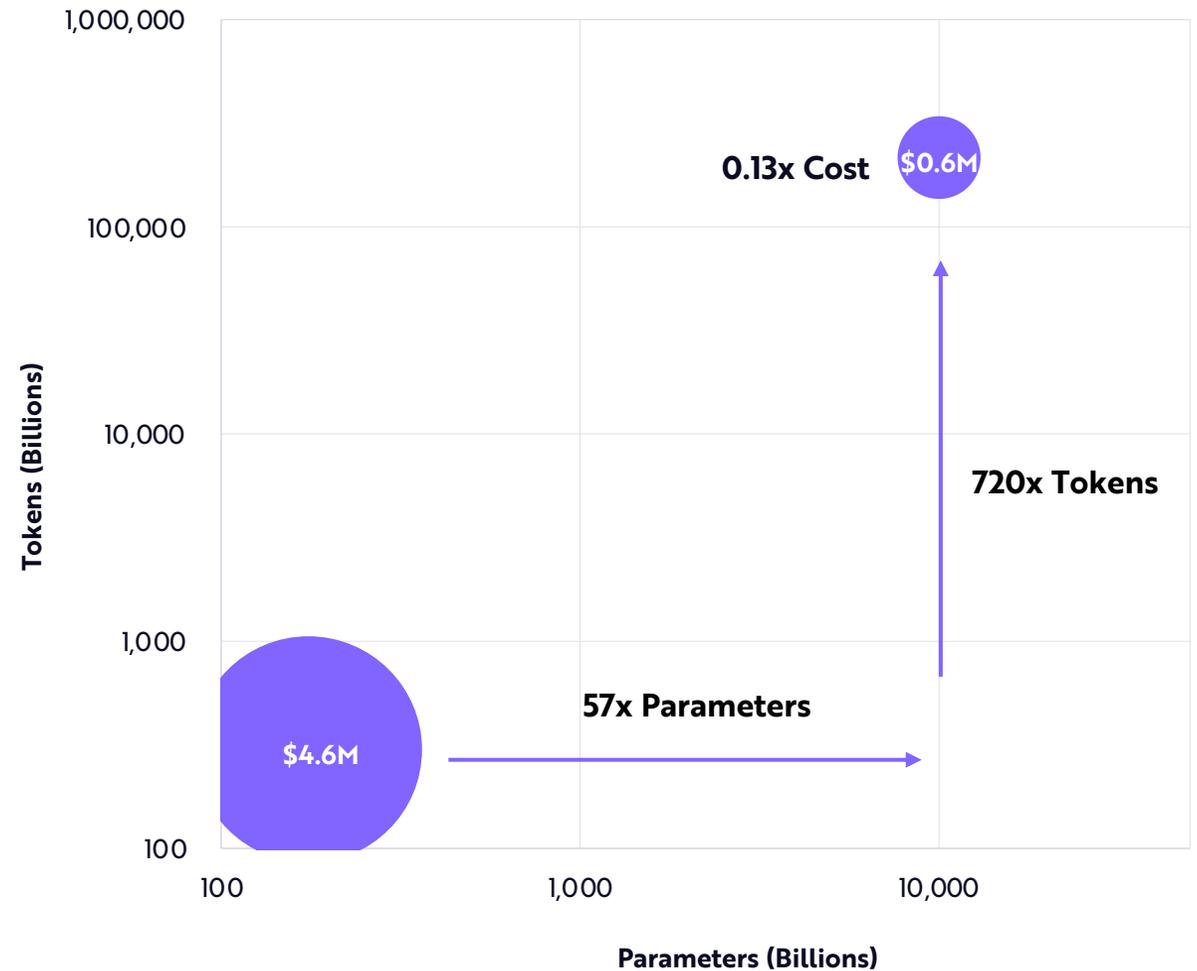


AI Is Creating Explosive Demand For Training Data

The cost to train the state-of-the-art GPT-3 in 2020 was \$4.6 million. Based on our modeling, the cost of training an AI model with 57x more parameters and 720x more tokens¹ than GPT-3 would drop from \$17 billion today to \$600,000 by 2030.

For perspective, Wikipedia's 4.2 billion words today represent roughly 5.6 billion tokens. Training a model with 162 trillion words, or 216 trillion tokens, should be possible in 2030. In a world of low-cost compute, data will become the primary constraint.

GPT-3 Capability Today vs. Projected Capability In 2030

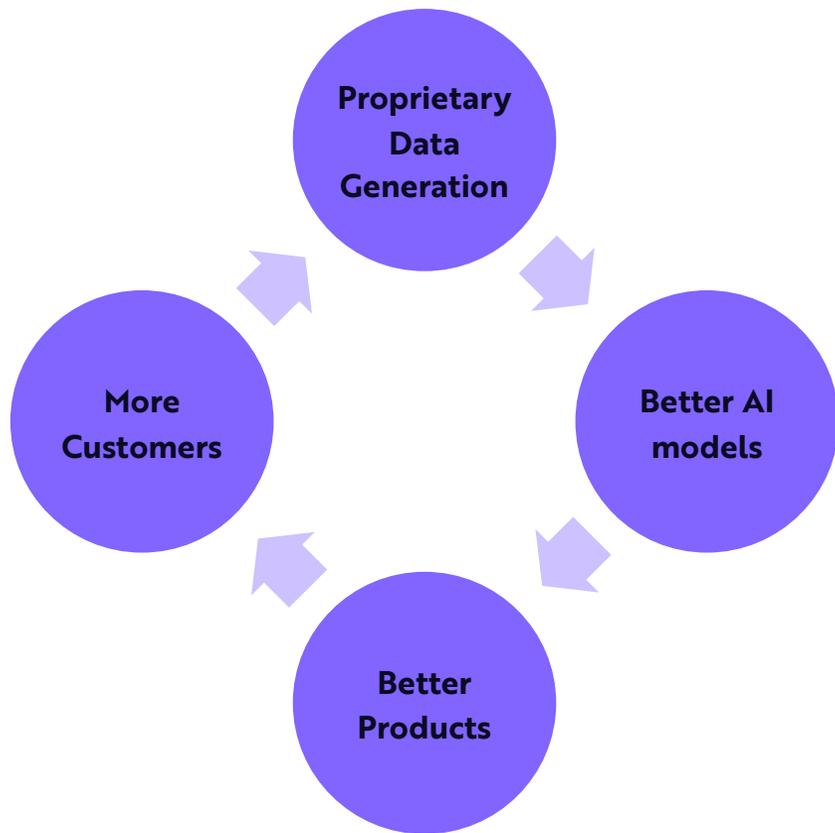


[1] A token is an instance of a sequence of characters in some particular document that are grouped together as a useful semantic unit for processing. A type is the class of all tokens containing the same character sequence. Sources: ARK Investment Management LLC, 2023. Wikipedia 2023; Hoffmann, J. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Proprietary Data Could Create Moats

High-quality domain-specific AI training data could result in winner-takes-most outcomes across vertical applications.



Domain	Autonomous Driving	Software Development	Dialogue
Data Metric	Recorded real-world driving miles	Lines of code	Logged conversations
Feedback Loop	Autonomous disengagements	Rejected code	Rephrased questions
Company Example	Tesla	Replit	Twilio



Digital Consumers

Transitioning To Online Leisure

In 2022, digital leisure spending* totaled \$6.6 trillion.

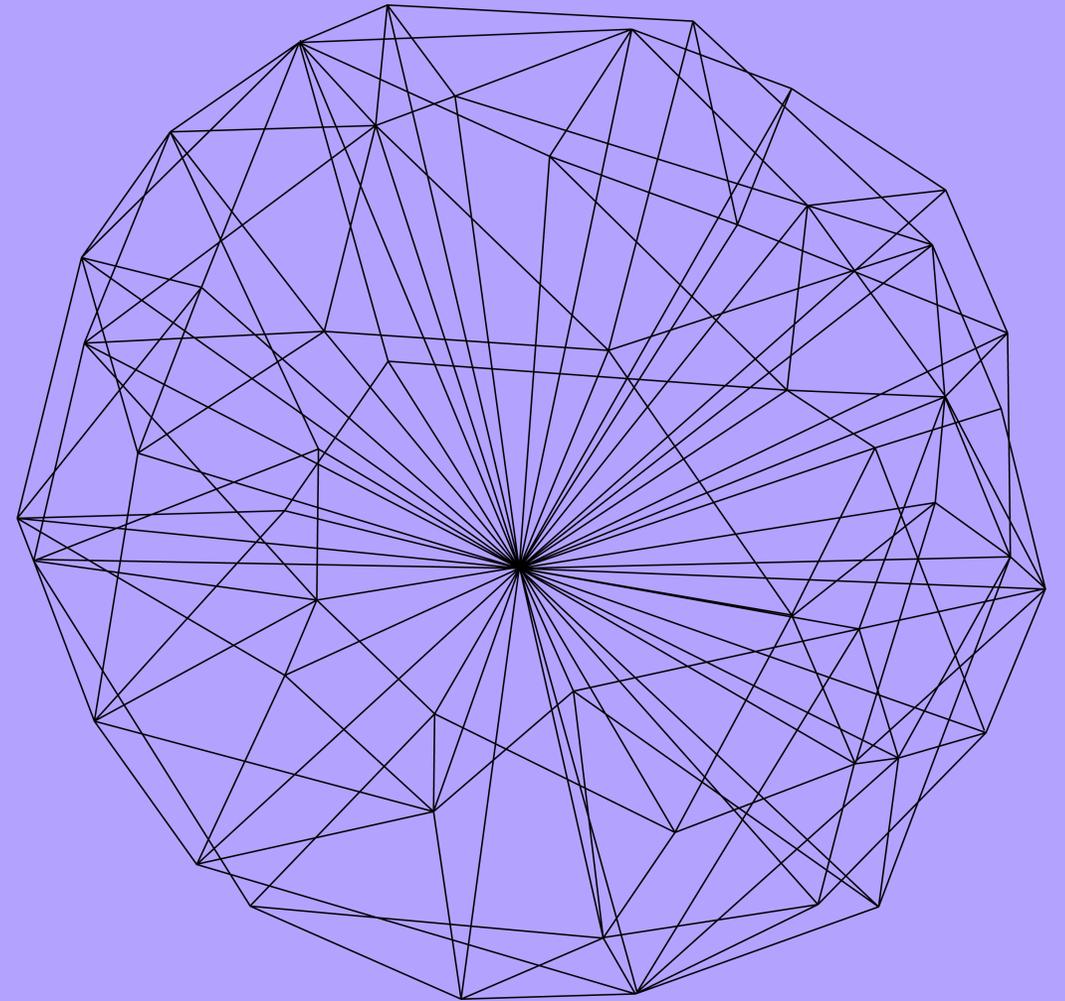
Connected TV (CTV): Roughly 85% of US households have access to at least one CTV, but the CTV ad market is only 23% the size of total US TV ad budgets. In our view, CTV is at an inflection point and will take share from both linear TV and other digital ad budgets.

New Social Platforms: Nearly 40% of Gen Z consumers prefer to search on TikTok and Instagram over Google Search and Maps. Social platforms with the best recommendation engines should command the majority of ad budgets, with content-based social media likely outperforming follow-and-feed social media.

Sports Betting: Despite macro headwinds, consumer demand for sports betting remains strong. Legalization of online/mobile sports betting should continue to catalyze growth.

Gaming: The convergence of video games and social media should sustain gaming revenue growth. Video games should provide end-to-end virtual entertainment that rivals physical experiences.

Research by Nicholas Grous, Associate Portfolio Manager & Andrew Kim, Research Associate

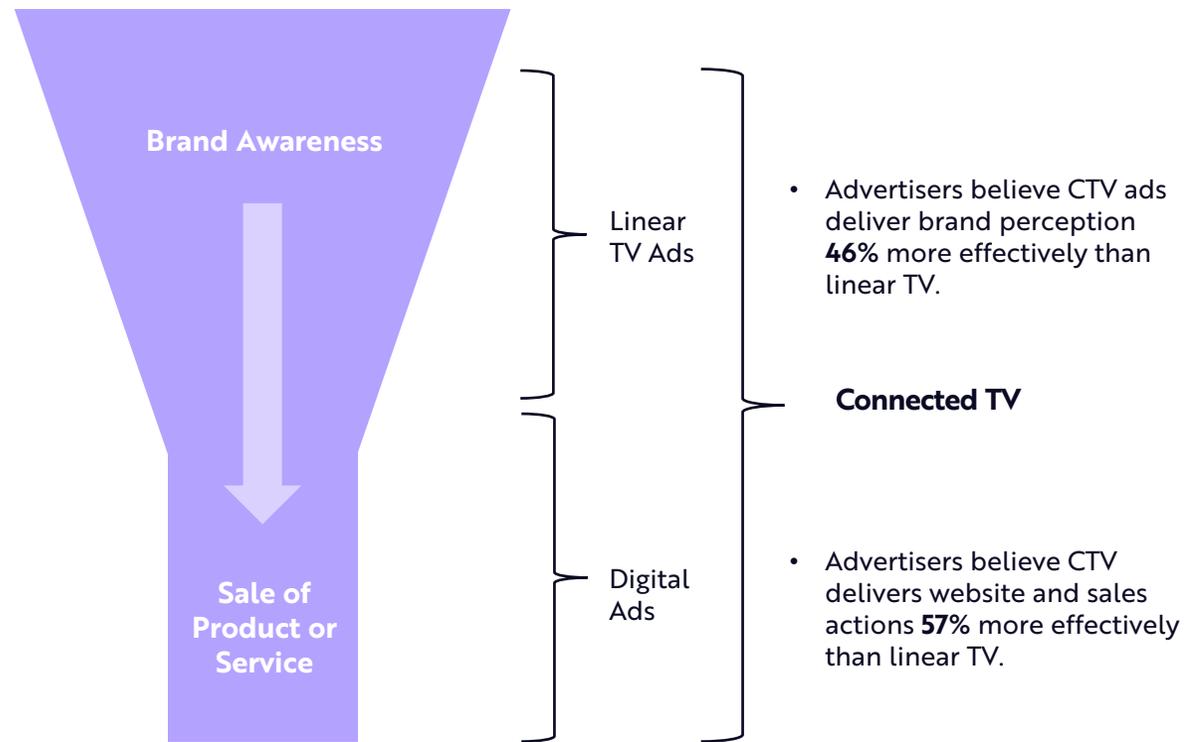


*We define digital leisure spending as the sum of consumer expenditures on leisure-related goods and services purchased online, NFTs, online sports betting, video game software and services, streamed video, and streamed audio. We only estimate online sports betting volume generated in Canada and the US. Sources: ARK Investment Management LLC, 2023; Altruda, C. 2022; Roblox, data as of 12/30/22; S&P Global Market Intelligence, data as of 01/25/23. The World Bank, data as of 12/30/22; Insider Intelligence, data as of 01/02/23; S&P Global Market Intelligence, data as of 01/25/23; Perez, S. 2022; Statista, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

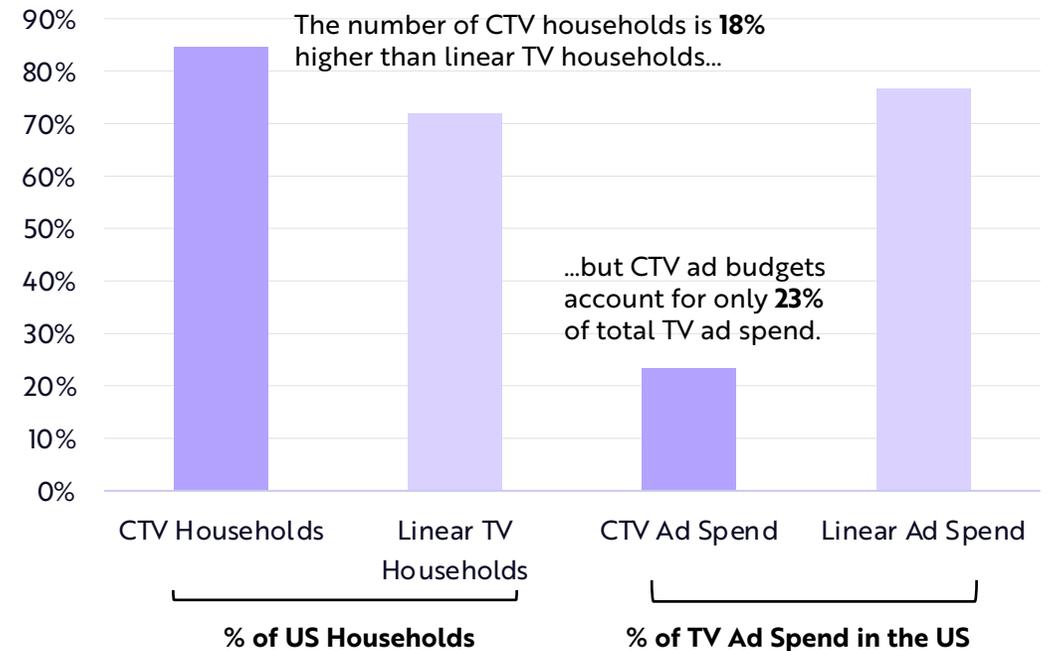


Advertisers Have Yet To Unlock The Potential Of CTV

CTV provides advertisers with the targeting and attribution measurement once reserved for traditional digital advertisers. Combining the advantages of linear TV and digital advertising, CTV could capture share of both brand and performance ad budgets.* A meaningful disconnect exists between viewership and advertising budgets in the US. In our view, advertisers will close the gap within the next five years.



**Viewership vs. Ad Spend
US CTV vs. Linear TV, 2022**



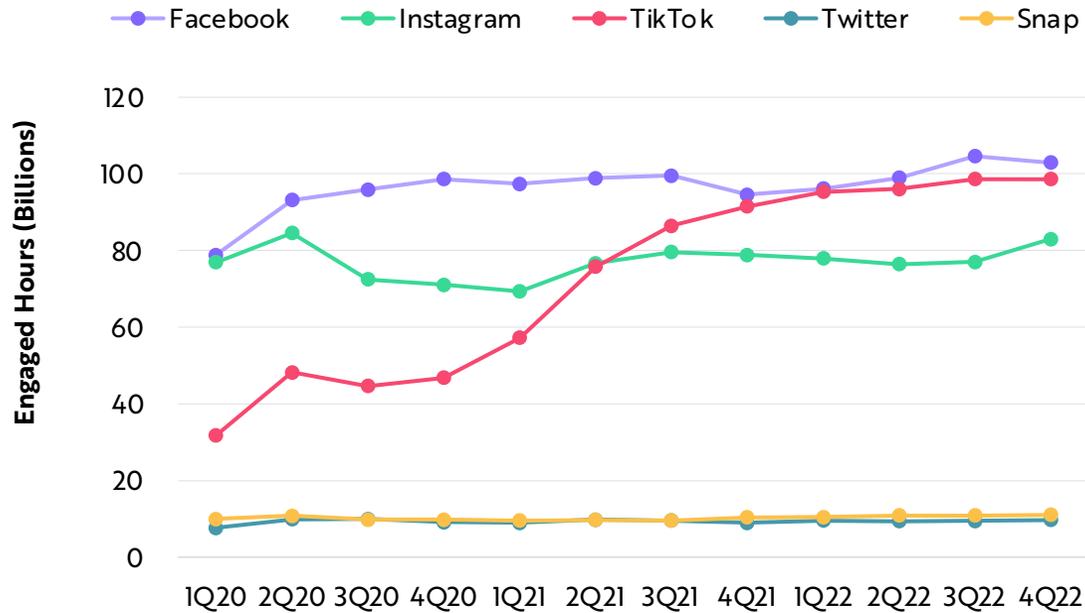
*We view a connected TV household as any household owning at least one large-screen display that can stream over-the-top (OTT) content natively through a built-in operating system (OS), external streaming media devices, video game consoles, etc. We define a linear TV household as any household that views TV via traditional pay TV subscriptions and/or free over-the-air broadcast. A single household may both be a connected TV household and a linear TV household. Sources: ARK Investment Management LLC, 2023. IAB 2022; Insider Intelligence, data as of 01/12/23; Insider Intelligence, data as of 01/12/23; S&P Global Market Intelligence, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



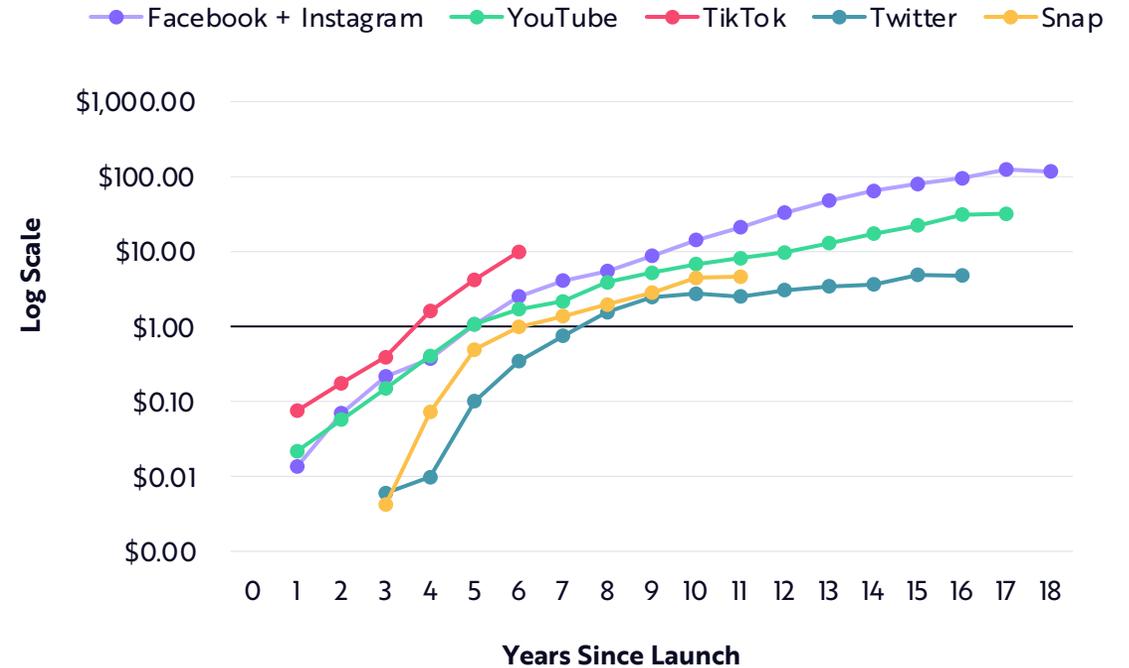
Short-Form Video And Recommendation Engines Are Displacing Incumbent Social Media

In 2022, TikTok and Facebook were roughly equal in engagement hours, which could mark the peak in traditional follow-and-feed social media. Despite scaling faster than other social media platforms, TikTok* accounted for only \$10 billion, or 2% market share, of the estimated \$470 billion spent on search, video, and social ads in 2022. Content-based social media is likely to capture advertising share more in line with its engagement hours.

**Global Hours Spent on Mobile Social Apps*
(iOS and Android)**



**Social Platform Ad Revenues*
(Annual Real 2022 \$, Billions)**



*Estimates for TikTok’s engagement hours do not include Douyin. Sources: ARK Investment Management LLC, 2023. Unified, data as of 01/02/23; Tsotsis, A. 2012; Meta Platforms, Inc., data as of 12/30/22; Arrington, M. 2007; Insider Intelligence, data as of 12/22/22; Alphabet, data as of 12/30/22; Iqbal, M. 2022; Twitter, Inc., data as of 12/30/22; Wilhelm, A. 2013; Colao, J. 2012; Snap Inc., data as of 12/30/22. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Digital Wallets

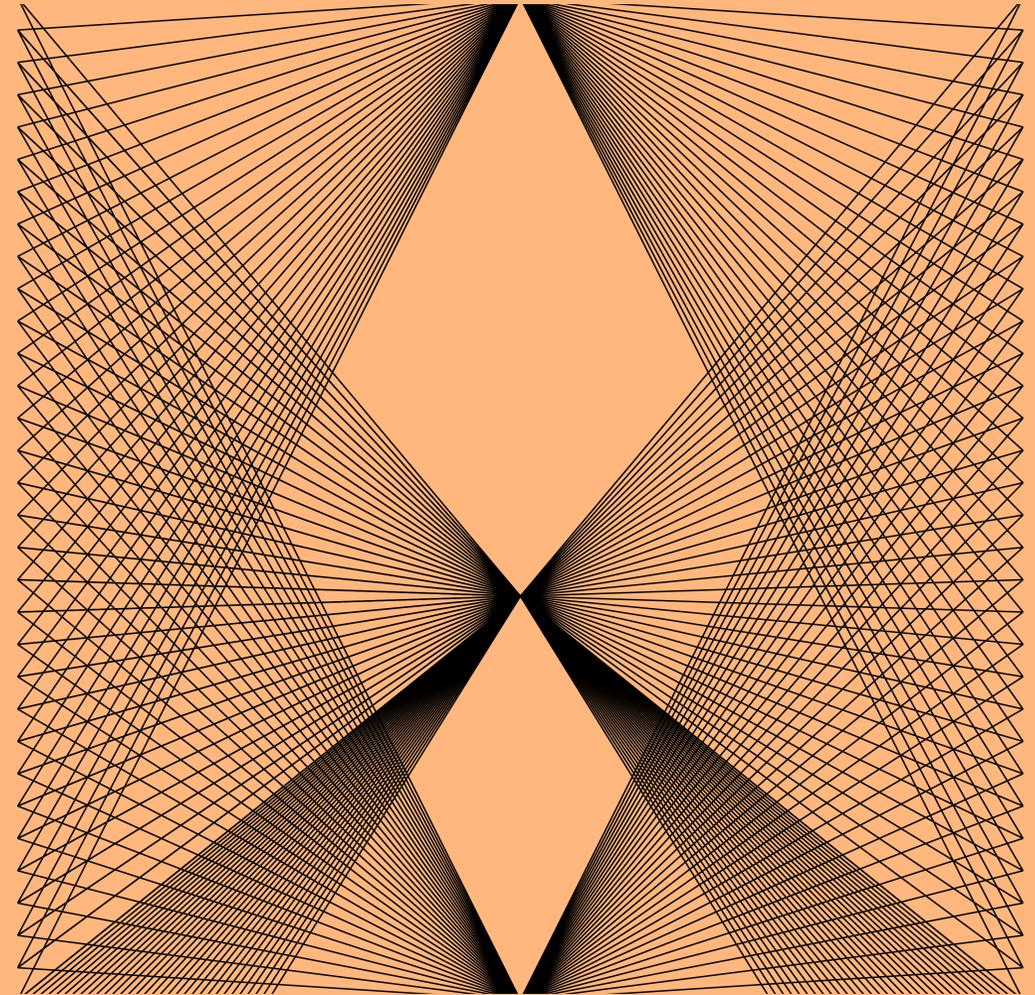
Disintermediating Traditional Banking

Having onboarded billions of consumers and millions of merchants, digital wallets could transform the economics associated with traditional payment transactions.

With 3.2 billion users, digital wallets have penetrated 40% of the global population.

As consumers and merchants adopt digital wallets, the usage of traditional checking accounts, credit and debit cards, and direct merchant accounts should decline, disrupting traditional payment intermediaries.

**Research by Maximilian Friedrich, Co-Lead, ARK Venture & Analyst
Andrew Kim, Research Associate**





Definitions, Risk & Disclosure Associated with Digital Wallets

Disruptive Innovation Risk. Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. Companies that initially develop a novel technology may not be able to capitalize on the technology. Companies that develop disruptive technologies may face political or legal attacks from competitors, industry groups or local and national governments. These companies may also be exposed to risks applicable to sectors other than the disruptive innovation theme for which they are chosen, and the securities issued by these companies may underperform the securities of other companies that are primarily focused on a particular theme.

Financial Technology Risk. Companies that are developing financial technologies that seek to disrupt or displace established financial institutions generally face competition from much larger and more established firms. Fintech Innovation Companies may not be able to capitalize on their disruptive technologies if they face political and/or legal attacks from competitors, industry groups or local and national governments. Blockchain technology is new and many of its uses may be untested. Blockchain and Digital commodities and their associated platforms are largely unregulated, and the regulatory environment is rapidly evolving. As a result, companies engaged in such blockchain activities may be exposed to adverse regulatory action, fraudulent activity or even failure.

Software Industry Risk. The software industry can be significantly affected by intense competition, aggressive pricing, technological innovations, and product obsolescence. Companies in the software industry are subject to significant competitive pressures, such as aggressive pricing, new market entrants, competition for market share, short product cycles due to an accelerated rate of technological developments and the potential for limited earnings and/or falling profit margins. These companies also face the risks that new services, equipment or technologies will not be accepted by consumers and businesses or will become rapidly obsolete. These factors can affect the profitability of these companies and, as a result, the value of their securities. Also, patent protection is integral to the success of many companies in this industry, and profitability can be affected materially by, among other things, the cost of obtaining (or failing to obtain) patent approvals, the cost of litigating patent infringement and the loss of patent protection for products (which significantly increases pricing pressures and can materially reduce profitability with respect to such products). In addition, many software companies have limited operating histories. Prices of these companies' securities historically have been more volatile than other securities, especially over the short term.

Internet Company Risk. Many Internet-related companies have incurred large losses since their inception and may continue to incur large losses in the hope of capturing market share and generating future revenues. Accordingly, many such companies expect to incur significant operating losses for the foreseeable future and may never be profitable. The markets in which many Internet companies compete face rapidly evolving industry standards, frequent new service and product announcements, introductions and enhancements, and changing customer demands. The failure of an Internet company to adapt to such changes could have a material adverse effect on the company's business.

Wallet Definitions and Risks:

Desktop wallets: Desktop wallets are software that can be downloaded to your PC or laptop that allow you to store your private keys on that computer.

Mobile app wallets: Mobile app wallets are apps that let you store your keys on your mobile device. Many mobile app wallets allow you to use your cryptocurrencies for small retail transactions with certain businesses.

Private Key. A private key is like a password — a string of letters and numbers — that allows you to access and manage your crypto funds.

Online wallets: Online wallets are a type of software that lets you store and access your keys from any Internet-connected device. In this case, your private keys are stored remotely on third-party servers owned by the provider of the online wallet. You create a username and password just as you would for a traditional online bank account and then you are able to use the software easily. Online wallets are commonly associated with cryptocurrency exchanges, which are entities that facilitate the trading of fiat currency for cryptocurrencies.

Digital Wallet Risk. Digital wallets are convenient because you don't have to memorize your private key, write it down or store it elsewhere. However, a downside of wallets is that they, like any service connected to the Internet, are vulnerable to hackers and malicious code. Desktop and mobile app wallets that store keys locally on a device are susceptible to loss, destruction and theft. For example, if you lose your phone that has a mobile app wallet that stores your cryptocurrency keys, you may permanently lose your investment.

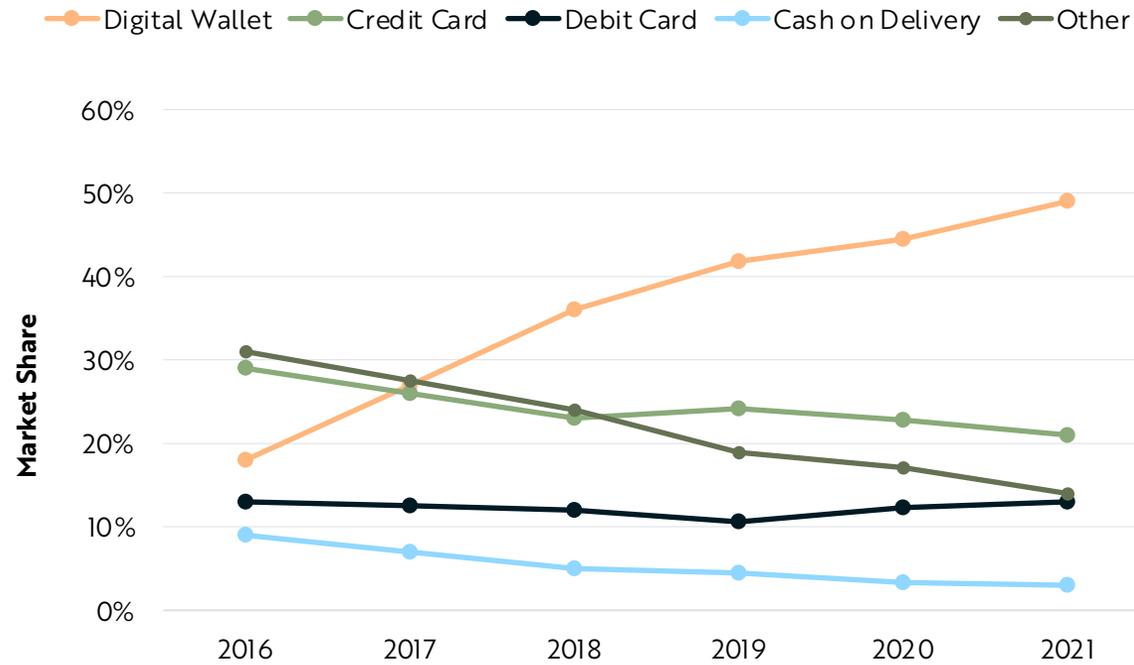


Digital Wallets Are Gaining Share In Online And Offline Transactions

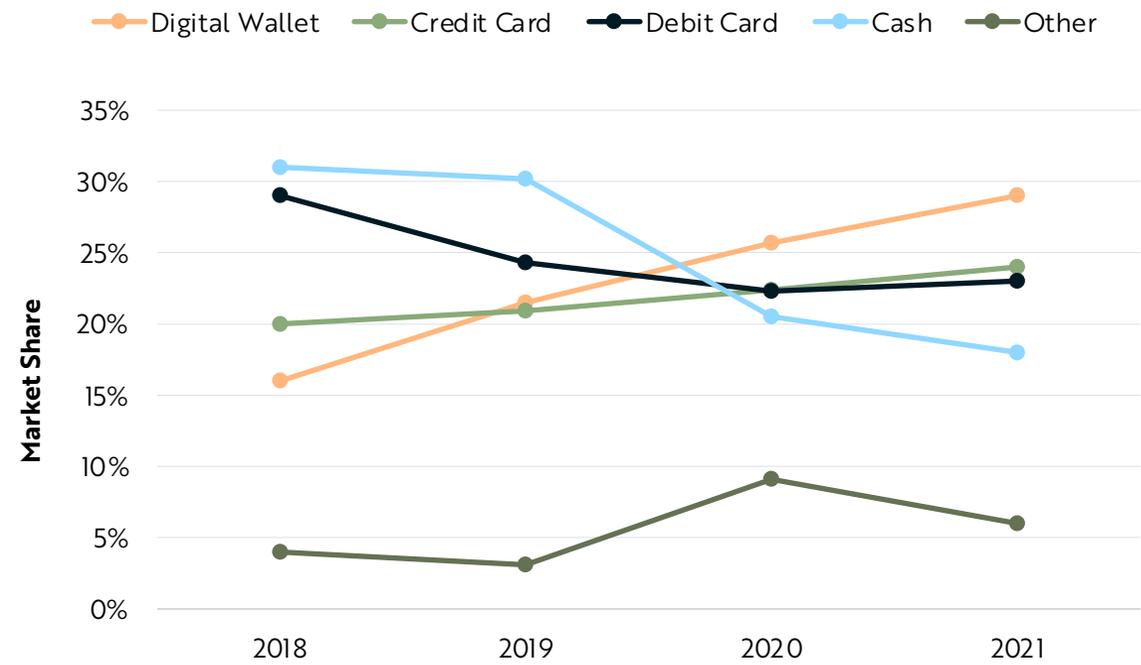
In 2021, digital wallets facilitated 49% of e-commerce transactions, up from 18% in 2016. Since 2016, digital wallets have been gaining share at the expense of credit cards, bank transfers, and cash.

In 2021, digital wallets facilitated 29% of offline transactions, nearly double the 16% in 2018. Overtaking cash as the primary means of offline transactions during the COVID pandemic in 2020, digital wallets continue to gain share.

Payment Methods As Share Of Global E-Commerce Volume



Payment Methods As Share Of Global Point-Of-Sale (POS) Volume

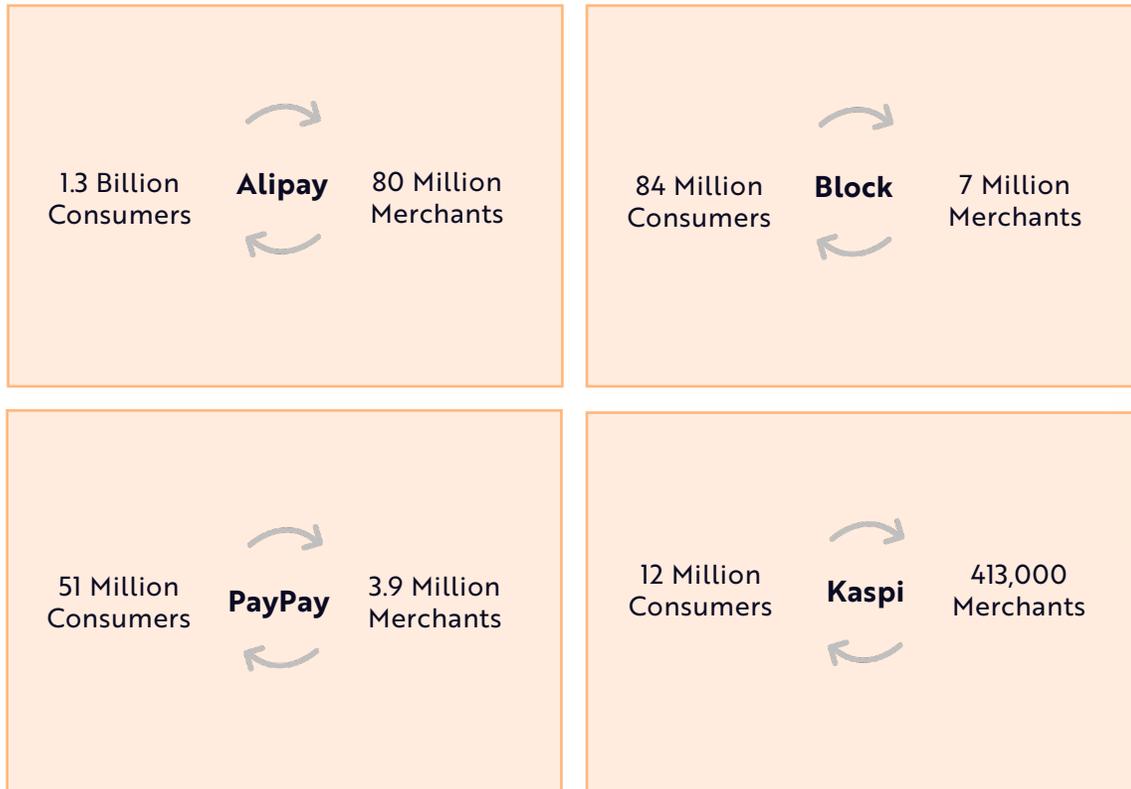


Sources: ARK Investment Management LLC, 2023. Worldpay, LLC 2017; Worldpay, LLC 2018; FIS 2020; FIS 2021; FIS 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

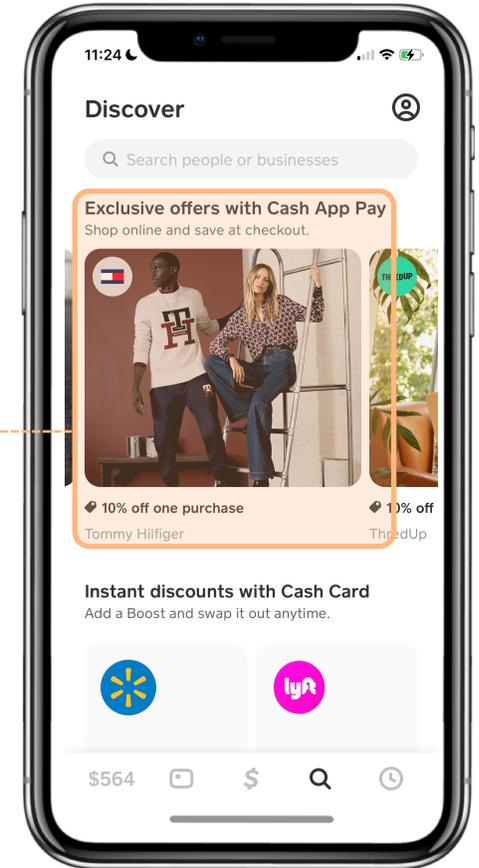


Digital Wallets Create Closed-Loop Ecosystems For Consumers and Merchants

After acquiring billions of users, digital wallets are onboarding millions of merchants to platforms that enable direct consumer-merchant transactions that disintermediate traditional financial institutions.*



Block encourages its 86 million Cash App users to shop in Cash App's merchant network with Cash App Pay.



*We estimate Cash App's annual active users in 2022 using public filings, public investor presentations and conferences, and third-party mobile app data. We estimate the number of merchants within Block's ecosystem by taking the average total payment volume (TPV) per annual active merchant account as disclosed in PayPal's public filings and divide the figure by our estimate for Block's consolidated TPV in 2022. Alipay's consumer and merchant count source citations published in 2021 and 2020, respectively. PayPay and Kaspi's consumer and merchant estimates are from each company's second fiscal quarter and third fiscal quarter filings, respectively. Sources: ARK Investment Management LLC, 2023. Block, Inc, data as of 12/29/22; Sensor Tower Inc, data as of 01/25/23; Kaur, D. 2022; China Internet Watch 2022; Z Holdings, data as of 01/17/23; Kaspi, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

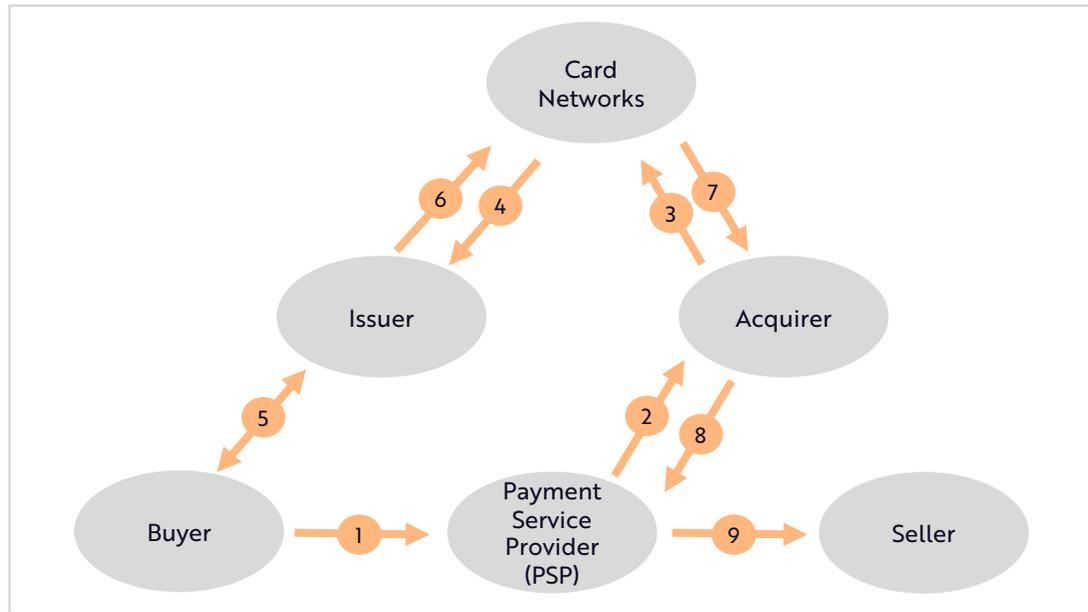


Digital Wallets Eliminate Middlemen By Enabling Direct Payments Between Consumers And Merchants

In the traditional payment chain, several intermediaries take tolls on payments* between consumers and merchants. By enabling in-network transactions, digital wallet providers capture more value per transaction and can share the savings with merchants and consumers.

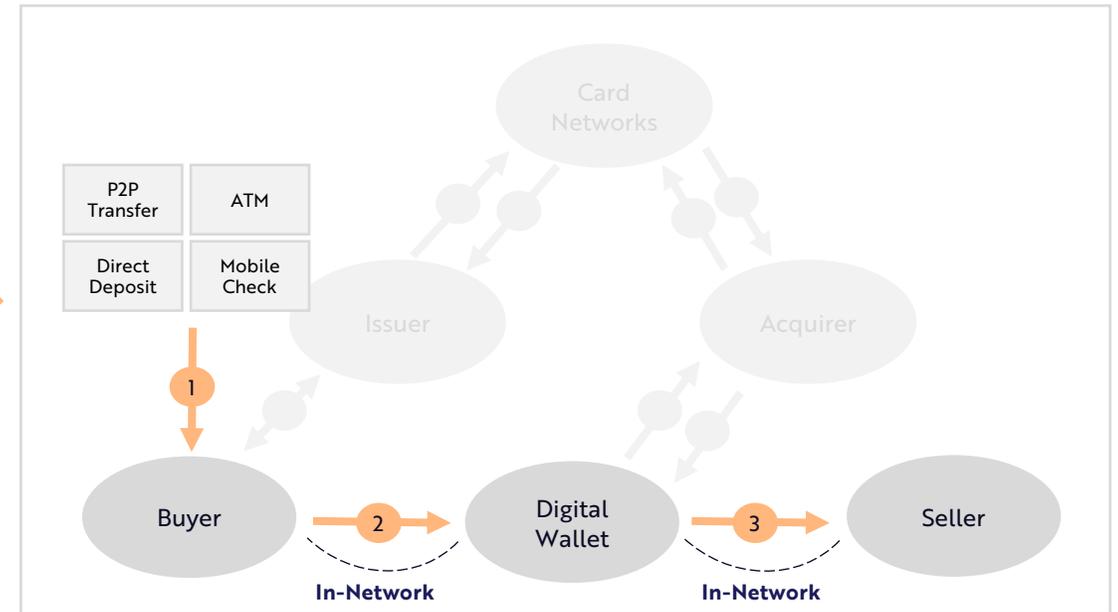
Traditional Open-Loop Credit And Debit Card Transaction

Steps Between Buyer and Seller: 9
 Estimated Intermediary Fees: 2.6%



Closed-Loop Balance-Funded Transaction

Steps Between Buyer and Seller: 3
 Estimated Savings: 2.4%



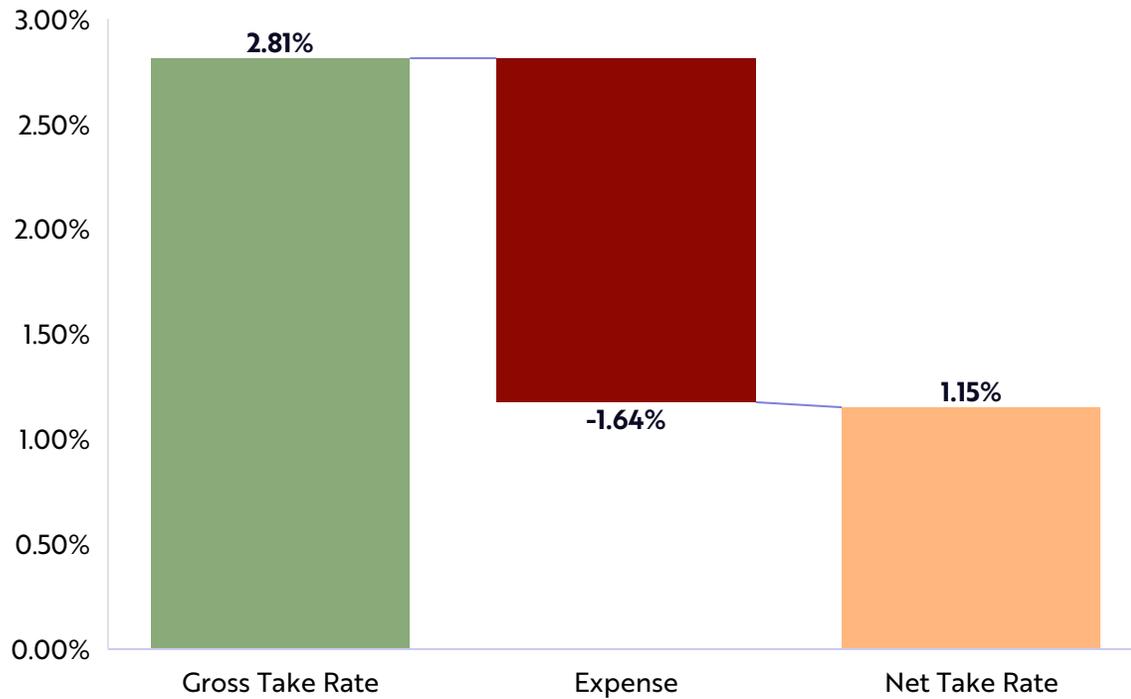
*Estimated fees and payment processes are rendered for illustrative purposes only and are based on sources specific to payment infrastructure in the United States. To estimate intermediary fees under the current payment value chain in the US, we embed our estimate for interchange, card network, issuer, acquirer, and PSP fees. We assume that a closed-loop transaction can eliminate interchange, card network, issuer, and legacy acquirer fees, but we add back estimated costs associated with topping up digital wallet balances and usage of modern payment facilitators. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



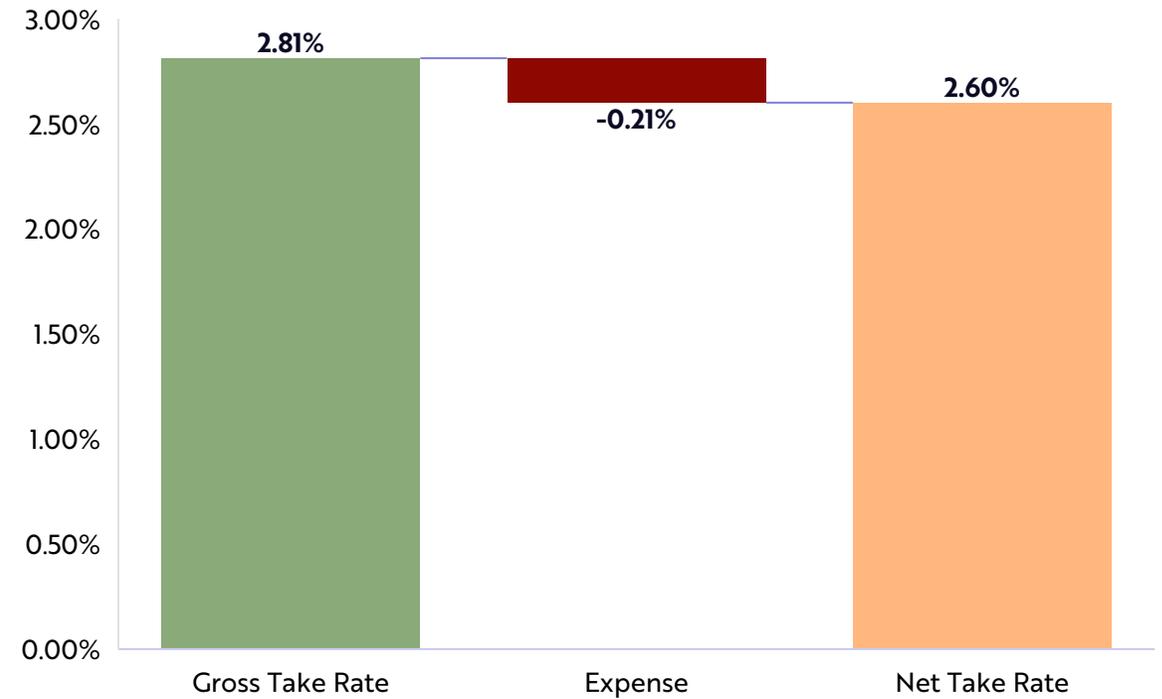
Closed-Loop Transactions Could Boost The Margin Structure Of Digital Wallet Providers

In 2022, Block paid ~60% of customer transaction fees to third parties for interchange, assessment, processing, and bank settlement fees. If Cash App customers were to use their balances to transact with Block merchants, Block's net take rate could more than double.*

**Block's Current Unit Economics
(Percent of Transaction)**



**Block's Potential Closed-Loop Unit Economics
(Percent of Transaction)**



*In the above exercise, we illustrate a scenario in which Block captures 100% of the cost savings associated with the implementation of closed-loop transactions. In reality, we believe the benefits of such cost savings will be shared across PSPs, consumers, and merchants. To calculate Block's gross take rate, we divide consolidated gross payment volume (GPV) by total transaction revenue. To calculate Block's net take rate, we divide total transaction gross profit by total GPV. We use the summed data disclosed by Block through the first three fiscal quarters of 2022. We embed 0.21% in costs associated with closed-loop transactions, attributable to ACH transactions and usage of third-party payment facilitators that help distribute the payment method to merchants. Sources: ARK Investment Management LLC, 2023. Block, Inc., data as of 01/19/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Public Blockchains

Gaining Traction In The Midst Of Crisis

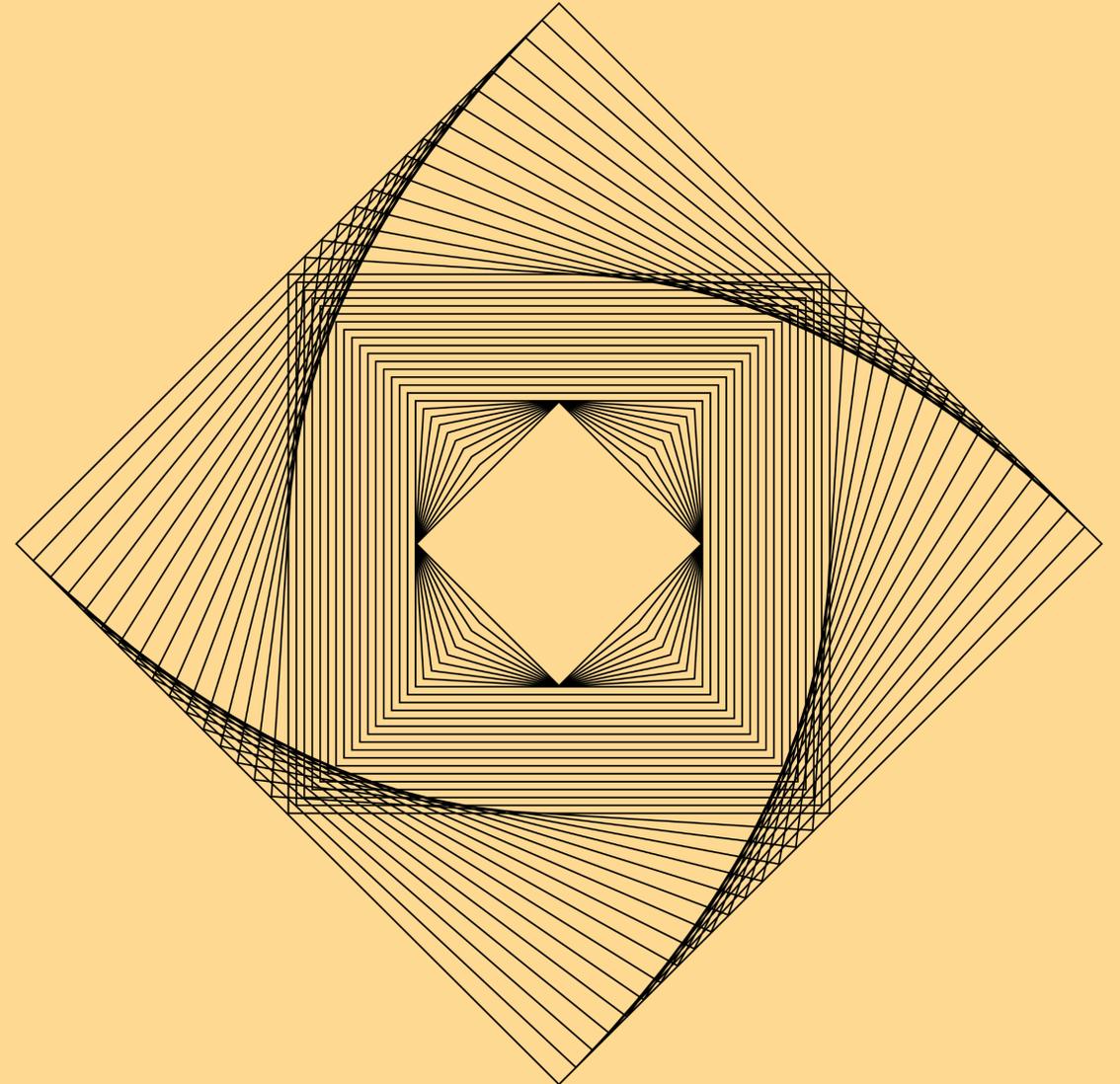
In 2022, the contagion from Terra/LUNA, Three Arrows Capital, Celsius, and FTX/Alameda wiped out ~\$1.5 Trillion in crypto market capitalization.

Despite the severe downturn, public blockchains continue to foster The Monetary, Financial, And Internet Revolutions. The long-term opportunity for Bitcoin, DeFi, and Web3 is strengthening.

Research by Yassine Elmandjra, Crypto Lead

Frank Downing, Director of Research, Next Generation Internet

David Puell, Research Associate





Definitions, Risk and Disclosure Associated with Public Blockchains

Definitions:

Blockchain: A system in which a record of transactions, especially those made in a cryptocurrency, is maintained across computers that are linked in a peer-to-peer network. The goal of blockchain is to allow digital information to be recorded and distributed, but not edited. In this way, a blockchain is the foundation for immutable ledgers, or records of transactions that cannot be altered, deleted, or destroyed.

Cryptocurrency (Crypto): A digital currency designed to work as a medium of exchange through a computer network that is not reliant on any central authority, such as a government or bank, to uphold or maintain it.

Smart Contract: A computer program or a transaction protocol that is intended to automatically execute, control or document events and actions according to the terms of a contract or an agreement.

Proof-of-Stake: A cryptocurrency consensus mechanism for processing transactions and creating new blocks in a blockchain. A consensus mechanism is a method for validating entries into a distributed database and keeping the database secure. Proof of stake achieves consensus by requiring participants to stake crypto behind the new block they want added to a cryptocurrency's blockchain. Meanwhile, proof of work achieves consensus by requiring participants to spend computational power — and electricity — in order to generate a new valid block.

Hash Rate: A measure of the computational power on a blockchain network. Hash rate is determined by how many guesses are made per second. The overall hash rate helps determine the security and mining difficulty of a blockchain network.

Decentralized Finance (DeFi): Offers financial instruments without relying on intermediaries such as brokerages, exchanges, or banks by using smart contracts on a blockchain.

Web3: An idea for a new iteration of the World Wide Web which incorporates concepts such as decentralization, blockchain technologies, and token-based economics.

Disclosure:

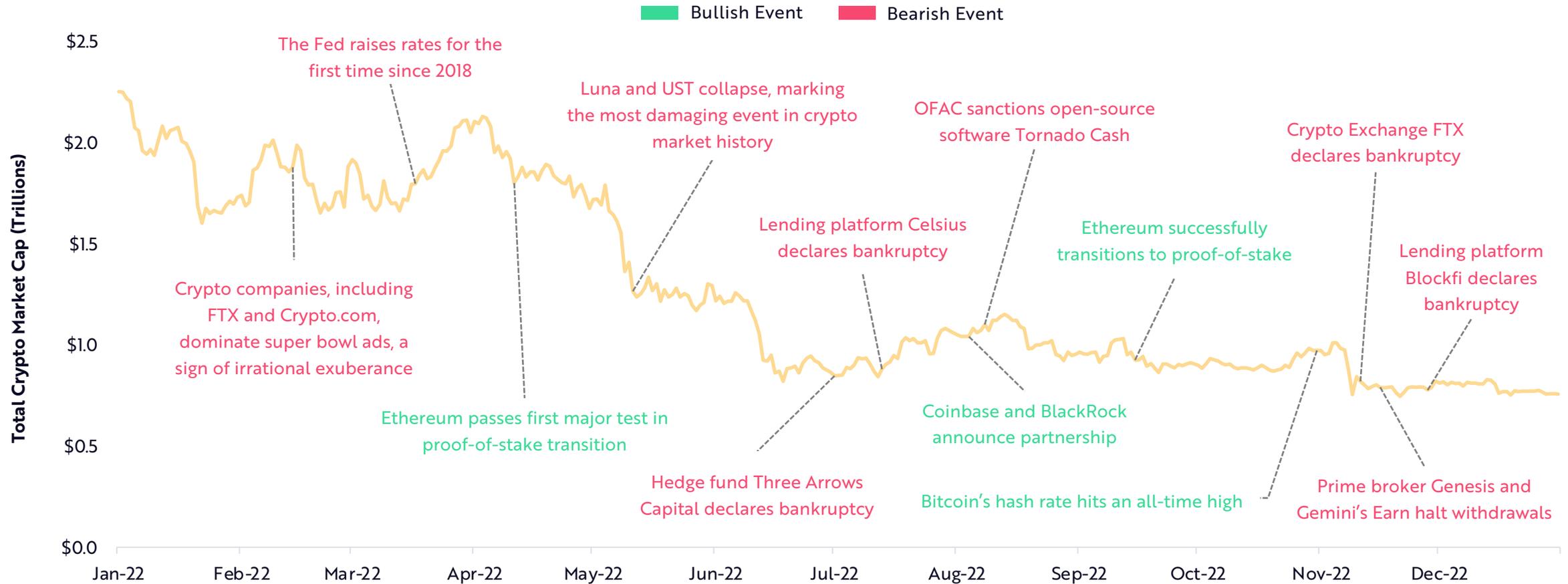
Cryptocurrency Risk: Cryptocurrencies (also referred to as “virtual currencies” and “digital currencies”) are digital assets designed to act as a medium of exchange. Cryptocurrency is an emerging asset class. There are thousands of cryptocurrencies, the most well-known of which is bitcoin. Cryptocurrency generally operates without central authority (such as a bank) and is not backed by any government. Cryptocurrency is not legal tender. Federal, state and/or foreign governments may restrict the use and exchange of cryptocurrency, and regulation in the U.S. is still developing. The market price of bitcoin and other cryptocurrencies have been subject to extreme fluctuations. Similar to fiat currencies (i.e., a currency that is backed by a central bank or a national, supra-national or quasi-national organization), cryptocurrencies are susceptible to theft, loss and destruction. Cryptocurrency exchanges and other trading venues on which cryptocurrencies trade are relatively new and, in most cases, largely unregulated and may therefore be more exposed to fraud and failure than established, regulated exchanges for securities, derivatives and other currencies. Cryptocurrency exchanges may stop operating or permanently shut down due to fraud, technical glitches, hackers or malware, which may also affect the price of cryptocurrencies. Cryptocurrency Tax Risk. Many significant aspects of the U.S. federal income tax treatment of investments in bitcoin and other cryptocurrencies are uncertain and still evolving.

Internet Company Risk. Many Internet-related companies have incurred large losses since their inception and may continue to incur large losses in the hope of capturing market share and generating future revenues. Accordingly, many such companies expect to incur significant operating losses for the foreseeable future and may never be profitable. The markets in which many Internet companies compete face rapidly evolving industry standards, frequent new service and product announcements, introductions and enhancements, and changing customer demands. The failure of an Internet company to adapt to such changes could have a material adverse effect on the company's business.



Contagion Wiped Out ~\$1.5 Trillion In Crypto Market Capitalization In 2022

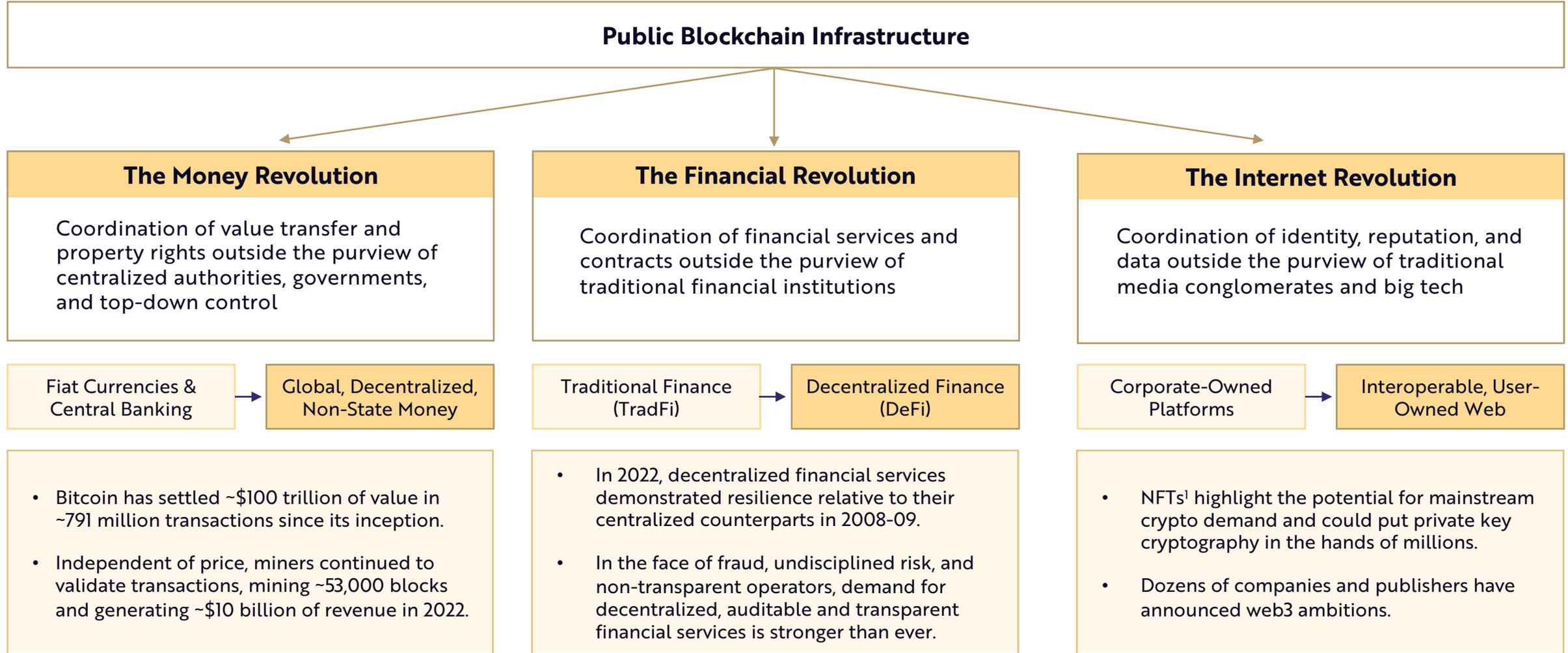
Total Crypto Market Cap In 2022



Sources: ARK Investment Management LLC, 2023. Ponnezhath, M. et al. 2022; Choo, L. 2022; Tepper, T. 2022; TechnoPixel 2022; Sandor, K. et al. 2022; De, N. et al. 2022; Tejpal, B. et al. 2022; US Department of the Treasury 2022; O'Neill, A. 2022; Sigalos, M. 2022; Ponciano, J. 2022; Sigalos, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Despite A Severe Downturn, Public Blockchains Continue To Foster Multiple Revolutions



[1] Non-fungible token (NFT), a unique, programmable blockchain-based digital object that proves ownership of digital assets. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23, figures not entity-adjusted. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Monetary Revolution | Bitcoin's Long-Term Opportunity Has Been Strengthening

THE PROBLEM

Centralized Monetary Systems Have Failed To Provide Strong Economic Assurances.

- > 4 billion people live under authoritarian regimes.
- > 2 billion people suffer from double-digit inflation.
- > 1 billion people cannot use traditional payment transfer apps.
- > 1 billion people rely on remittances.

THE DATA

Bitcoin Network Stats	2022	Cumulative ¹
Transfer Volume (\$ Trillions)	+\$38.7	\$105.3
Transaction Count (Millions)	+95.4	791.4
Total Addresses ² (Millions)	+147.5	1,100
Addresses With A Balance (Millions)	+3.75	43.2
Miner Revenue (\$ Billions)	+\$9.5	\$47.4

THE REVOLUTION

Bitcoin is censorship-resistant.

The barriers to transacting on Bitcoin are low, the only requirement being possession of a private key.

Bitcoin is seizure-resistant.

Bitcoin combines elliptic curve cryptography and secure custody to ensure independent property rights.

Bitcoin is auditable and transparent.

Bitcoin decision making is transparent and decentralized. Running a full node, a user is free to validate transactions and audit supply.

[1] Cumulative since inception in January 3, 2009. [2] A Bitcoin address is a unique identifier that serves as a virtual location where the cryptocurrency can be sent. People can send the cryptocurrency to Bitcoin addresses similarly to the way fiat currencies can often be sent to email addresses. Sources: ARK Investment Management LLC, 2023. Kasparov, G. et al. 2017; Hall, J. 2022; The World Bank 2021; International Fund for Agricultural Development 2022; Glassnode, data as of 01/20/23, figures not entity-adjusted. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Financial Revolution | Decentralized Finance Powered Through The Crypto Crisis

THE PROBLEM

- More than 2 billion people lack access to basic banking services, including account management and credit.
- The opacity of traditional financial institutions has caused catastrophic financial collapses.
- Counterparty risk among traditional financial institutions results in single points of failure, and centralized decision making enables rampant rent-seeking.

THE DATA

- ~\$1.2 trillion in DeFi trading volume, up 12x from 2020 to 2022.
- ~52% increase in DeFi trading volume relative to total crypto trading volume after the FTX collapse.
- ~\$9 trillion in on-chain stablecoin transfers, more than card networks Mastercard, Amex, and Discover combined in 2022.
- ~\$32 billion in withdrawals and nearly \$1 billion in liquidations in 2022.



THE REVOLUTION

DeFi may eliminate traditional intermediaries.

Automated smart contracts guarantee execution without the need for trusted toll-takers.

DeFi is global.

Financial services deployed on open protocols enable anyone with an internet connection access to custody, trading, and lending facilities.

DeFi is interoperable.

Financial services are open-source and interoperable, allowing for rapid innovation and experimentation.

DeFi is auditable and transparent.

Users govern risk and functions, while collateralization and asset flows are open for inspection.



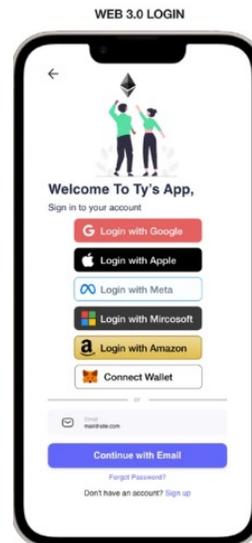
Internet Revolution | The Case For Web3 Is Reaching A Tipping Point

THE PROBLEM

- The Internet relies on tech monopolies that exploit, own, and monetize user data.
- Online identity and reputation are not interoperable.
- Centralized decision makers dictate the discovery of information, subjectively moderating content and communication.

THE DATA

- 5 million unique IDs issued across the Ethereum Name Service and Unstoppable Domains.
- \$22 billion in annual NFT¹ trading volume, up 15% in 2022.
- 127 million in cumulative NFT creations.
- Major brands, including Starbucks, Adidas, Nike, Coca-Cola, and the NBA, partnering with Web3 protocols.
- Major social platforms including Instagram, Twitter, Reddit launching NFT-powered capabilities.



THE REVOLUTION

Web3 is user owned.

Web3 introduces digital property rights for the first time.

Web3 relies on protocols, not platforms.

Decentralized protocols enable the governance of—and open access to — distributed data, limiting central aggregator control.

Web3 enables new monetization paradigms.

Web3 embeds economics into software, enabling users to monetize and participate in network development.

Web3 enables the convergence between consumption and investment.

Consumer behavior is shifting as the economy becomes digitally native, enabling a new paradigm for purchasing, owning, and using goods and services.

[1] Non-fungible token (NFT), a unique, programmable blockchain-based digital object that proves ownership of digital assets. Sources: ARK Investment Management LLC, 2023. Malwa, S. 2023; Unstoppable Domains, data as of 01/16/23; CryptoSlam, data as of 01/17/23; Dune Analytics, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Bitcoin

A Durable Network

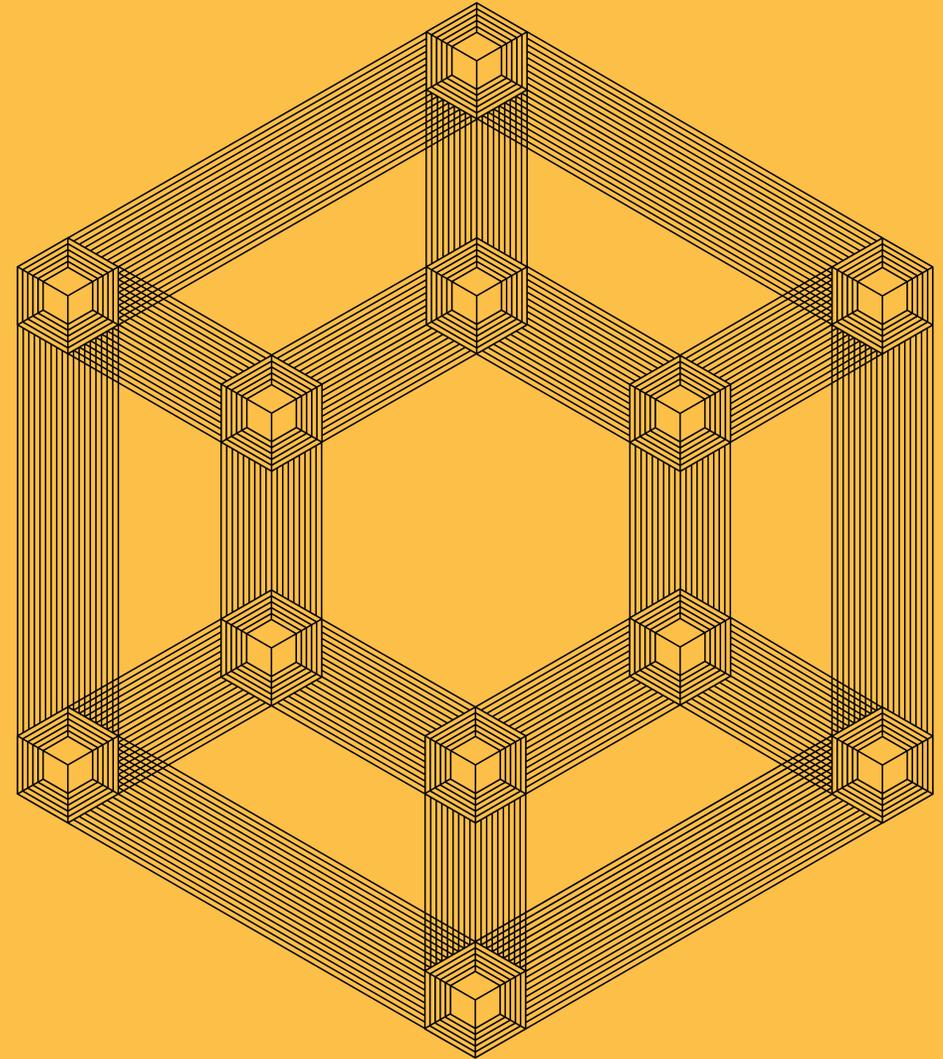
We believe Bitcoin's long-term opportunity is strengthening. Despite a turbulent year, Bitcoin has not skipped a beat. Its network fundamentals have strengthened and its holder base has become more long-term focused.

Contagion caused by centralized counterparties has elevated Bitcoin's value propositions: decentralization, auditability, and transparency.

Research by Yassine Elmandjra, Crypto Lead

Frank Downing, Director of Research, Next Generation Internet

David Puell, Research Associate





The Drawdown From Bitcoin's All-Time High Was The Fifth Largest And Second Longest In History

Bitcoin Percent Drawdowns In Bear Markets



Bitcoin's Bear Market Drawdowns

Peak		Trough		
Date	Price	Date	Price	Drawdown
June 2011	\$31.91	November 2011	\$2.00	-93.7%
November 2013	\$1,242	January 2015	\$152	-87.7%
December 2017	\$19,891	December 2018	\$3,128	-84.3%
November 2021	\$69,000	November 2022 ¹	\$15,797	-76.7%
Peak-to-Peak Average CAGR²	157.9%	Trough-to-Trough Average CAGR²	153.6%	

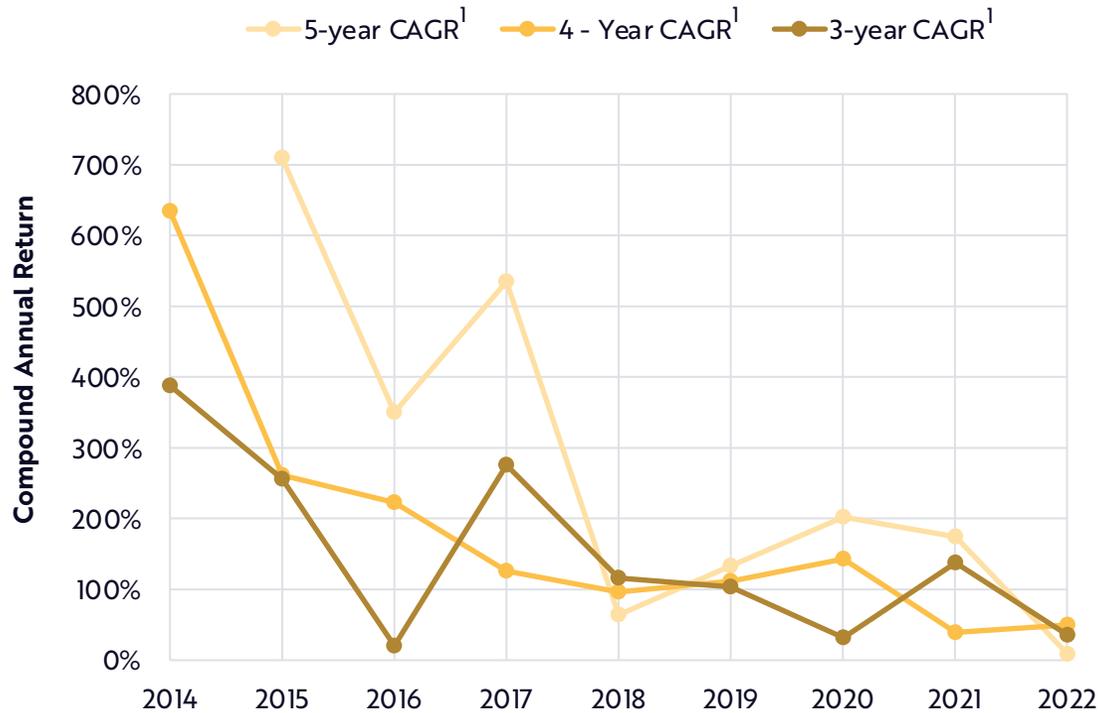
Note: Bitcoin experienced an 81% drawdown in April 2013 that is not included in the chart or table given the duration lasted only 6 days and, in this context, is considered an outlier. [1] The trough in November 2021 is assumed to be the lowest mark in price as of December 31, 2022. Lower price levels may develop during 2023 or after. [2] CAGR = Compound Annual Growth Rate. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Despite Severe Drawdowns, Bitcoin Has Outperformed Every Major Asset Class Over Longer Time Horizons

Bitcoin’s volatility has obscured its long-term returns. Despite five drawdowns greater than 75% since its inception in 2009, bitcoin has delivered positive annualized returns over 3-, 4-, and 5-year time horizons.

Bitcoin’s Compound Annual Returns (CAGR) Are Positive Over 3-, 4-, and 5-Year Time Horizons*



Bitcoin Has Outperformed Traditional Asset Classes Since Its Inception

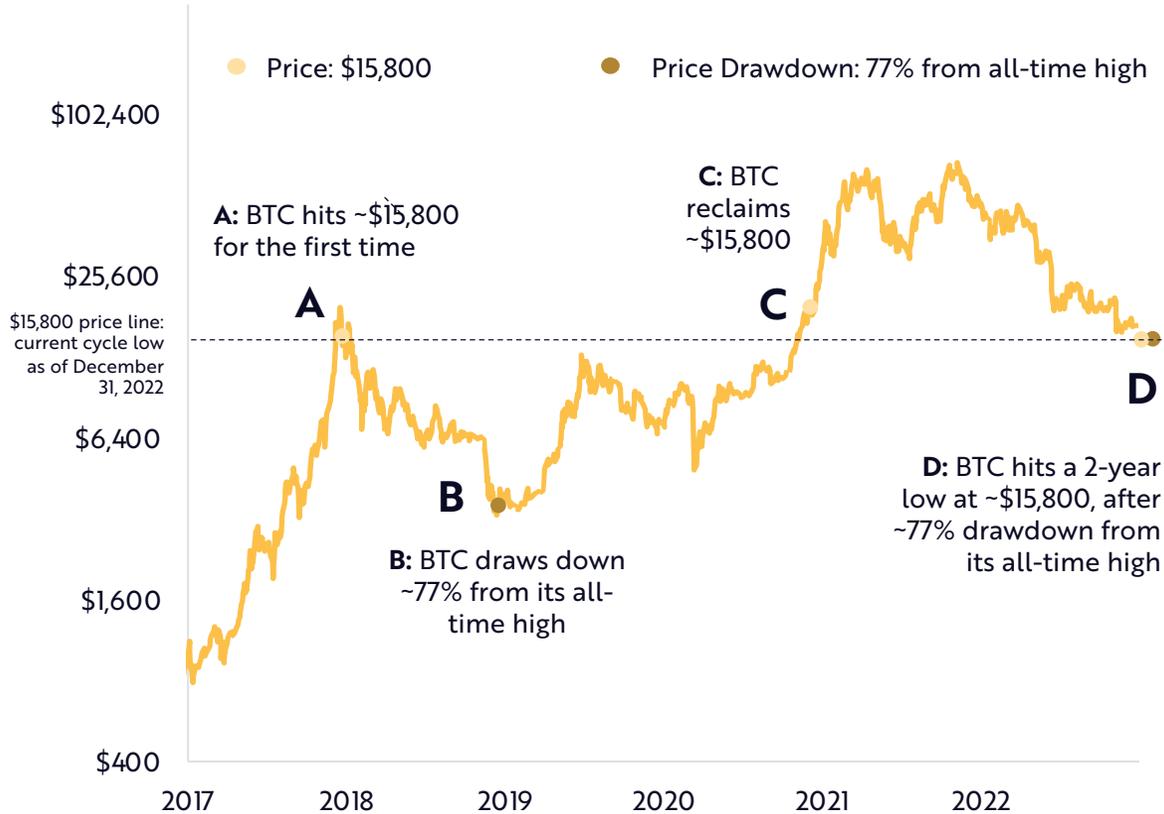
Asset Classes	3-Year CAGR ¹		4-Year CAGR ¹		5-Year CAGR ¹	
	Average ²	2022	Average ²	2022	Average ²	2022
Global Equities³	10.6%	4.9%	10.1%	10.2%	6.1%	6.1%
Global Debt⁴	1.5%	-4.5%	1.5%	-1.8%	1.4%	-1.7%
Gold	2.4%	6.3%	2.5%	9.2%	2.2%	7.0%
Bitcoin	152%	35.6%	187%	49.4%	272%	8.7%

[1] CAGR = Compound Annual Growth Rate. [2] Average CAGRs are calculated since bitcoin’s price inception. [3] MSCI World Index used as a proxy. [4] Bloomberg Global-Aggregate Total Return Index used as a proxy. Index Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23; Bloomberg, data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Bitcoin's Fundamentals Are Stronger Today Than In Past Drawdowns

Bitcoin In Perspective At \$15,800 After 77% Drawdowns



Bitcoin Metrics	A Dec. 10, 2017	B Nov. 20, 2018	C Nov. 11, 2020	D Nov 21, 2022
Market Cost Basis (Realized Cap, \$, Billions) ¹	\$58.2	\$85.1	\$126.3	\$393
Cost Basis Per BTC (Realized Price, \$) ²	\$3,485	\$4,713	\$6,811	\$20,459
Hash Rate (EH/s) ³	12.6	44.5	127.8	262.4
Supply Of BTC Last Moved >1 Year Ago (%)	44.1%	51.8%	61.8%	66.5%
BTC Addresses With Non-Zero Balance (Millions)	24.0	22.5	32.6	43.5
Long-Term Holder Supply (%) ⁴	51.9%	67.5%	66.3%	71.8%
Lightning Network Capacity (BTC) ⁵	N/A	340	1,040	4,700

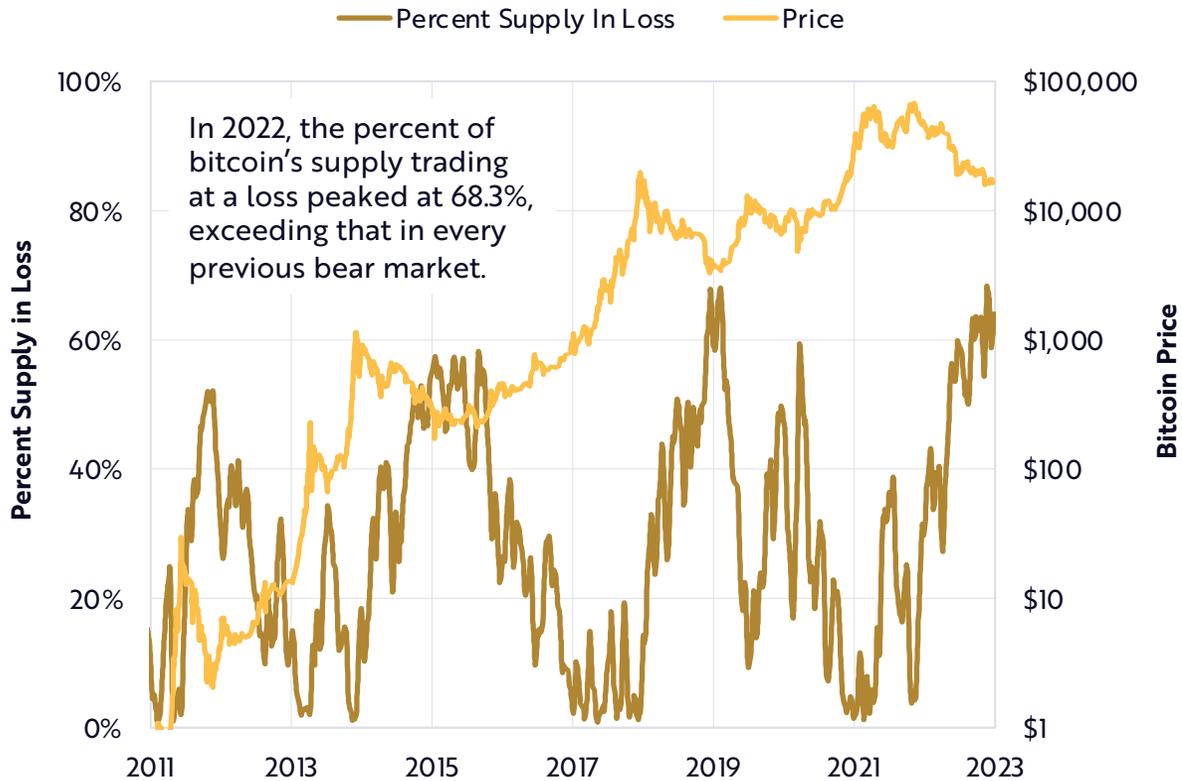
[1] Market cost basis: The on-chain volume-weighted average price of the market, calculated by aggregating the value of all bitcoins in circulation at the time when they last moved. Also known as realized cap. [2] Cost basis per BTC: The market cost basis divided by total outstanding supply. Also known as realized price. [3] Hash rate: The number of computations per second produced by miners and a proxy for network security. [4] Long-term holder supply: The number of coins that last moved 155 days or longer. 155 days is the threshold when the probability of a bitcoin being spent in the future diminishes substantially. [5] Lightning Network capacity: The number of bitcoins locked in the Lightning Network. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



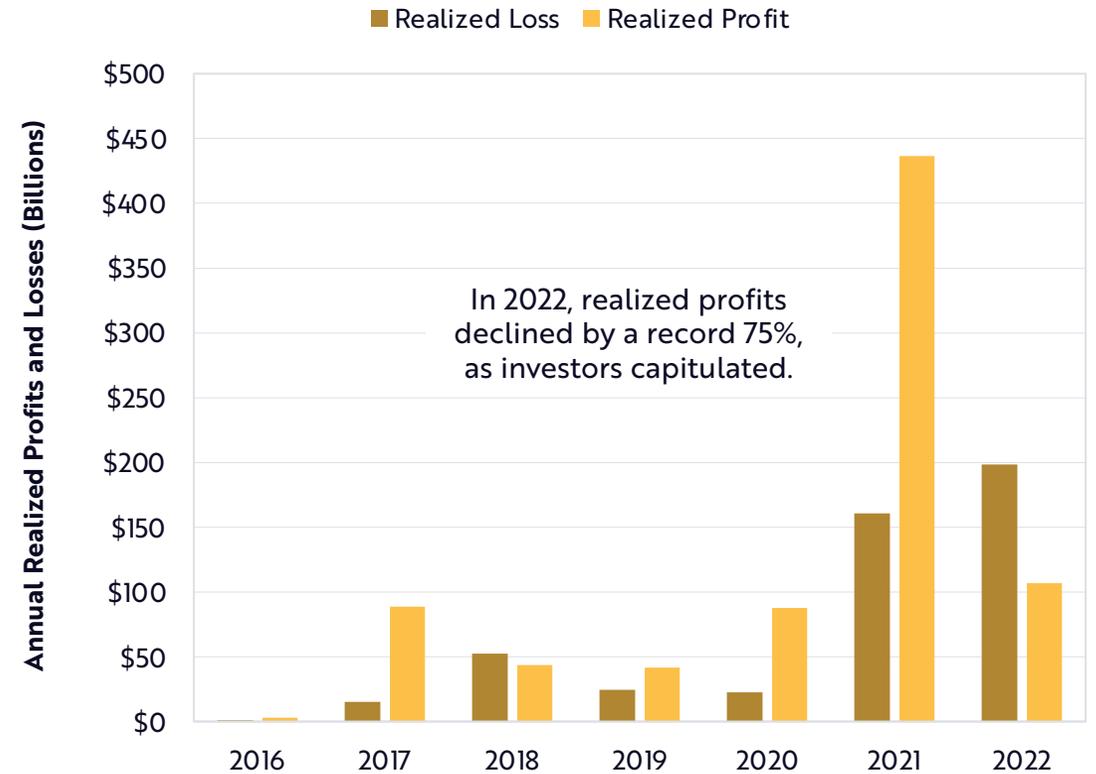
Bitcoin Capitulation Has Hit Levels Associated With Price Troughs In The Past

In 2022, bitcoin holder capitulation was proportionate to that at previous cycle lows.

The Percentage Of Bitcoin Trading At A Loss Reached An All Time High in 2022¹



Bitcoin Holders Realized Record Losses Of ~\$200 Billion In 2022²



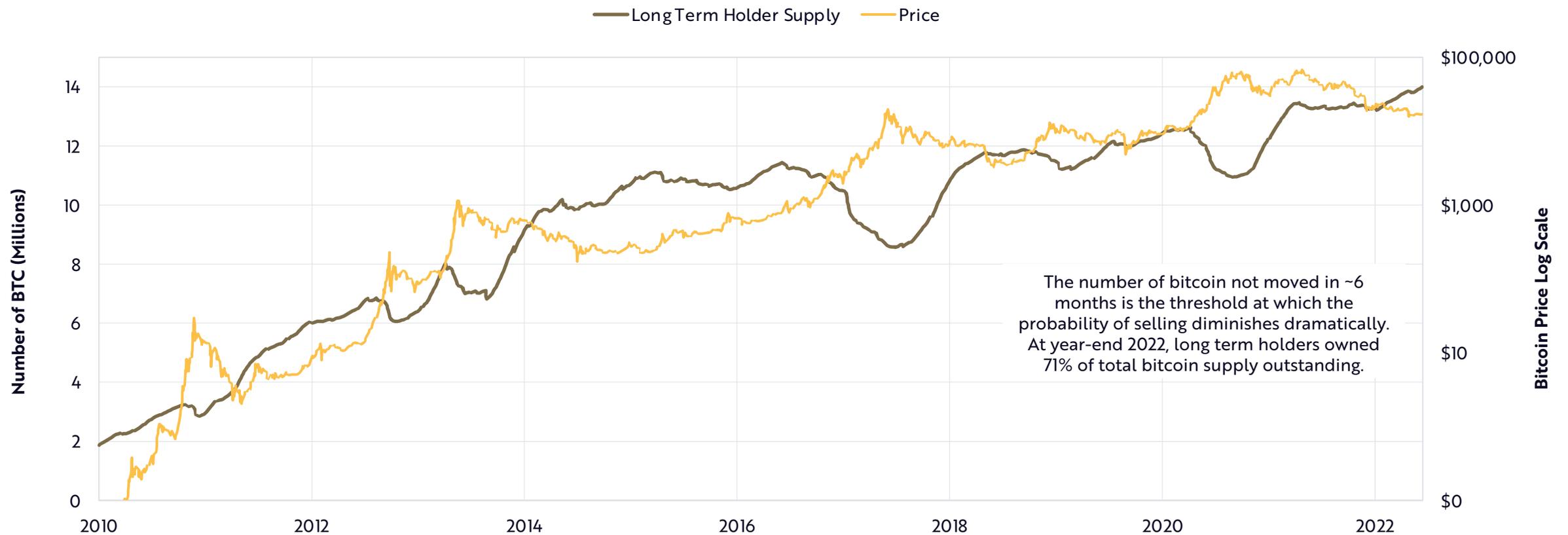
[1] The percent of bitcoin at loss is adjusted by discounting coins that have not moved in 7 years or longer. This serves as a heuristic to remove potentially lost coins from calculation. [2] Realized losses: The number of coins moved on-chain at a price lower than when they last moved. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Bitcoin Holders Are More Long-Term Focused Than At Any Point In History

Despite extreme market fear fueled by the collapse of several major crypto entities, on-chain data suggest that bitcoin holders remained focused on long-term fundamentals.

Bitcoin Supply Held By Long-Term Holders Hit An All Time High in 2022¹

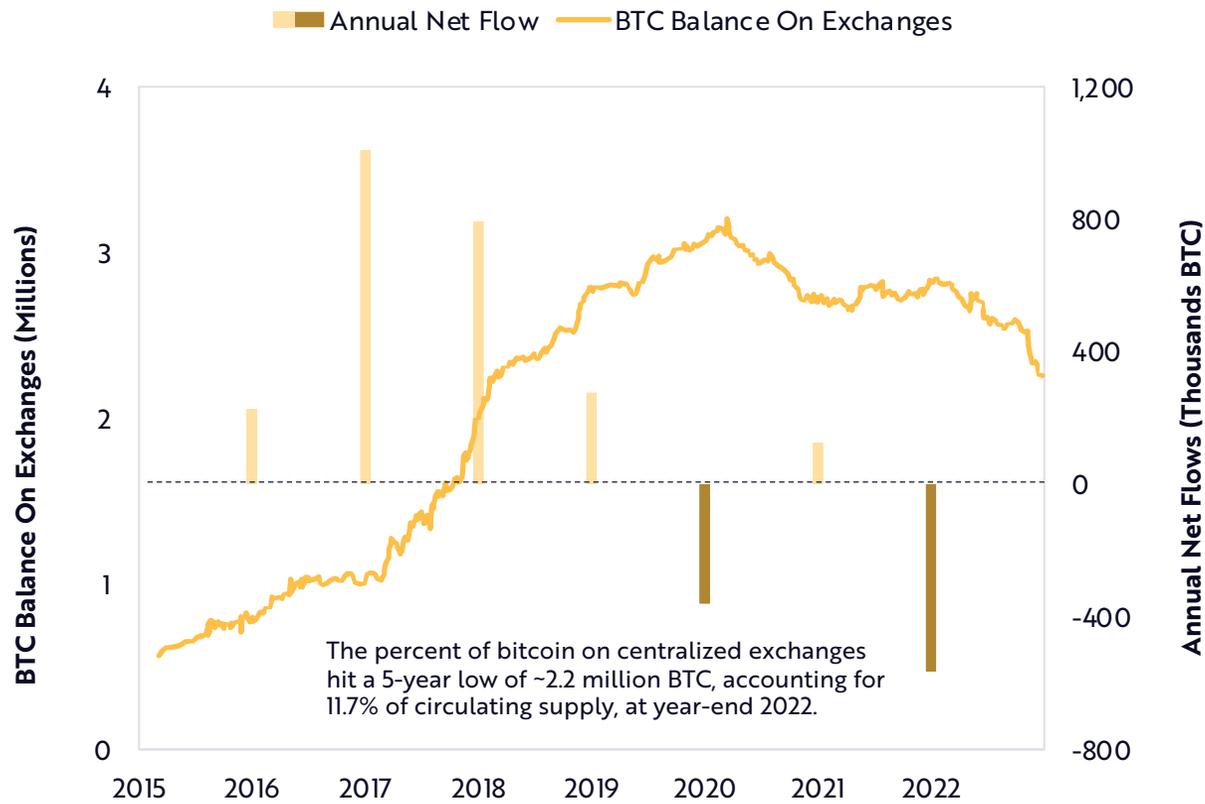


[1] Long-term holder supply: The number of coins that last moved 155 days or longer. 155 days is the threshold when the probability of a bitcoin being spent in the future diminishes substantially. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Exchanges Have Increased Transparency In Response To The Collapse Of Trust In Centralized Crypto Entities

In 2022, Net Outflows From Centralized Exchanges Totaled 560,000 BTC, The Largest In History¹



A “run on the bank” forced a record number of exchanges to publish auditable financials and cryptographically verifiable attestations of solvency, otherwise known as “proof-of-reserves” (PoR).

Exchange	“PoR” Publication Year ²
Binance	2022
BitMEX	2021
ByBit	2022
Coinbase ³	2021
Crypto.com	2022
Deribit	2022
Gate.io	2020
Kraken	2014
Kucoin	2022
Luno	2021
OKX	2014

[1] Outflows from exchanges saw historical values in 2022 and so did the market share between these. For instance, Coinbase saw an increase of 11 percentage points in market share amongst fiat exchanges during 2022, from 29% to 40% (as per The Block), remaining as the premier regulated retail on-ramp in the US. [2] The proofs-of-reserves herein vary in quality and standard. [3] While Coinbase has not conducted a cryptographic proof of reserves, its status as a public company requires it to publish extensive “proof of solvency” reporting. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23; Carter, N. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Institutions Are Committing To Bitcoin During A Bear Market

Entity

BlackRock

BNY Mellon

Eaglebrook Advisors

Fidelity

Market Validation

June 2022: BlackRock's Aladdin partnered with Coinbase Prime to provide institutional clients with direct access to crypto, starting with bitcoin. Connecting to Coinbase Prime, Blackrock's Aladdin could usher trillions of dollars into the asset class in the coming years.

October 2022: BNY Mellon launched a cryptoasset custody platform to safeguard assets for institutional investors. Touching more than 20% of the world's investable assets, BNY Mellon could use bitcoin to scale financial services cost-effectively.

October 2022: Eaglebrook Advisors and ARK Investment Management partnered¹ to offer financial advisors access to actively-managed crypto strategies, including direct cryptoasset ownership, low minimums, and portfolio reporting integration.

November 2022: Fidelity officially launched retail bitcoin and ether trading accounts enabling investors to trade and custody them on its platform.

[1] Eaglebrook and ARK are unaffiliated and ARK provides a non-discretionary model portfolio to Eaglebrook for its financial advisor clients to implement. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.



Precision Therapies

Expanding Medicine To Treat And Cure Disease

Precision therapies are patient-centric and target the root cause of disease, not symptoms. Designed using novel experimental and computational methods, precision therapies could develop faster and more cost-effectively than traditional therapies.

Rapid advances in technologies like artificial intelligence (AI), DNA and RNA sequencing, CRISPR gene editing, and laboratory automation have spawned new therapies, enabling the treatment of diseases previously considered intractable. Increasingly, precision therapies are becoming multiomic, with mechanisms of action spanning DNA, RNA, proteins, and more.



Research by Ali Urman, Analyst & Pierce Jamieson, Research Associate



Definitions, Risk & Disclosure Associated with Precision Therapies

Health Care Sector Risk. The health care sector may be affected by government regulations and government health care programs, restrictions on government reimbursement for medical expenses, increases or decreases in the cost of medical products and services and product liability claims, among other factors. Many health care companies are: (i) heavily dependent on patent protection and intellectual property rights and the expiration of a patent may adversely affect their profitability; (ii) subject to extensive litigation based on product liability and similar claims; and (iii) subject to competitive forces that may make it difficult to raise prices and, in fact, may result in price discounting. Many health care products and services may be subject to regulatory approvals. The process of obtaining such approvals may be long and costly, and delays or failure to receive such approvals may negatively impact the business of such companies. Additional or more stringent laws and regulations enacted in the future could have a material adverse effect on such companies in the health care sector. In addition, issuers in the health care sector include issuers having their principal activities in the biotechnology industry, medical laboratories and research, drug laboratories and research and drug manufacturers, which have the additional risks described below.

Biotechnology Company Risk. A biotechnology company's valuation can often be based largely on the potential or actual performance of a limited number of products and can accordingly be greatly affected if one of its products proves, among other things, unsafe, ineffective or unprofitable. Biotechnology companies are subject to regulation by, and the restrictions of, the U.S. Food and Drug Administration, the U.S. Environmental Protection Agency, state and local governments, and foreign regulatory authorities.

Pharmaceutical Company Risk. Companies in the pharmaceutical industry can be significantly affected by, among other things, government approval of products and services, government regulation and reimbursement rates, product liability claims, patent expirations and protection and intense competition.

Definitions:

Deoxyribonucleic acid (DNA) is a polymer composed of two polynucleotide chains that coil around each other to form a double helix carrying genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses.

Ribonucleic acid (RNA) is a polymeric molecule essential in various biological roles in coding, decoding, regulation and expression of genes.

A double-strand DNA break (DSB) occurs or arises when both strands of the DNA duplex are severed, often as the result of ionizing radiation.

Zinc finger nucleases (ZFNs) are a class of engineered DNA-binding proteins that facilitate targeted editing of the genome by creating double-strand breaks in DNA at user-specified locations.

Transcription Activator-Like Effector Nuclease (TALENs) are chimeric proteins that contain two functional domains: a DNA-recognition transcription activator-like effector (TALE) and a nuclease domain. They work for gene editing by recognizing a specific sequence, which the user can design, and introducing a double-stranded break with an overhang.

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is gene editing is a genetic engineering technique in molecular biology by which the genomes of living organisms may be modified. It is based on a simplified version of the bacterial CRISPR-Cas9 antiviral defense system.

Cas9 Enzyme (Cas) is a protein which plays a vital role in the immunological defense of certain bacteria against DNA viruses.

Base editing is a novel technology that has the potential to generate gene knockouts or to correct certain errors or mutations in the DNA of intact cells. Prime editing is a gene editing method that can perform targeted small insertions, deletions, and base swapping in a precise way.

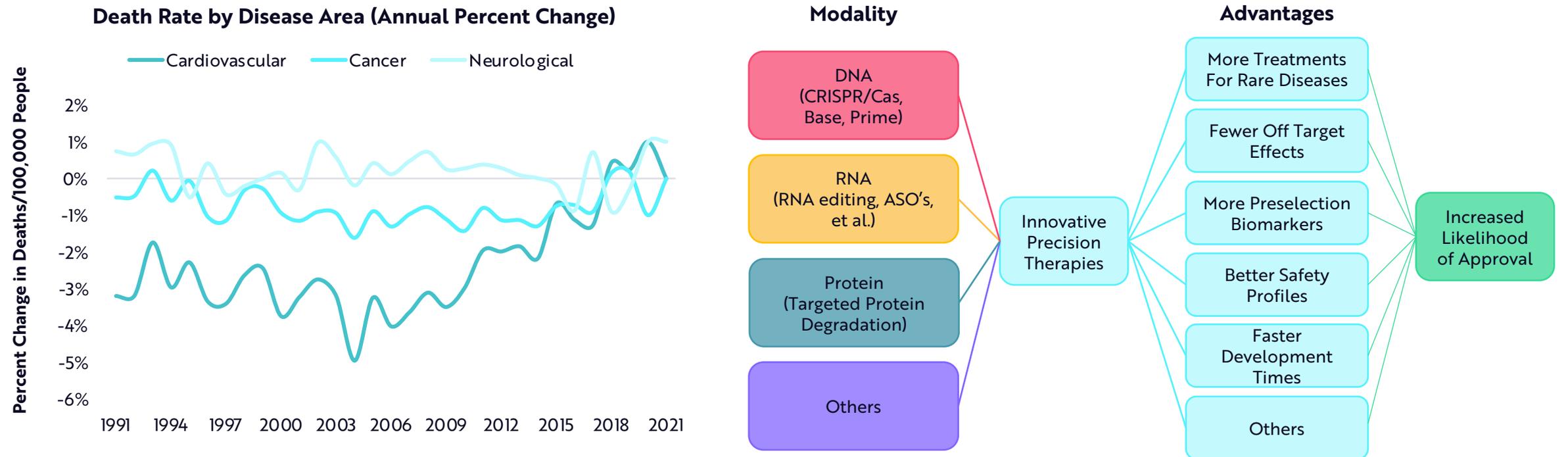
Antisense Oligonucleotide (ASO) is a single-stranded, synthetic RNA (or DNA) sequence. ASOs are designed to selectively bind via complementary base-pairing to messenger RNA (mRNA) and are the basis for one type of RNA-based therapeutics being explored to treat cancer and genetic disorders.



Pharmaceuticals Need Innovation

Unlike the last 30 years, the change in death rates associated with cancer and cardiovascular diseases during the past five years has not improved significantly, suggesting that existing approaches have reached diminishing returns, as shown on the left below. Emerging precision therapy modalities could become best-in-class, lowering death rates across many diseases, including neurological, as shown on the right below.

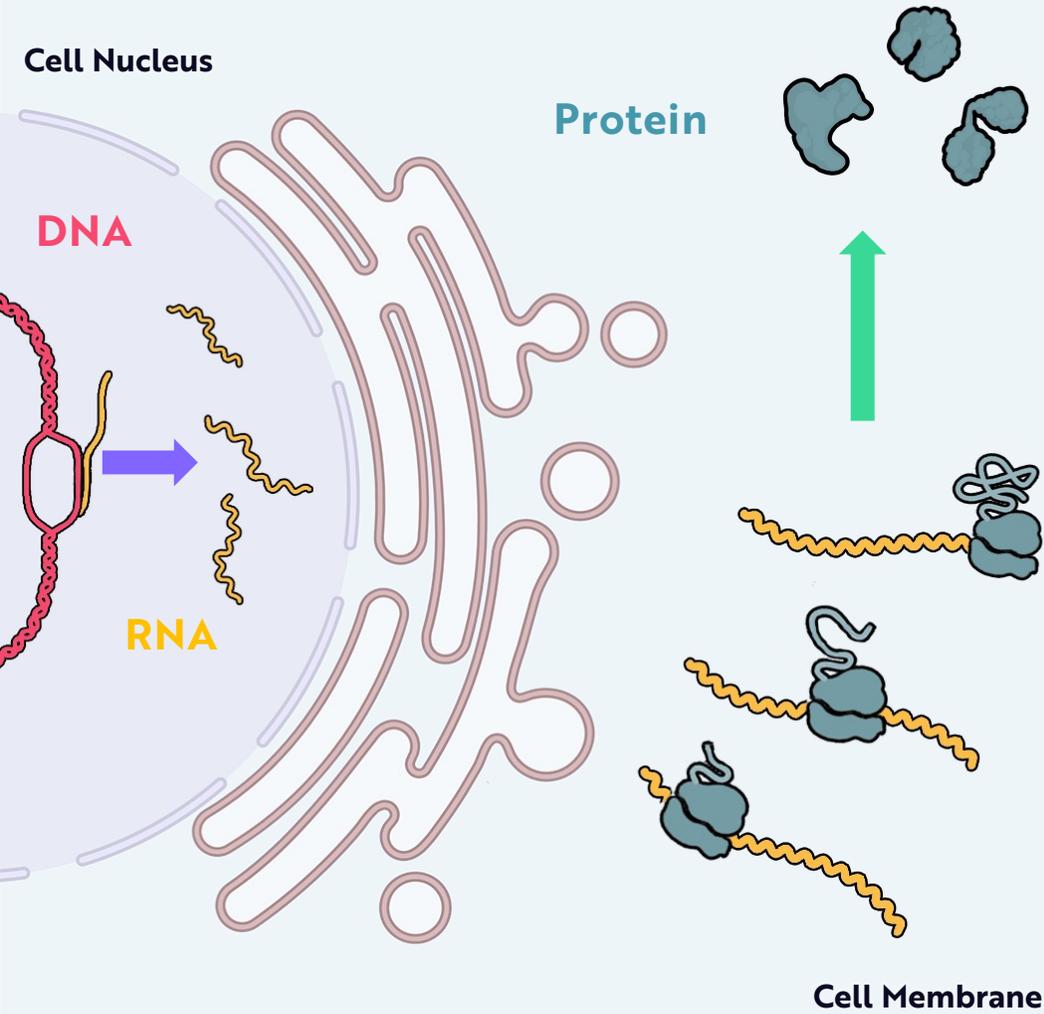
Compared to older pharmaceuticals, innovative precision therapies have advantages that could cause significant shifts in market share. Precision therapy toolkits are broadening with techniques that target DNA, RNA, proteins, and more—giving researchers unprecedented flexibility to tackle different diseases.



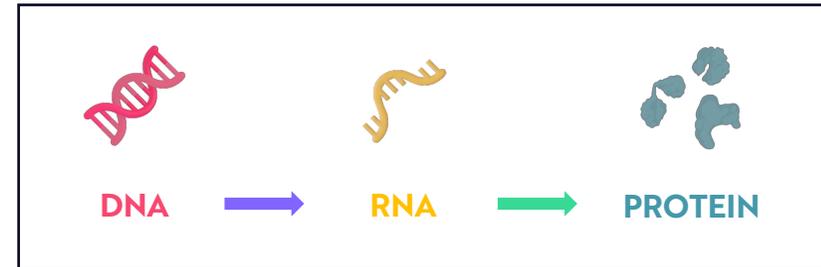
Sources: ARK Investment Management LLC, 2023. World Health Organization, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



The Central Dogma Of Biology



The central dogma describes the flow of information through biological systems. With **DNA** as the template, our cells transcribe **RNA** molecules, which translate into **proteins**. DNA mutations migrate through this process, sometimes producing dysfunctional proteins. Although proteins are the main causes of disease, scientists can target any molecule—**DNA**, **RNA**, or **proteins**—with precision therapies.



We believe that more therapeutic targets could result in better health outcomes for patients.



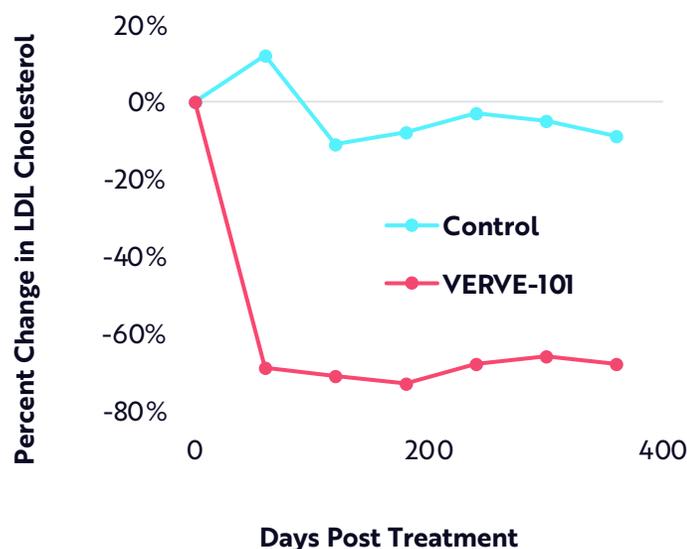
Innovative Therapies Are Targeting Each Part Of The Central Dogma



Researchers can target **DNA**¹ using gene editing to cure or prevent heart disease, silence **RNA**² to control polyneuropathy, and degrade **proteins**³ to limit the growth of tumors.

DNA

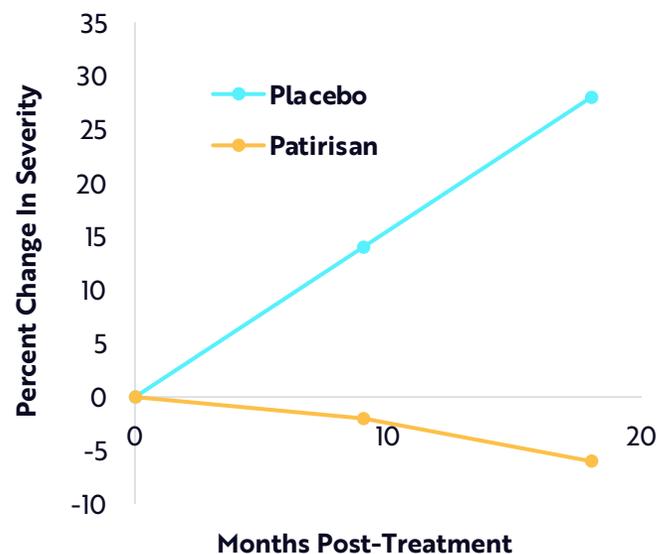
DNA Editing Is Preventing Cardiovascular Disease in Non-Human Primates (NHPs)



VERVE-101 is a gene editing therapy for the treatment of hypercholesterolemia under clinical investigation by Verve Therapeutics.

RNA

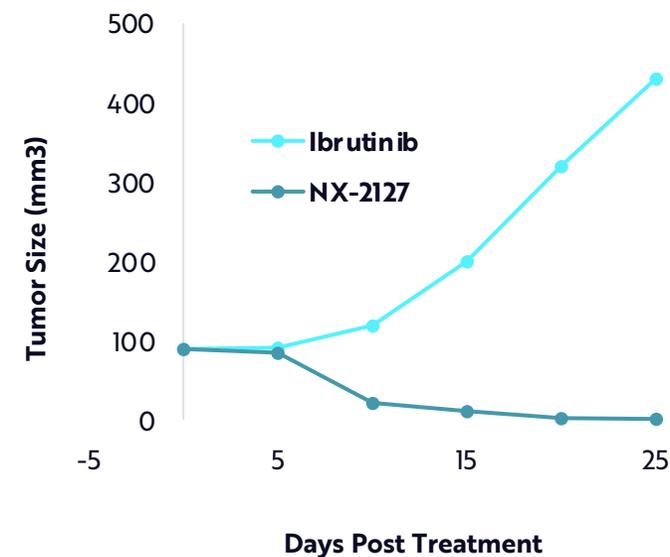
RNA Silencing Is Reversing Neurological Diseases



Developed by Alnylam Pharmaceuticals, Patirisan was approved recently by the FDA for hATTR⁴

PROTEIN

Targeted **PROTEIN** Degraders Inhibit Tumor Growth



Ibrutinib is a small molecule drug for treatment of several cancer types.

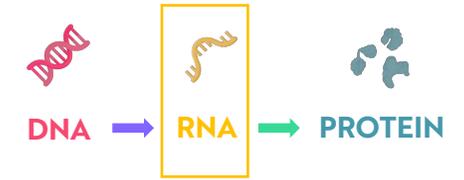
NX-2127 is Nurix Therapeutics' targeted protein degrader currently under clinical investigation.

Sources: ARK Investment Management LLC, 2023. [1] Musunuru, K. et al. 2021; [2] Adams, D. et al. 2018; [3] Robbins, D. et al. 2020. [4] Hereditary transthyretin amyloidosis (hATTR) is a rare, progressive, and fatal disease. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.



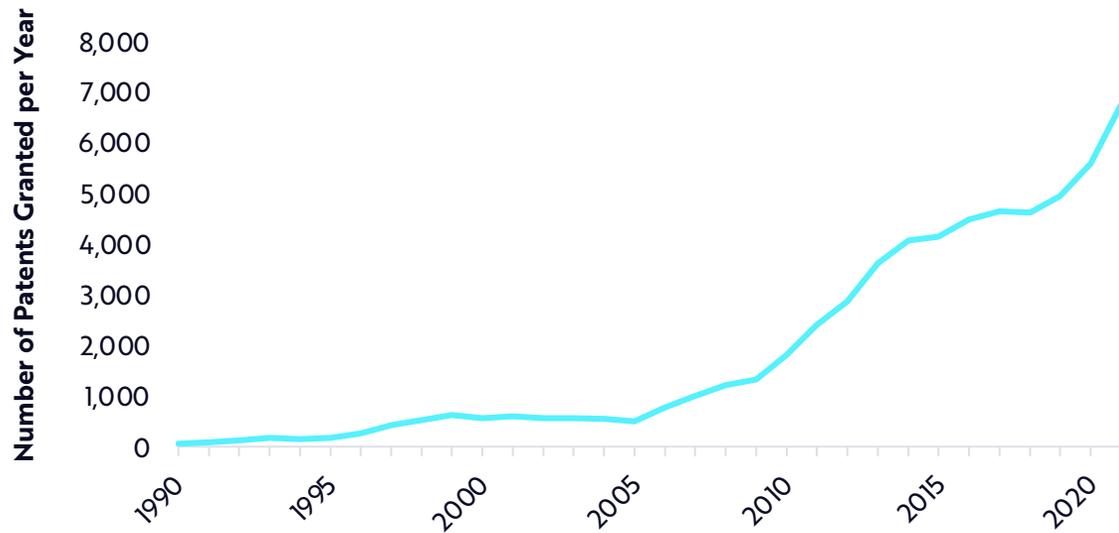
RNA-Based Therapeutics Are Gaining Traction

RNA-based medicines alter the structure, function, quantity, or localization of **RNA** and/or other molecules. This class of medicine can treat “undruggable” targets. While traditional small molecule therapies target the active binding site of a **protein**, only 14% of **proteins** have such sites. RNA-based medicines could help close this gap.

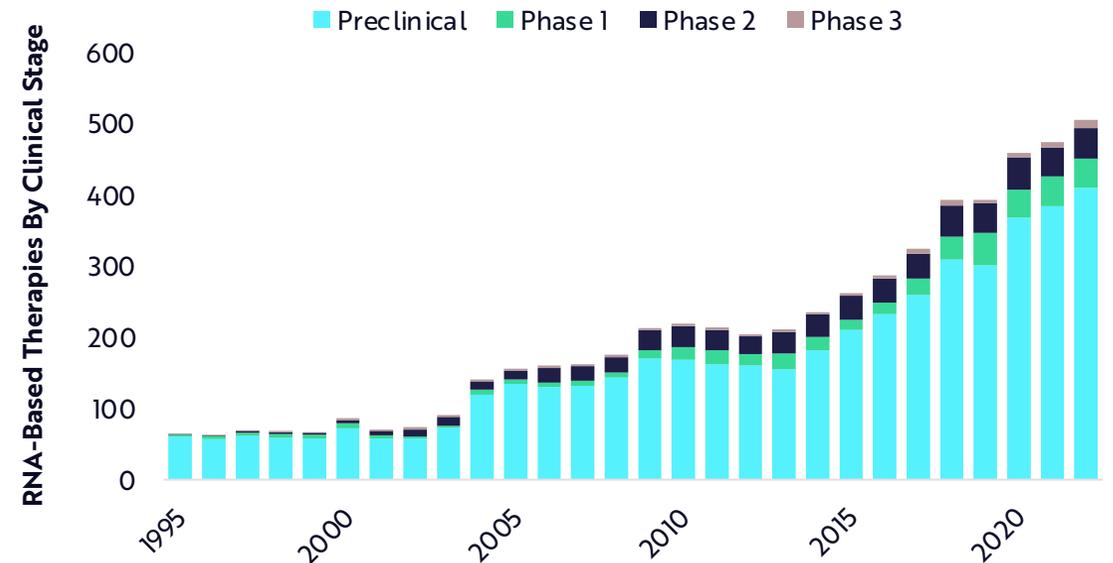


During the past 20 years, the number of annual **RNA** patent grants has increased 10-fold and the number of **RNA-based** therapies in clinical pipelines has more than quintupled to ~500.

RNA Technology Patents Granted Over Time



Clinical Pipeline of RNA-Based Therapies Over Time

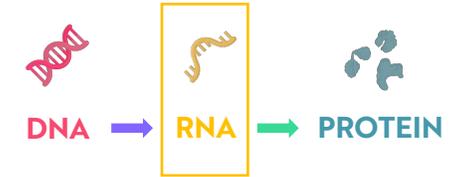


Sources: ARK Investment Management LLC, 2023. Clarivate, data as of 01/17/23; Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



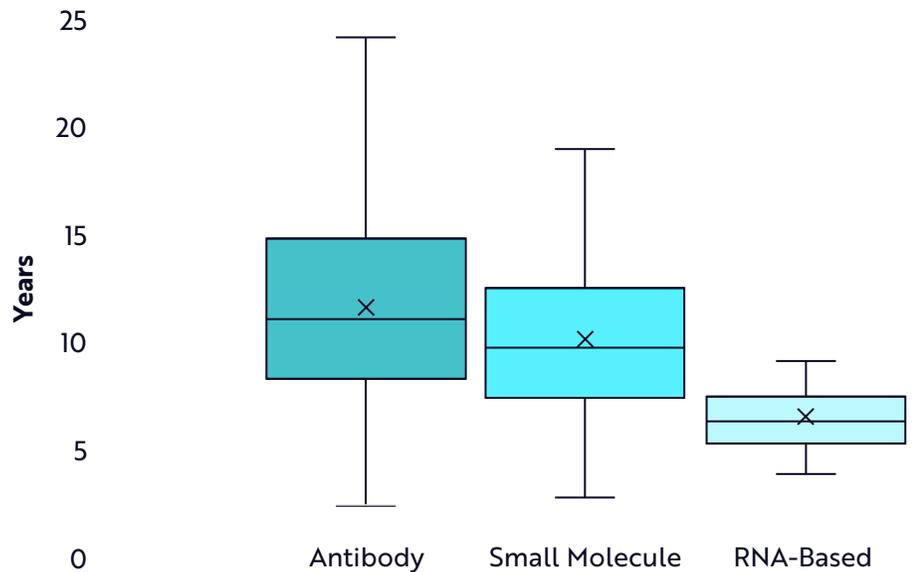
RNA-Based Therapeutics Should Lower Costs and Improve Time To Market

Traditional clinical development costs, including the cost of failures, have averaged \$2 billion over ten years, before any commercialization costs. Thanks to recent multiomic breakthroughs like next generation sequencing, CRISPR gene editing, and artificial intelligence, drug failure rates and commercialization timelines are likely to decline.

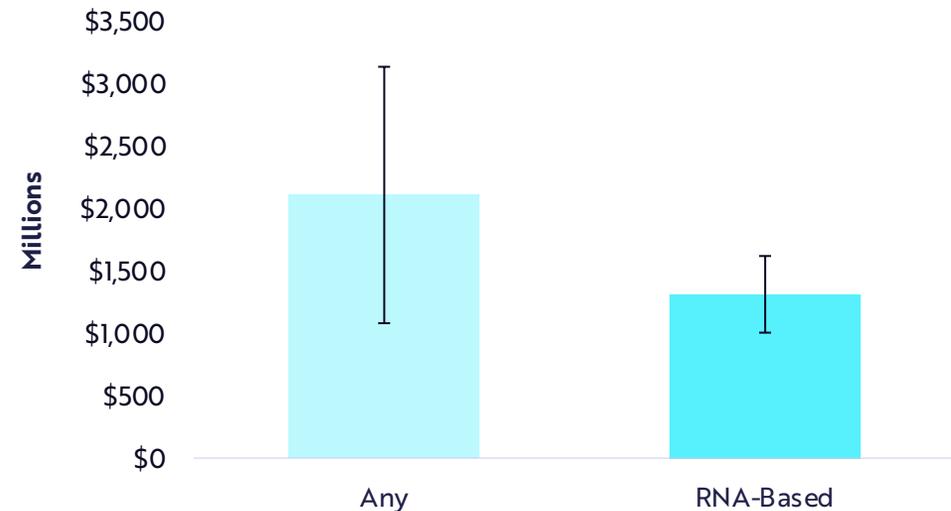


Compared to other modalities, the production of **RNA-based** therapeutics is faster and less expensive. **RNA-based** development, including failures, averages five years and costs \$1.25 billion, compared to small molecule and antibody trials that average 10 years and cost more than \$2 billion.

Clinical Development Time by Therapeutic Class*



Cost of Clinical Development



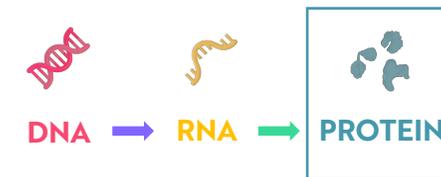
*This is a box and whisker plot used to display data that includes error bars. Sources: ARK Investment Management LLC, 2023. Wouters, O. et al. 2020; Brown, D. et al. 2021; Lindeborg, R. et al. 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



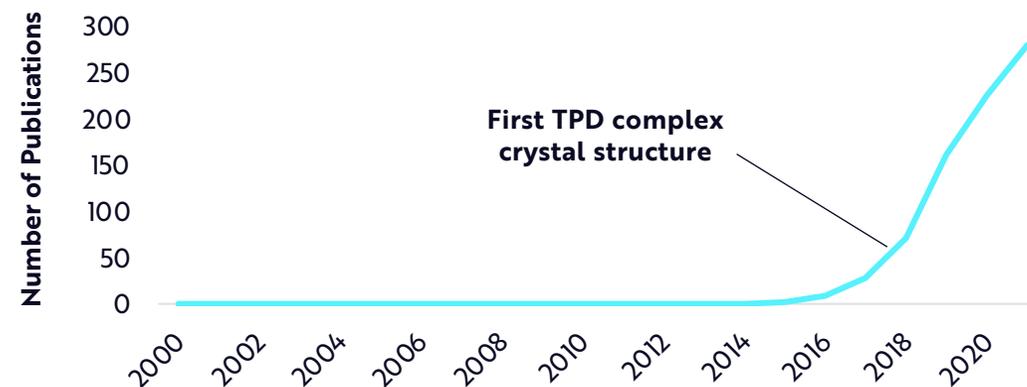
Targeted Protein Degraders (TPD) Could Treat Many Diseases

Targeted **Protein** Degraders (TPDs) leverage the body's system to lower the number of disease-causing misfolded **proteins**. TPDs have doubled the number of druggable **proteins** and are in the clinic for oncology, autoimmune, and fibrotic diseases, sometimes in combination with cell therapies.

During the period of 2015-2020, the number of TPD patent publications increased ten-fold. According to our research, 88% of TPD trials are in early phases, and the number of TPD licensing deals has increased more than 10-fold to 50+.



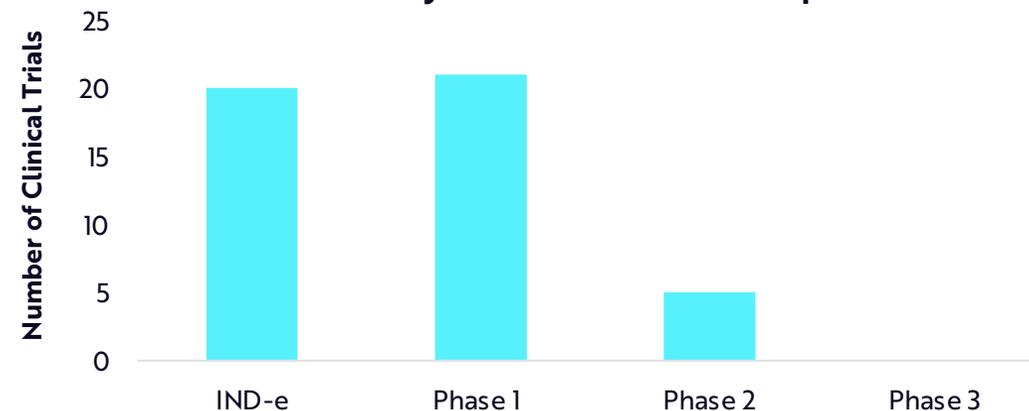
TPD Patent Publication



Cumulative Investment in the Targeted Protein Degradation Space



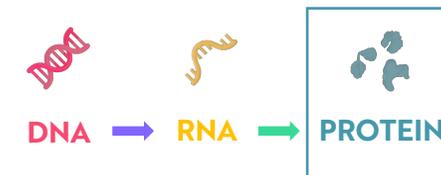
Maturity of TPD Clinical Landscape



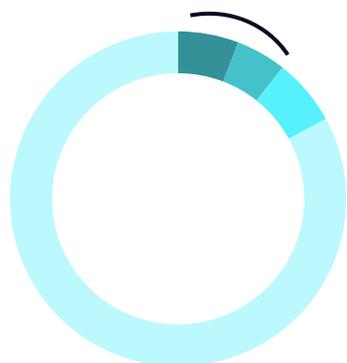
Sources: ARK Investment Management LLC, 2023. Koppal, T. 2020; Nasir, M. et al. 2022; Biomedtracker, data as of 01/17/23; Samarasinghe, K. et al. 2021; Békés, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



TPD Therapy Could Address The “Undruggable” Proteome¹



More Than Half of Protein Targets Under Investigation Are TPD-Enabled



- Targets Under Investigation (TPD-Enabled)
- Targets Under Investigation (Non-TPD-Enabled)
- Targets With An Approved Drug (Not TPDs)
- Remaining Targets (n=24,000)

Targeted **Protein** Degraders (TPDs) have more than doubled the number of druggable human protein targets.

One TPD molecule can degrade hundreds of target **proteins** (iterative mechanism of action) over its lifetime, whereas traditional small molecule inhibitors can target only one. As a result, TPD's have a very attractive safety profile relative to small molecules.

Benefit of Therapeutic Modality	Small-Molecule Inhibitors	TPDs
Potential to Treat Undruggable Proteins	No	Yes
Iterative Mechanism of Action	No	Yes
Orally Bioavailable	Yes	Yes
Ease of Manufacturing	Yes	Yes
Preclinical Validation	Yes	Yes
Clinical Validation	Approved	Phase 2

[1] The term “undruggable” is used to describe a protein that is not pharmacologically capable of being targeted; recently, however, substantial efforts have been made to turn these proteins into “druggable” targets. Thus, “difficult to drug” or “yet to be drugged” are perhaps more appropriate terms. A proteome is the entire complement of proteins that is or can be expressed by a cell, tissue, or organism. Sources: ARK Investment Management LLC, 2023. Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

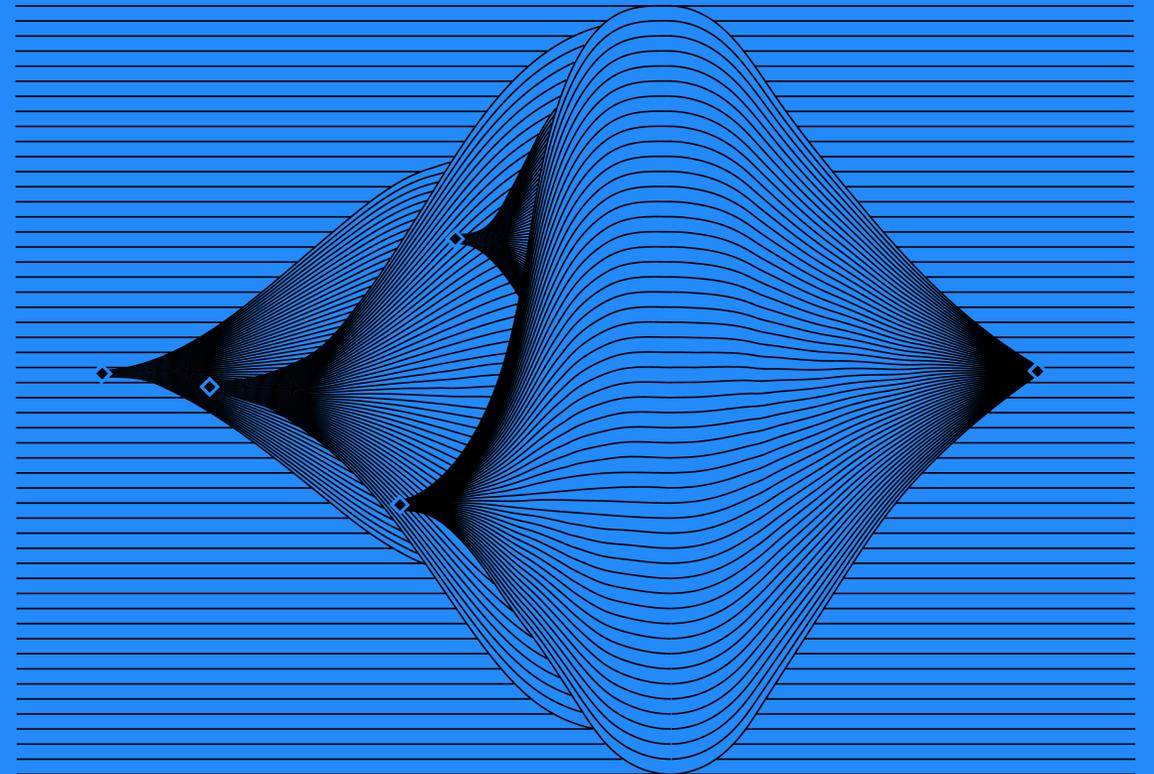


Molecular Cancer Diagnostics

Transforming Biological Signals Into Better Patient Outcomes

Next-generation sequencing (NGS) costs have collapsed, making molecular diagnostic tests more feasible and turbocharging our understanding of tumor biology.¹

By leveraging artificial intelligence (AI), cancer diagnostics labs have created less invasive tests like liquid biopsies to supplement tissue biopsies.²



Research by Simon Barnett, Director of Research, Life Sciences



Definitions, Risk & Disclosure Associated with Molecular Cancer Diagnostics

Health Care Sector Risk. The health care sector may be affected by government regulations and government health care programs, restrictions on government reimbursement for medical expenses, increases or decreases in the cost of medical products and services and product liability claims, among other factors. Many health care companies are: (i) heavily dependent on patent protection and intellectual property rights and the expiration of a patent may adversely affect their profitability; (ii) subject to extensive litigation based on product liability and similar claims; and (iii) subject to competitive forces that may make it difficult to raise prices and, in fact, may result in price discounting. Many health care products and services may be subject to regulatory approvals. The process of obtaining such approvals may be long and costly, and delays or failure to receive such approvals may negatively impact the business of such companies. Additional or more stringent laws and regulations enacted in the future could have a material adverse effect on such companies in the health care sector. In addition, issuers in the health care sector include issuers having their principal activities in the biotechnology industry, medical laboratories and research, drug laboratories and research and drug manufacturers, which have the additional risks described below.

Biotechnology Company Risk. A biotechnology company's valuation can often be based largely on the potential or actual performance of a limited number of products and can accordingly be greatly affected if one of its products proves, among other things, unsafe, ineffective or unprofitable. Biotechnology companies are subject to regulation by, and the restrictions of, the U.S. Food and Drug Administration, the U.S. Environmental Protection Agency, state and local governments, and foreign regulatory authorities.

Pharmaceutical Company Risk. Companies in the pharmaceutical industry can be significantly affected by, among other things, government approval of products and services, government regulation and reimbursement rates, product liability claims, patent expirations and protection and intense competition.

Definitions:

Deoxyribonucleic acid (DNA) is a polymer composed of two polynucleotide chains that coil around each other to form a double helix carrying genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses.

Ribonucleic acid (RNA) is a polymeric molecule essential in various biological roles in coding, decoding, regulation and expression of genes.

Multi-omics aims to combine two or more omics data sets to aid in data analysis, visualization and interpretation to determine the mechanism of a biological process. Proteomics is the large-scale study of proteins.

Primary Sequence is the linear sequence of amino acids in a protein or of nucleotides in a nucleic acid.

Phasing involves separating maternally and paternally inherited copies of each chromosome into haplotypes to get a complete picture of genetic variation.

Epigenetics is the study of how your behaviors and environment can cause changes that affect the way your genes work. Unlike genetic changes, epigenetic changes are reversible and do not change your DNA sequence, but they can change how your body reads a DNA sequence. A variant is any change in the DNA sequence of a cell. Variants may be caused by mistakes during cell division, or they may be caused by exposure to DNA-damaging agents in the environment.

The phenotype is the set of observable characteristics or traits of an organism. The term covers the organism's morphology or physical form and structure, its developmental processes, its biochemical and physiological properties, its behavior, and the products of behavior. Protein quantification is necessary to understand the total protein content in a sample or in a formulated product.

Posttranslational modifications (PTMs) are covalent processing events that change the properties of a protein by proteolytic cleavage and adding a modifying group, such as acetyl, phosphoryl, glycosyl and methyl, to one or more amino acids.

Proteoforms are the different forms of a protein produced from the genome with a variety of sequence variations, splice isoforms, and post-translational modifications. Proteoform captures the disparate sources of biological variation which alter primary sequence and composition at the whole-protein level. Gene isoforms are mRNAs that are produced from the same locus but are different in their transcription start sites, protein coding DNA sequences and/or untranslated regions, potentially altering gene function.

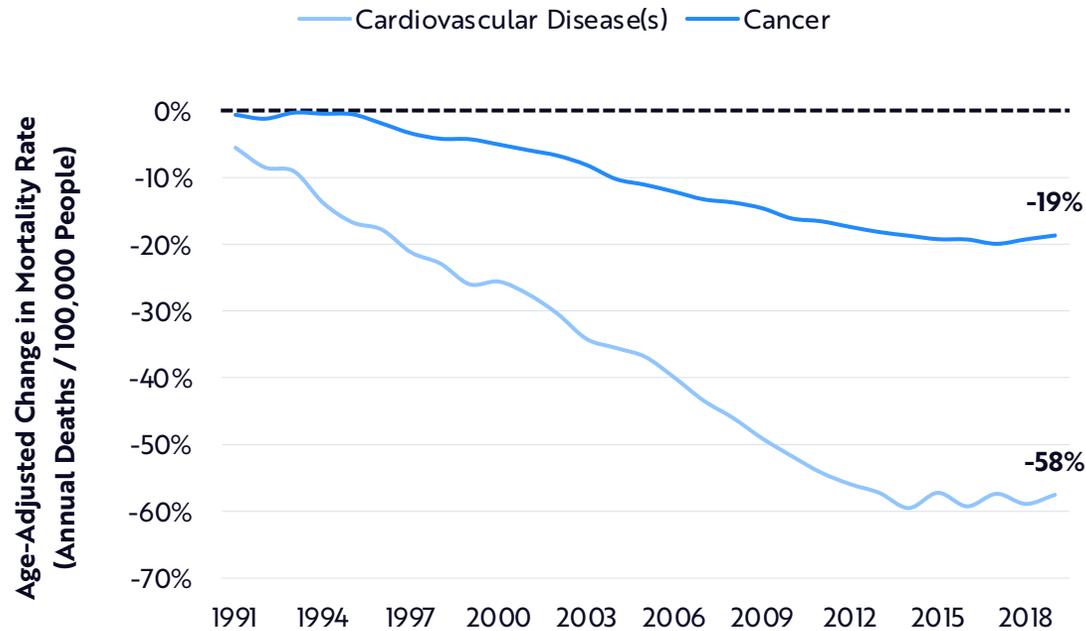


Cancer Could Be The Next Victory In Public Health

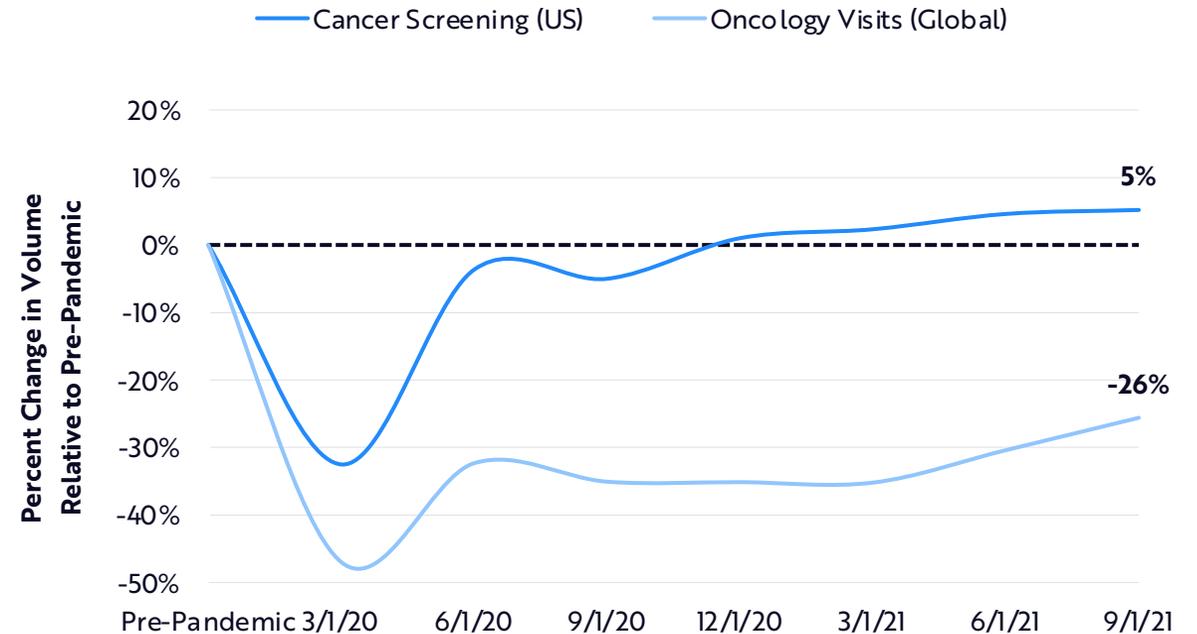
Since 1990, while the age-adjusted mortality rate for cardiovascular diseases has dropped more than 50%,¹ that for cancer has declined only ~19%.² Alongside improved therapies, emerging diagnostics could result in a dramatic drop in cancer mortality.

The need to focus on cancer has never been greater, especially because the COVID-19 pandemic severely disrupted cancer care, causing patients to miss more than 30 million screenings and ~60,000 diagnoses.³

Progress Fighting Cardiovascular Diseases and Cancer^{1,2}



COVID's Impact on Global Oncology Practices³



Sources: ARK Investment Management LLC, 2023. [1] Mensah, G. et al. 2017; [2] Roser, M. et al. 2019; [3] IQVIA Inc 2022. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

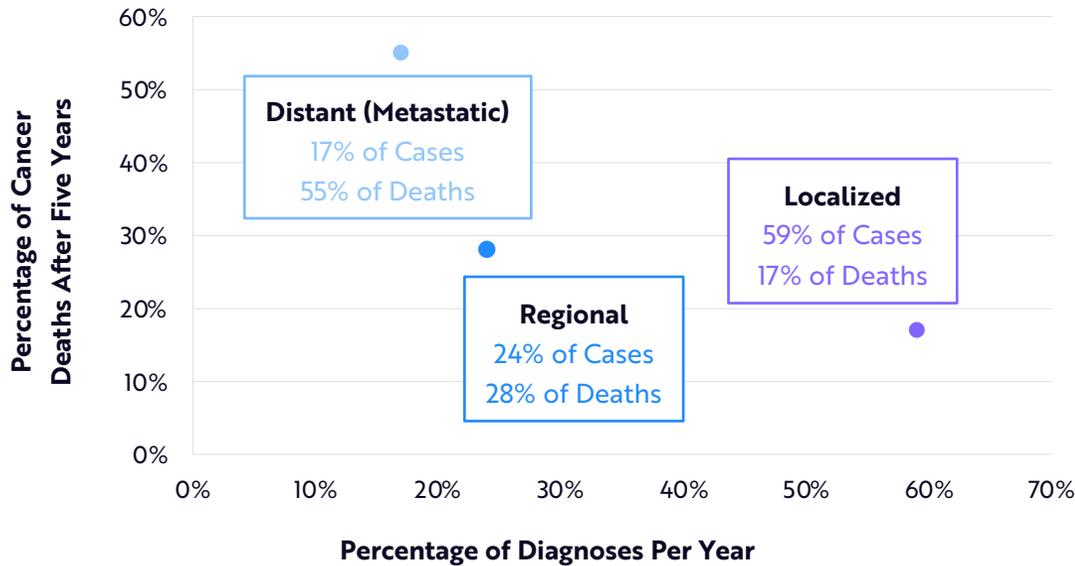


Diagnostics + Therapeutics Should Reduce Cancer Mortality

We believe next-generation diagnostics and therapeutics will work together to lower cancer mortality.¹

Advanced cancers account for only 17% of new diagnoses each year but 55% of deaths after five years. The importance of early detection is clear.²

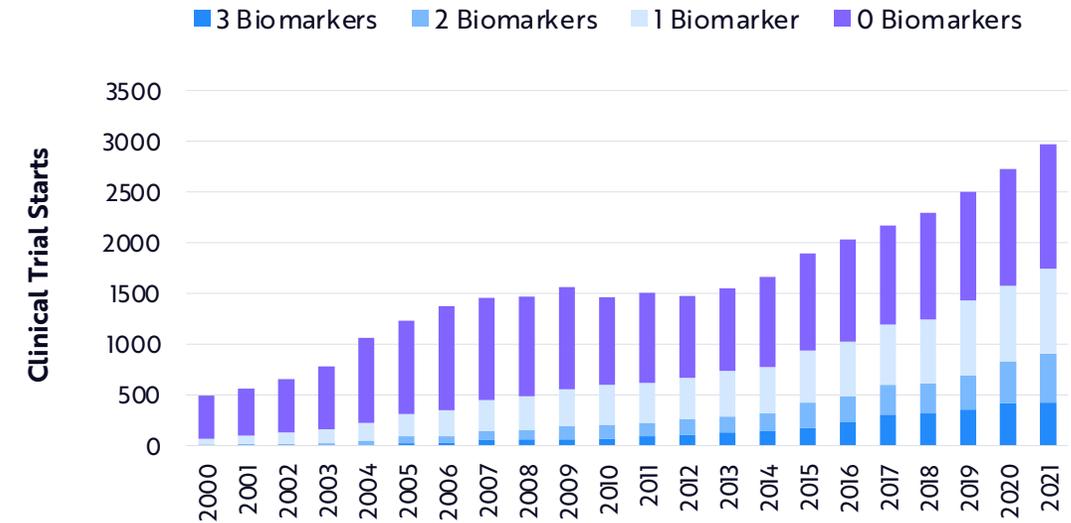
Advanced Cancers Account For The Minority of New Cases But Cause the Majority of Deaths²



Molecular testing is a prerequisite for precision therapy. The tests surface tumor-specific mutations, also called biomarkers, which point oncologists towards specific treatments.

Evidence suggests that biomarkers improve trial success rates,³ so most oncology clinical trials now include molecular biomarkers.⁴

The Majority of Oncology Clinical Trials Use Molecular Biomarkers⁴



Sources: ARK Investment Management LLC, 2023. [1] Mensah, G. et al. 2018; [2] National Cancer Institute, data as of 01/19/23; [3] Parker, J. et al. 2021; [4] Vadas, A. et al. 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

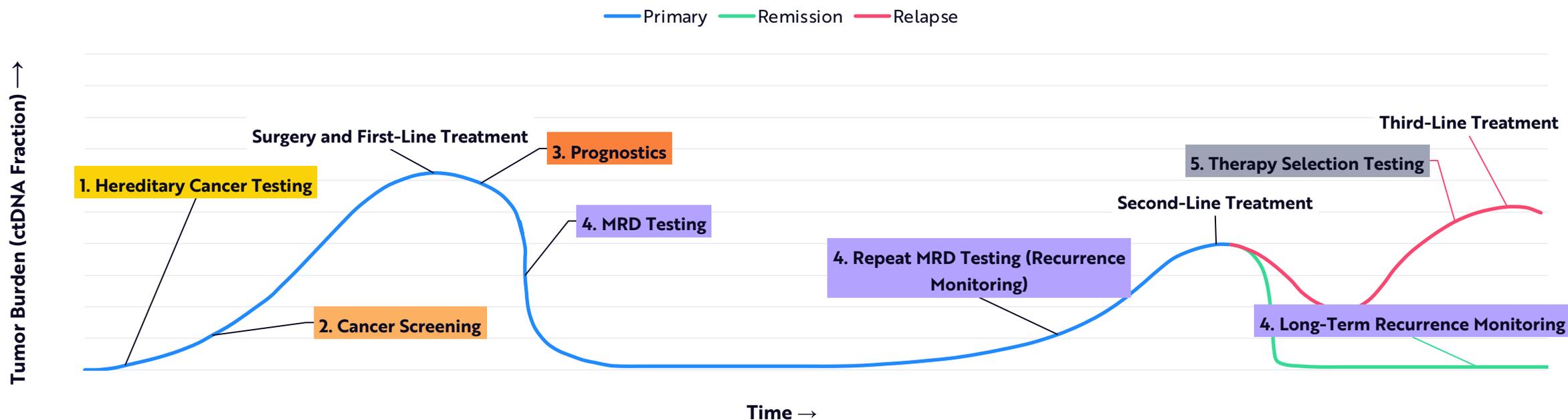


The Molecular Cancer Testing Market Segments By “Tumor Burden”

Molecular cancer tests examine biological samples like blood or tissue and use techniques like next-generation sequencing to transform biological information into digital information. Among the categories of molecular cancer testing are: (1) hereditary cancer testing, (2) screening, (3) prognostics, (4) minimal residual disease (MRD),¹ and (5) therapy selection.

Tumor burden is a rough proxy for cancer’s severity, typically quantified by the amount of circulating tumor DNA (ctDNA) in a patient’s bloodstream. Using this framework, we segment the cancer testing market, as shown below.

The Molecular Testing Landscape is Governed by a Patient's Tumor Burden



This image is not drawn to scale. The relationship between tumor burden and time is meant to be purely illustrative, not representative of a specific data set.

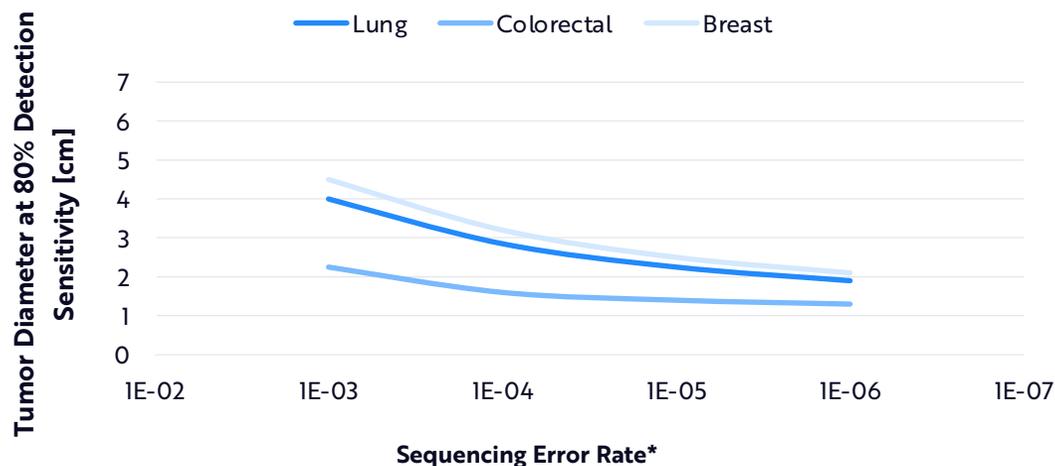
[1] Minimal residual disease is the name given to small numbers of leukaemic cells that remain in the person during treatment, or after treatment when the patient is in remission. It is the major cause of relapse in cancer and leukemia. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Multiomics Is Powering Screening Tests For The Deadliest Cancers

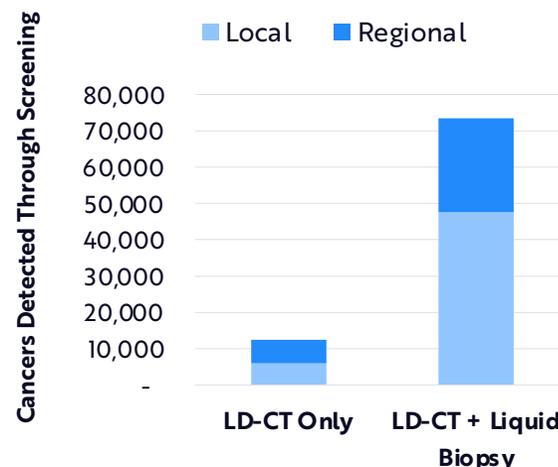
Non-invasive tests like Cologuard are supplementing standard-of-care screening technologies, a trend that should accelerate. Sequencing ctDNA mutations alone does not detect early-stage cancers reliably.¹ Even extremely accurate ctDNA sequencing methods struggle to find cancers until they are 1-2 cm in diameter, as shown below.¹ Multiomics tests incorporating other circulating cancer signals—like DNA fragmentation patterns—enable better performance.

DNA Mutations Alone are Insufficient to Screen for Most Stage I Cancers Economically¹



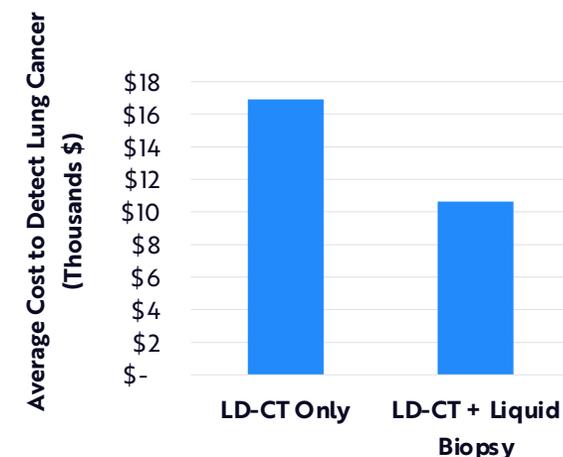
*1E-03 means 1-in-1,000 bases is incorrect, 1E-06 means 1-in-1,000,000.

Blood-Based Tests Could Improve Lung Cancer Screening^{2,3}



LD-CT = Low-Dose CT Scan

Blood-Based Tests Could Lower the Average Cost of Detecting Lung Cancer²



Powerful tests focused on lethal cancers, like pancreatic, are likely to proliferate during the next five years.

With currently available data, blood-based screening should increase early-stage lung cancer detection by six-fold.^{2,4} Improved cancer detection, in turn, should lower average detection costs.

Sources: ARK Investment Management LLC, 2023. [1] Avanzini, S. et al. 2020; [2] Mathios, D. et al. 2021; [3] When describing the stage, doctors may use the words local, regional or distant. Local means that the cancer is only in the lung and has not spread to other parts of the body. Regional means the cancer has spread to lymph nodes or other parts of the chest on the same side of the body as the cancer. [4] Zhao, Y. et al. 2011. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

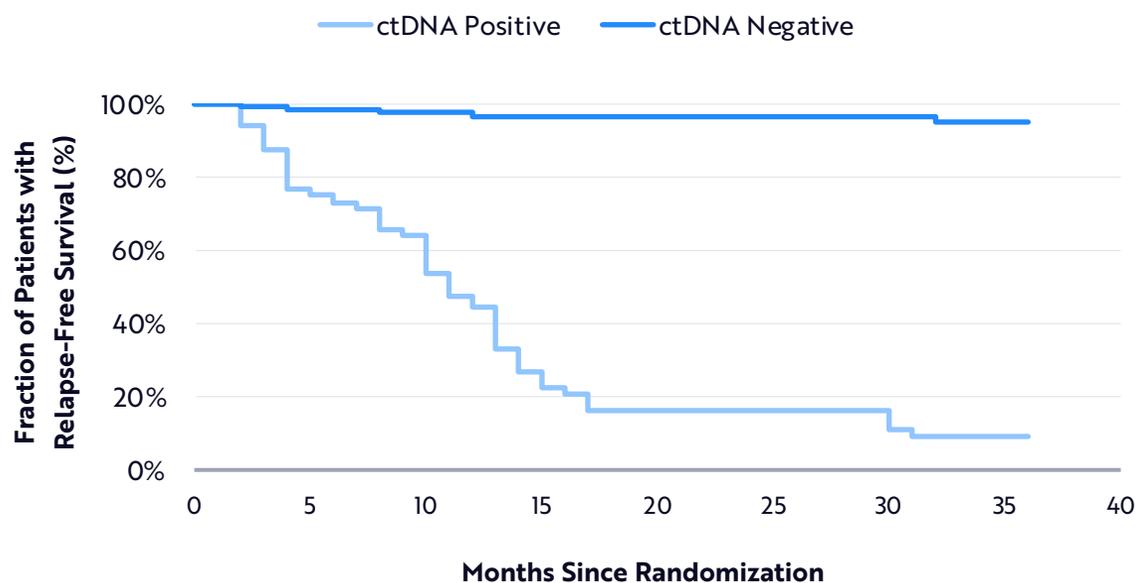


Blood-Based Testing Could Revolutionize The Treatment Of Early-Stage Cancer

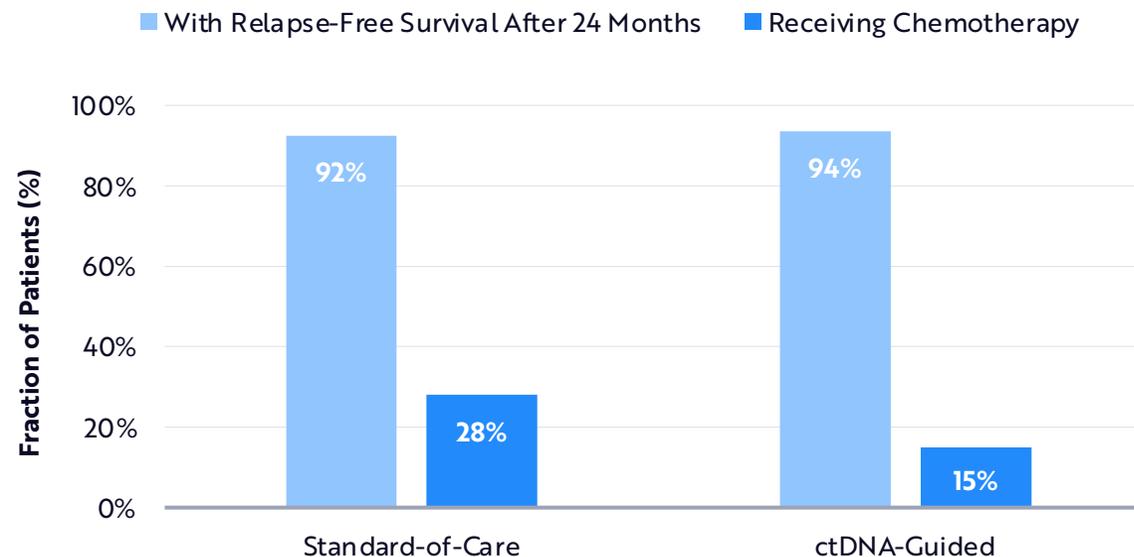
Historically, oncologists have used a metric called minimal residual disease (MRD)—the amount of cancer remaining in the body after treatment—to guide treatment for liquid tumors like multiple myeloma.¹ Solid tumors, which constitute 90% of annual diagnoses, require deep, expensive sequencing, making solid tumor MRD testing prohibitively expensive, until recently.²

Thanks to less expensive sequencing techniques, oncologists now test solid tumor patients not only with imaging but also with molecular MRD. ctDNA can predict relapse-free survival, helping patients avoid unnecessary chemotherapy.^{3,4}

ctDNA Status is an Excellent Predictor of Relapse-Free Survival for Multiple Cancers³



ctDNA-Guided Cancer Care Achieved Comparable Survival Rates While Halving The Percent of Patients On Chemo⁴

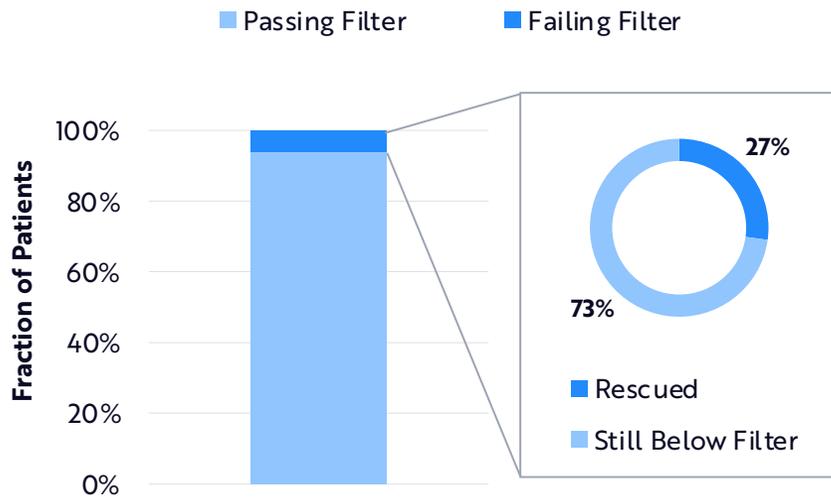




Therapy Selection Tests Add More Content And Sample Types

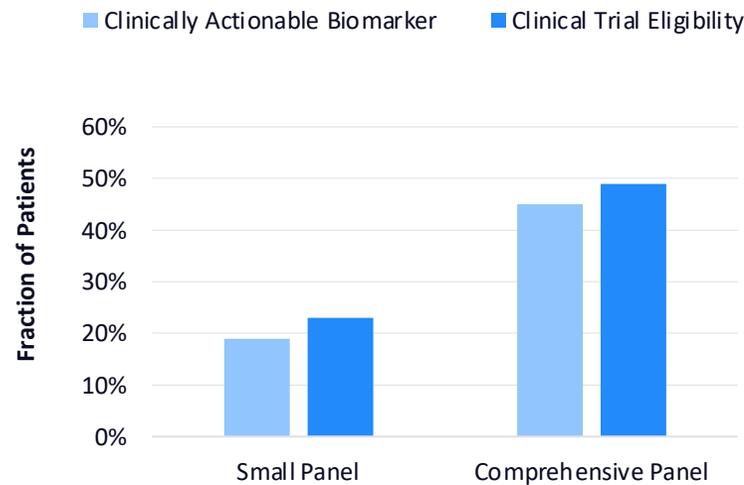
Designed for patients with more advanced cancers, therapy selection tests surface cancers' molecular drivers. While more mature than other molecular diagnostics, therapy selection tests are adding more sample types like blood,¹ more genes, and more analytes like RNA, increasing patient access and the probability of matches to targeted therapies or clinical trials.^{2,3}

Blood-Based Therapy Selection Is An Alternative for Patients with Insufficient Tissue¹

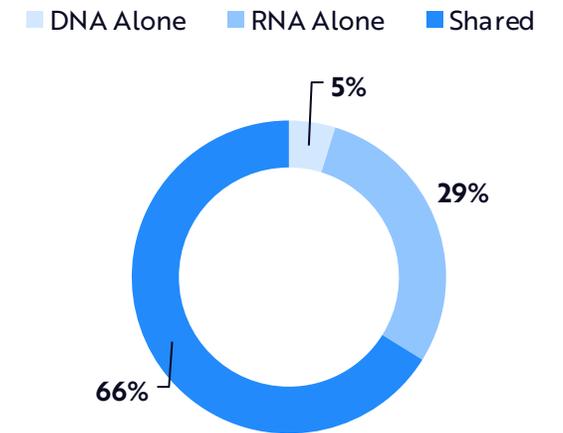


Passing filter means a patient has sufficient, high-quality tumor tissue for molecular testing.

Comprehensive Therapy Selection Tests Surface More Actionable Information for Patients



RNA Sequencing Discovers 29% More Fusion Targets Than DNA Sequencing Alone³



RNA fusions are a class of druggable targets for cancer therapies.

Sources: ARK Investment Management LLC, 2023. [1] Mackay, M. et al. 2022; [2] Raval, A. 2022; [3] Michuda, J. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

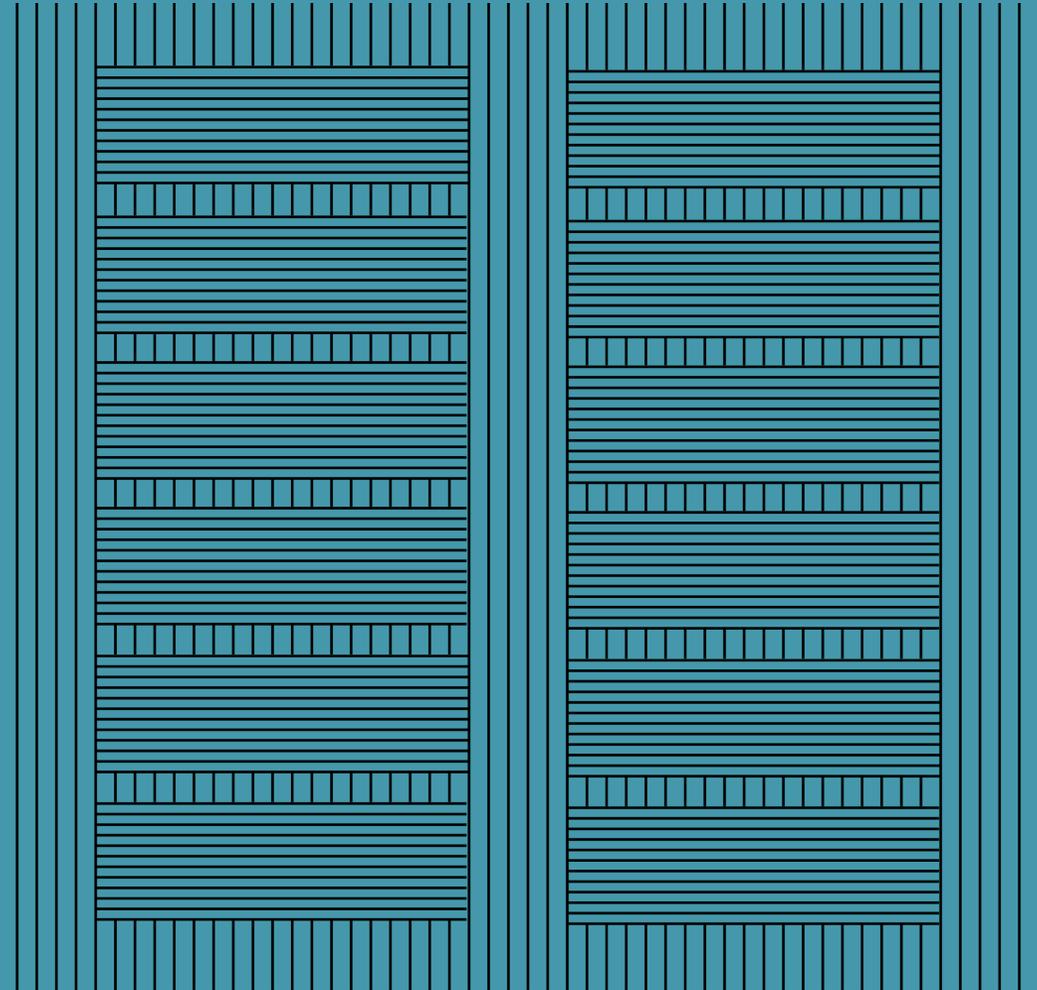


Electric Vehicles

Potential To Defy The Skeptics With Exponential Growth

Investors once questioned whether the future was electric. Demand for EVs has scaled despite a pause in cost declines caused by commodity price shocks. Now investors doubt whether or not the growth will be exponential.

The debate around electric vehicles has shifted from demand to supply.

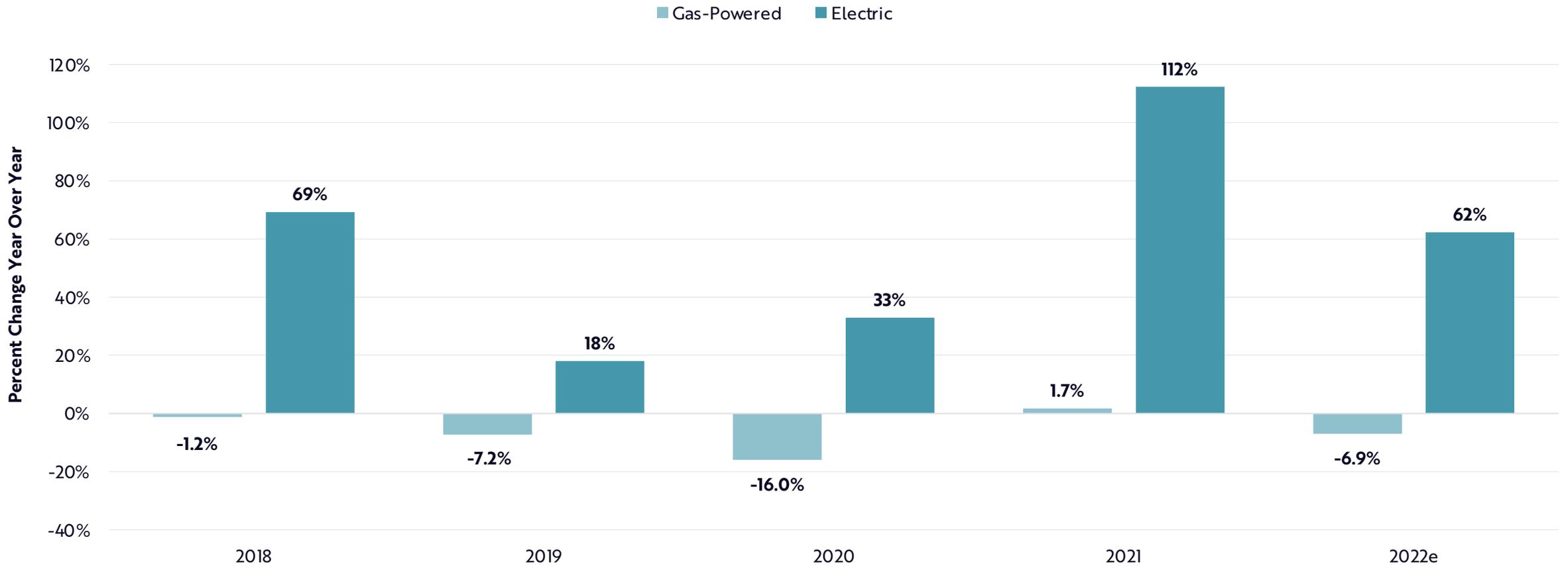


Research by Sam Korus, Director of Research, Autonomous Technology & Robotics



Electric Vehicle Sales Continue To Take Share

Growth In Global Vehicle Sales*



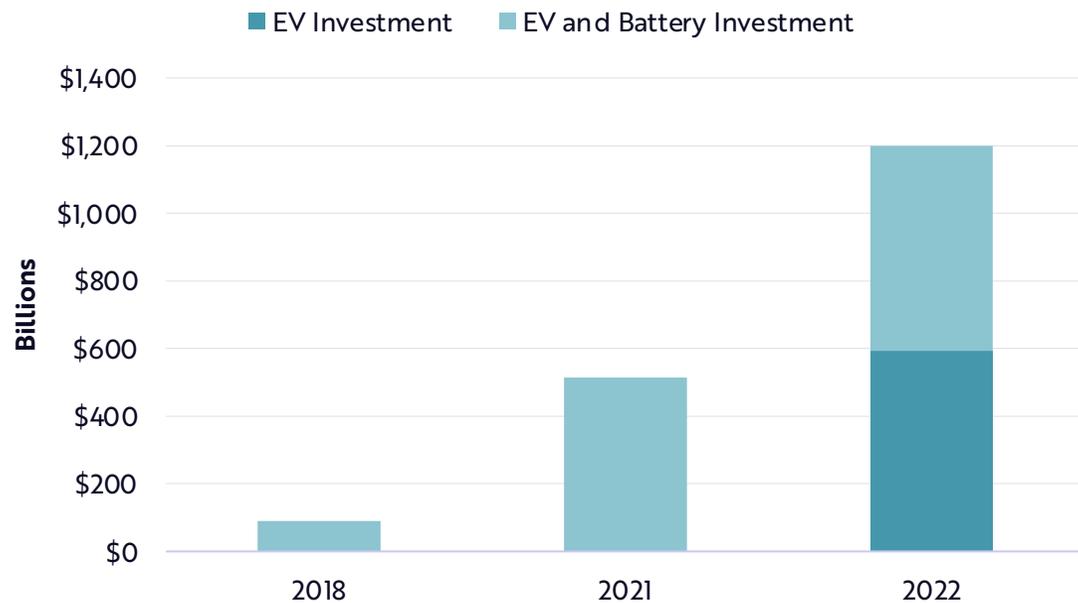
*The chart's "Gas-Powered" category includes hybrid vehicles. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



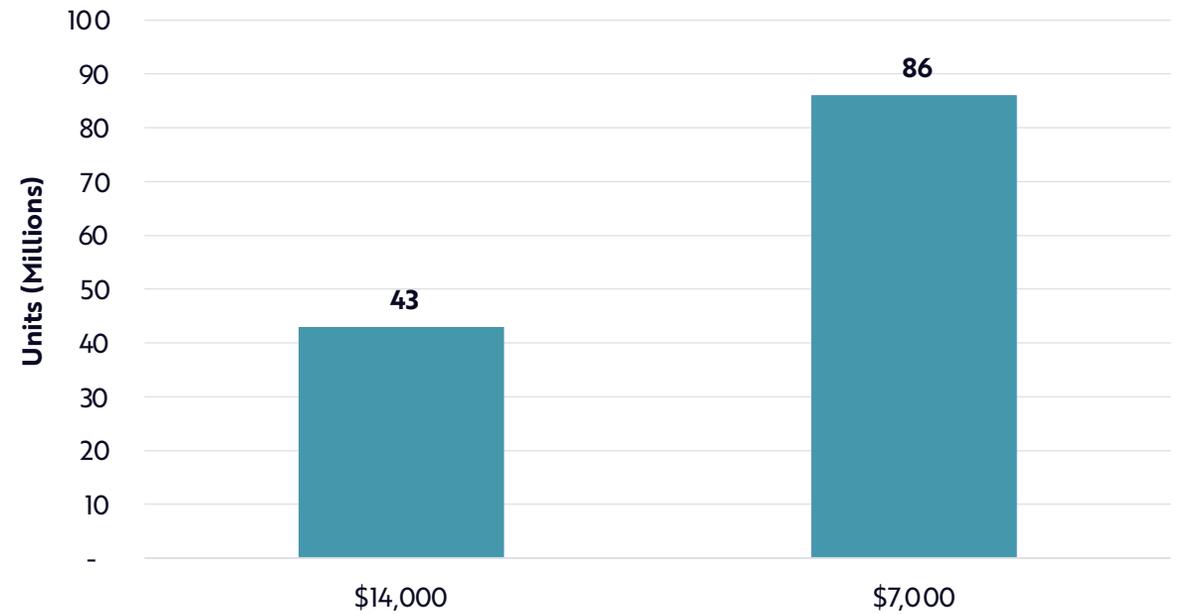
Global Automakers Have Increased Investment Plans For EVs And Batteries More Than 10-Fold Over The Past Four Years

At a historical auto industry capital efficiency of \$14,000 per unit capacity, the annualized ~\$600 billion earmarked for EV investment would equate to 43 million units in annual production per year. If all automakers were to realize the capital efficiency associated with EVs, \$600 billion would accommodate 86 million units, approaching total auto production today.

Global Automaker Investment Plans for Electric Vehicles and Batteries Over The Next Ten Years



Annual EV Production Capacity



Cost Per Unit of Production Capacity

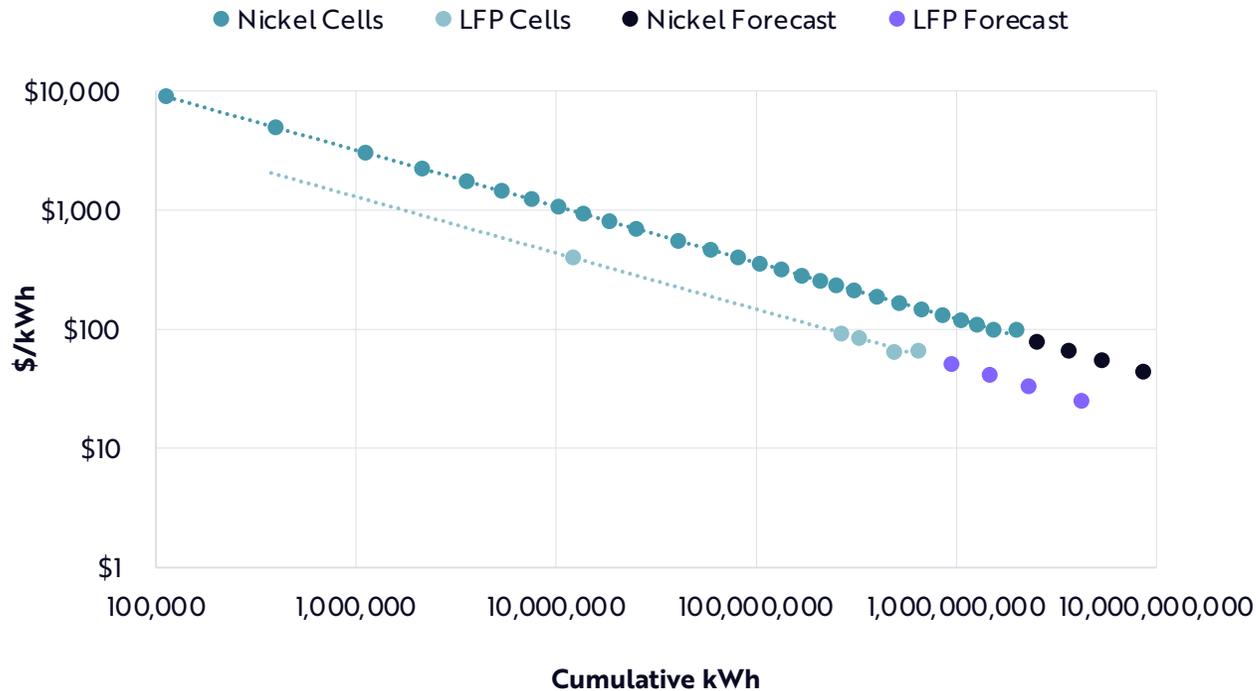
Sources: ARK Investment Management LLC, 2023. Lienert, P. 2022; Lienert, P. et al. 2021; Lienert, P. 2018; White, J. et al. 2017. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



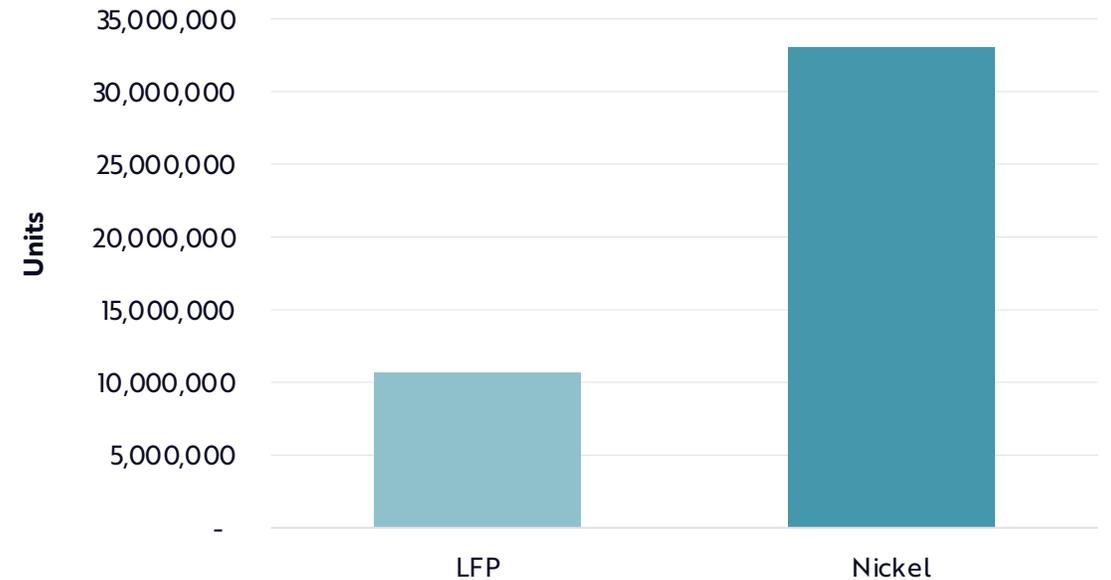
Wright's Law Has Modeled The Decline In Battery Costs Accurately And Points To LFP¹ Cells As The Dominant Chemistry

The largest cost component of an EV is its battery, the declining cost of which should decrease the cost of Electric Vehicles. According to Wright's Law,² for every cumulative doubling in the number of units produced, battery cell costs will fall by 28%. Despite the recent commodity spikes and associated battery price increases, this relationship should persist over the long term. At a lower production base, lithium iron phosphate cells could accelerate the cost and price declines.

Battery Cost Decline



EV Units Necessary for a Cumulative Doubling of Production

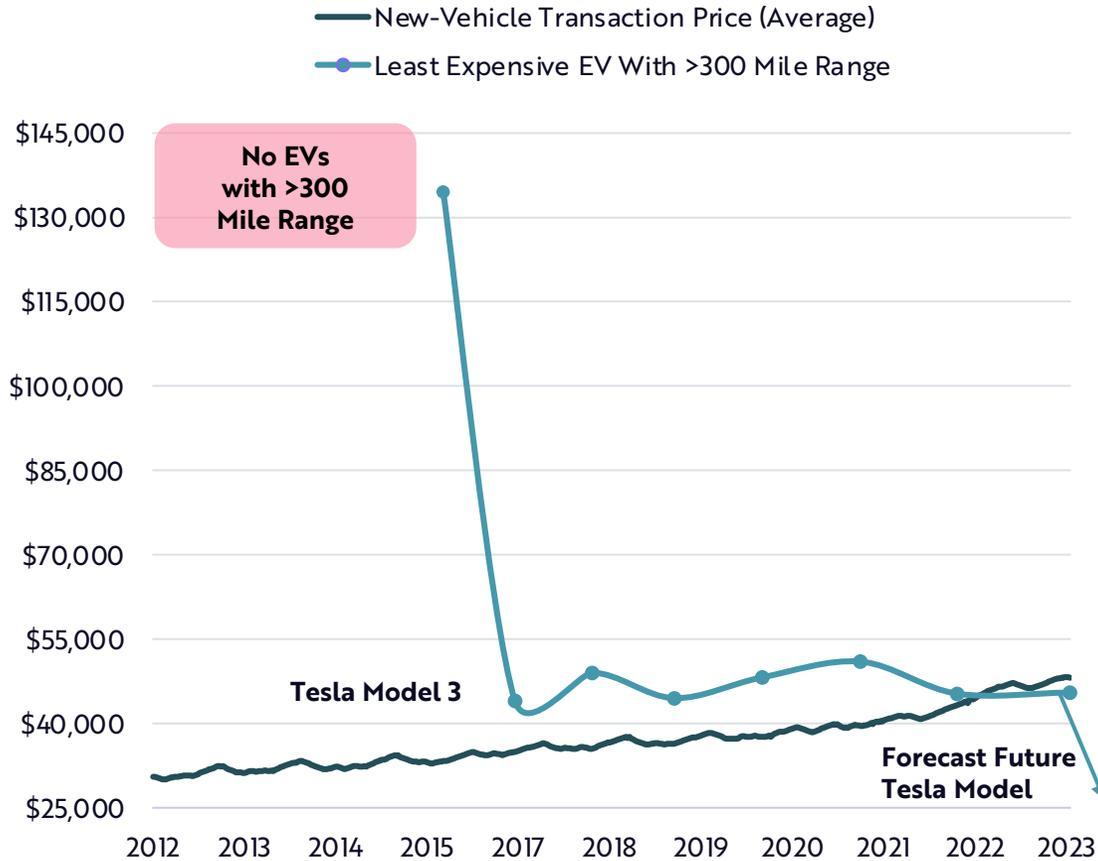


[1] Lithium iron phosphate (LFP). [2] Pioneered by Theodore Wright in 1936, Wright's Law aims to provide a reliable framework for forecasting cost declines as a function of cumulative production. Specifically, it states that for every cumulative doubling of units produced, costs will fall by a constant percentage. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

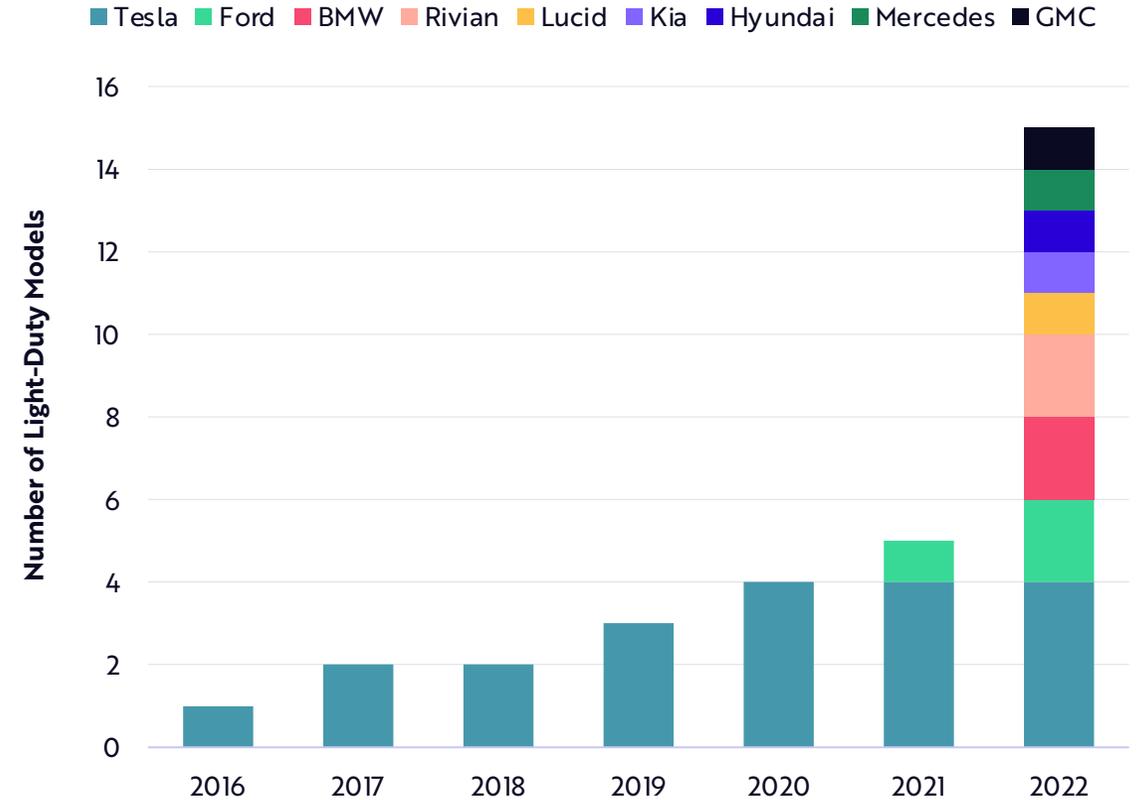


EVs Have Hit Price-Parity With Gas-Powered Vehicles

Transaction Price



Models Of Light-Duty Electric Vehicles In The US With Range >300 Miles*



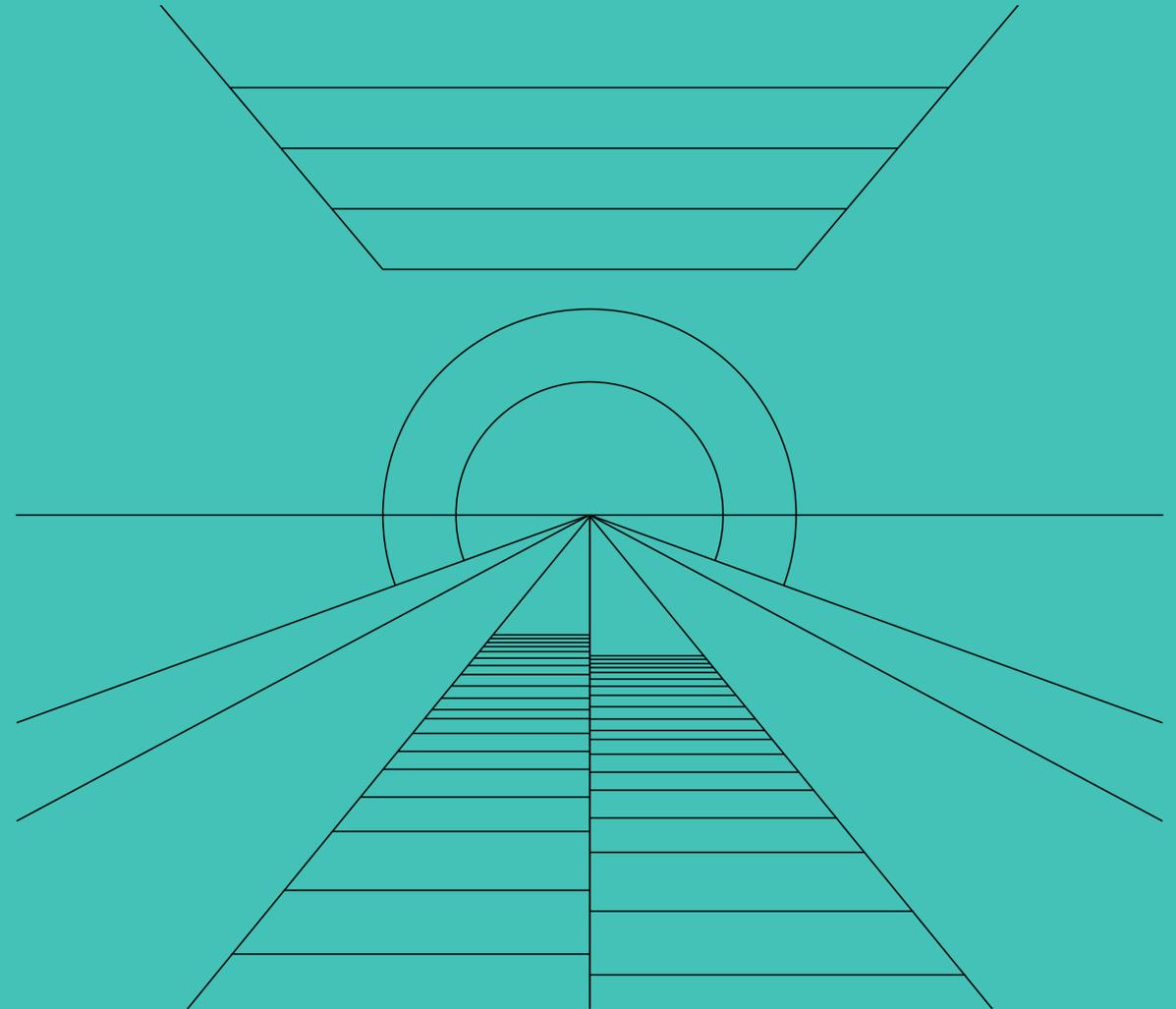
*Model Year 2016-2022. Sources: ARK Investment Management LLC, 2023. Kane, M. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Autonomous Ride-Hail

Scaling Toward Widespread Commercial Adoption

Today, autonomous ride-hail¹ services delight riders across ~15 cities internationally².



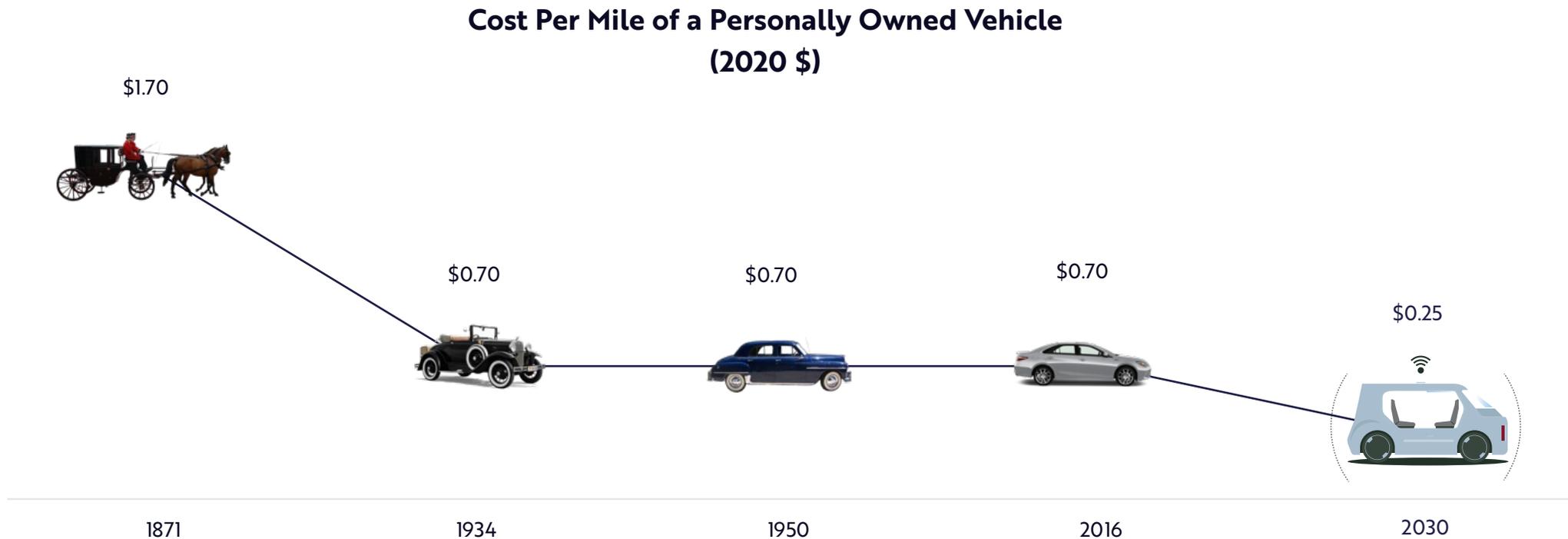
Research by Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

[1] Ride-hailing (an act when a customer orders a customized ride online usually via a smartphone application. In essence, it is similar to a taxi service) that is autonomous (characterized by having the freedom to govern itself or control its own affairs). [2] This number includes both commercial and non-commercial services operating at the end of 2022. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Autonomous Ride-Hail Is Likely To Increase Access to Convenient Point-to-Point Transportation

Adjusted for inflation, the cost of owning and operating a personal car has not changed since the Model T rolled off the first assembly line nearly 100 years ago. ARK estimates that autonomous taxis at scale could cost consumers as little as \$0.25 per mile, spurring widespread adoption.





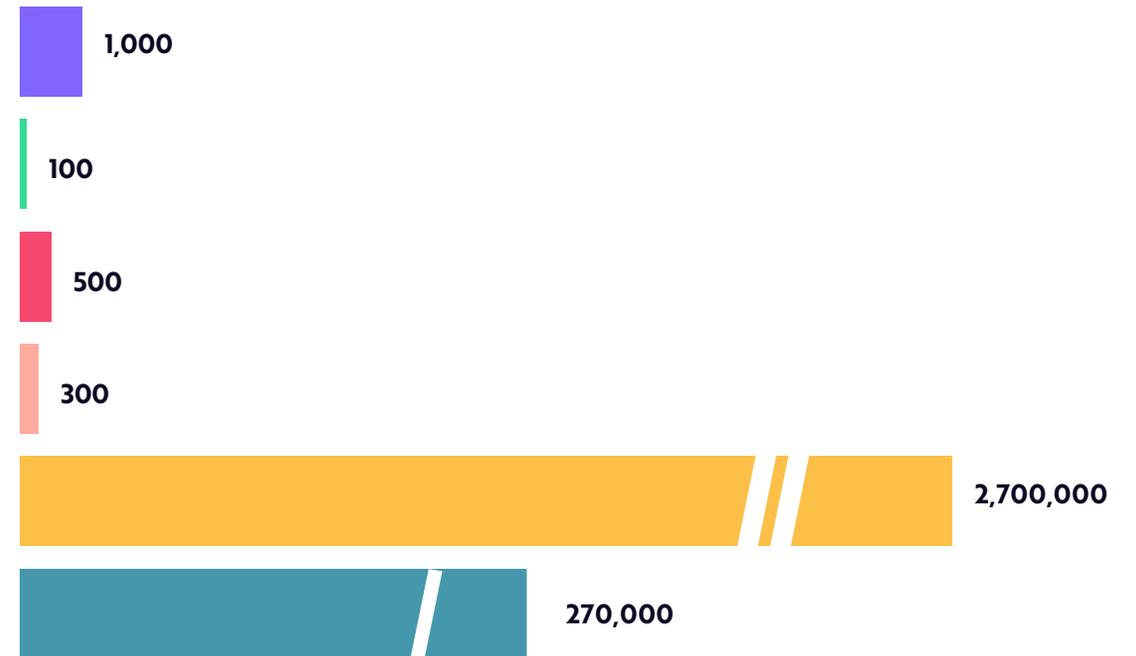
Autonomous Taxis Are A Reality Today

The first players to scale should become the market leaders.

Robotaxi Commercial Launch Year



Number of Cars Collecting Data Today*



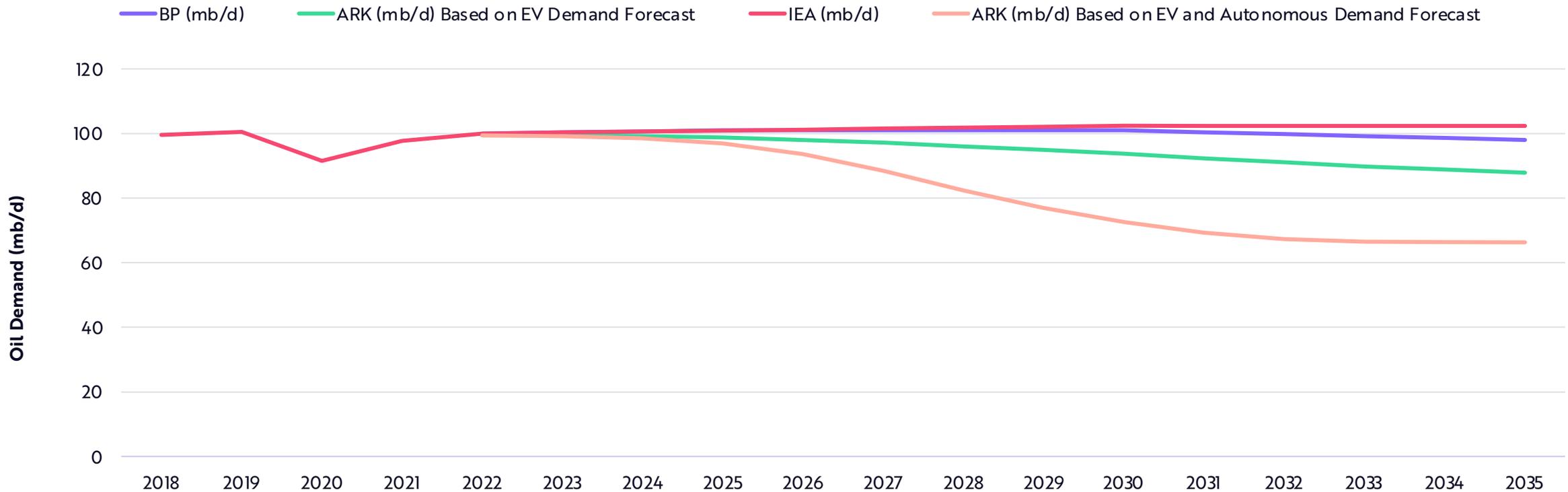
*These cars can collect data for autonomous driving, though all the vehicles are not yet "robotaxi ready" in the case of Xpeng. Estimates are based on publicly available data and ARK research. Numbers are rounded and may not be exact. The bars in this chart are broken because they are of two outliers, and if charted the data accurately, a viewer would not have the ability to distinguish any difference between the other values. Sources: ARK Investment Management LLC, 2023. Welch, D. 2022; Bellan, R. 2022; Zhang, P. 2022; Irle, R. 2022; Lee, T. 2022; Wessling, B. 2022; TechNode 2022; TechNode 2022; Pandaily 2022; Bellan, R. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Based On The Shift To Autonomous Electric Vehicles, Oil Demand Could Decline 30% By 2030

Based on ARK’s electric vehicle forecast, oil demand is peaking and could decline by 5%, or 5 million barrels per day, by 2030 and 10% by 2035. Adding the adoption of autonomous vehicles, the capacity utilization of which could be 10x higher than that for personally-owned cars, oil demand could decline 30 million barrels per day by 2035.

Global Oil Demand*



*BP = British Petroleum, IE = International Energy Agency, MB/D = Million Barrels per Day. Sources: ARK Investment Management LLC, 2023. Cozzi, L. et al. 2022; BP p.l.c. 2022; IEA 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Global Auto Sales May Have Peaked In 2017

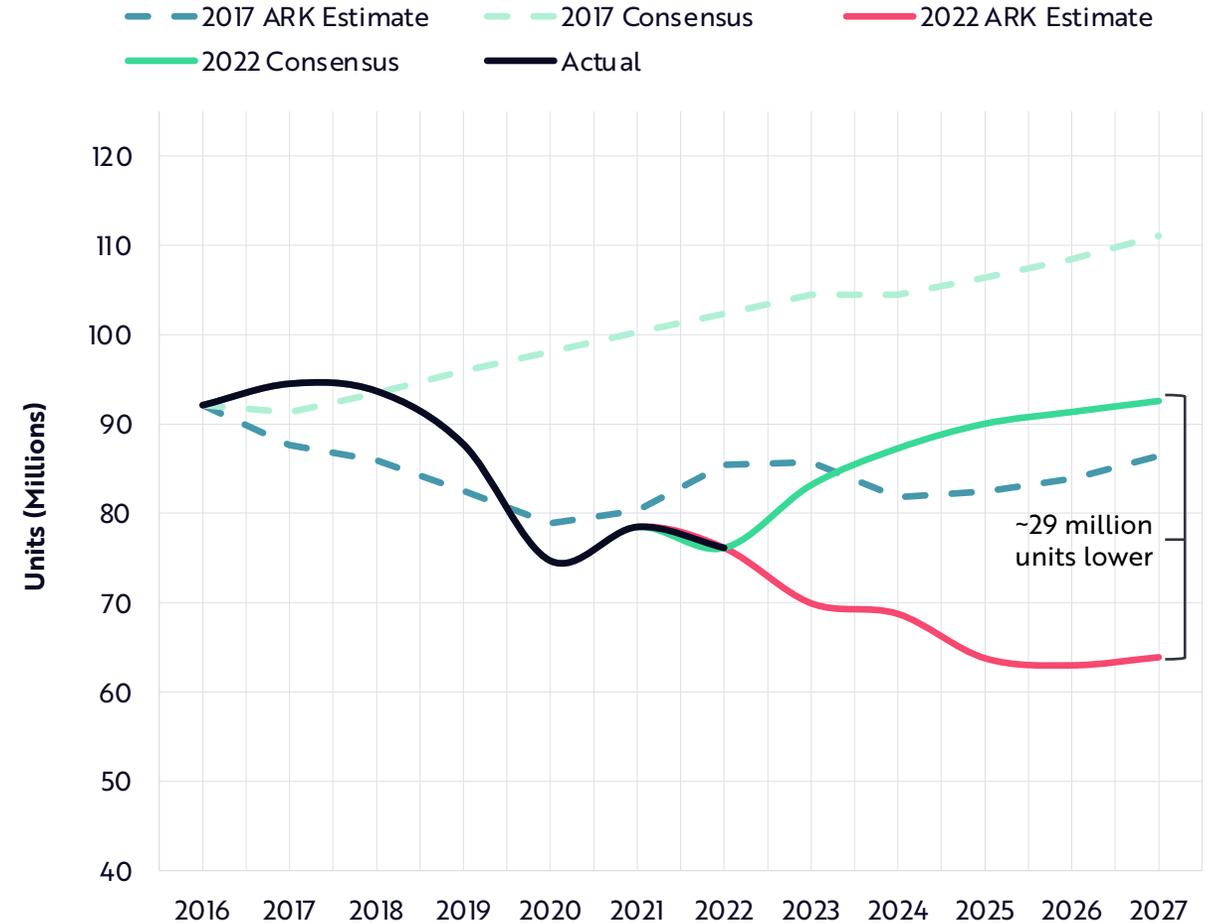
In 2017, ARK predicted that human-driven ride-hail and autonomous taxis would reduce overall auto sales by ~24 million relative to consensus expectations for 2025.

Since 2017, auto sales have declined more than we predicted, largely because of the supply chain crisis associated with COVID-19.

Autonomous vehicles should have higher utilization rates than human-driven cars, lowering the number of vehicles on the road despite higher numbers of passengers and per capita miles.

As autonomous taxis begin to dominate urban transit, ARK now expects unit volumes to be ~26 million and ~29 million units lower than today's consensus expectations for 2025 and 2027, respectively.

Global Annual Auto Sales



Sources: ARK Investment Management LLC, 2023. S&P Global, data as of 12/28/22. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Autonomous Taxis Could Eliminate ~60% Of Short-Haul Airline Flights¹

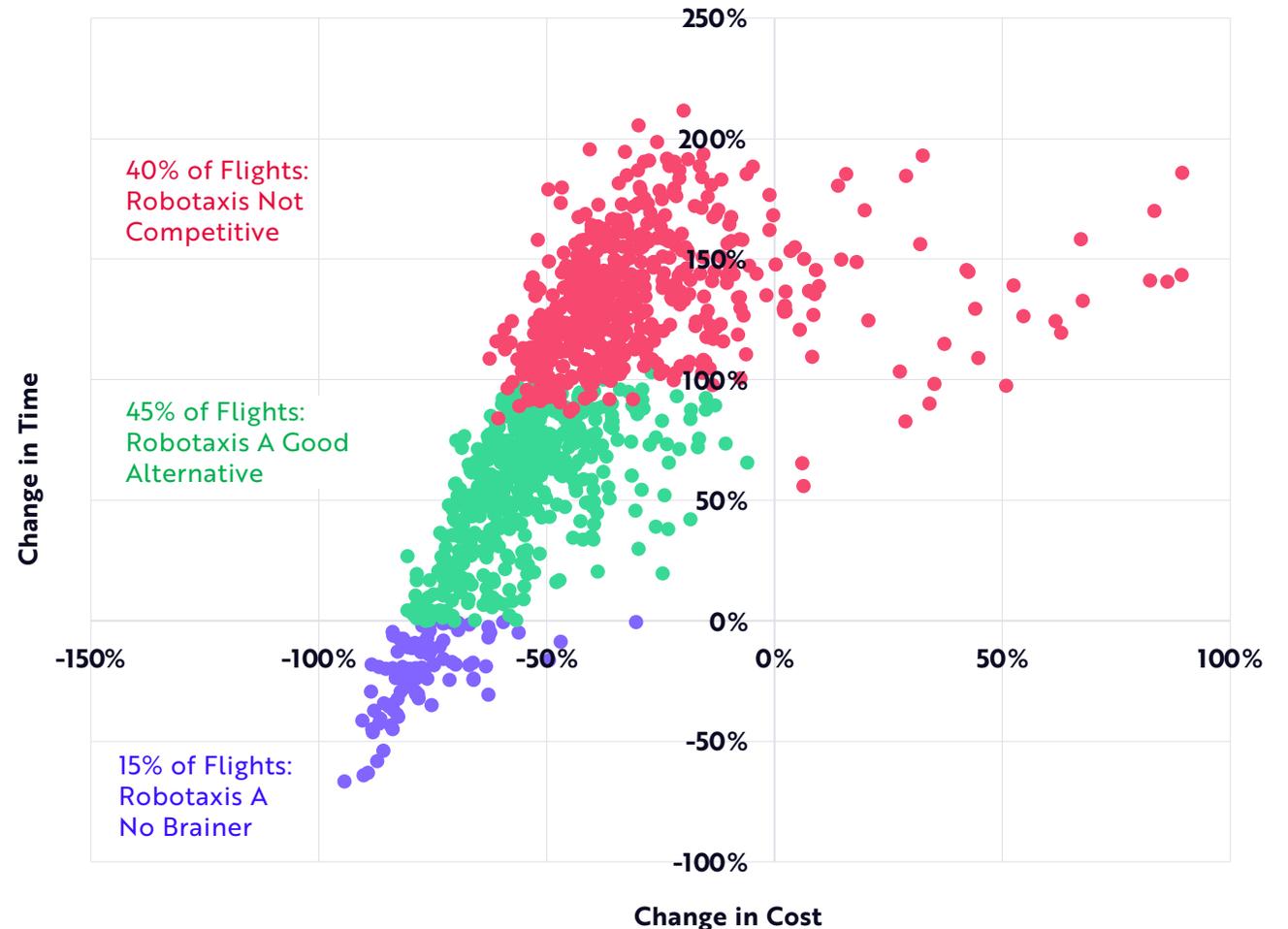
With prices ranging from \$4 to \$0.25 per mile, robotaxis could be a more attractive option than ~60% of short-haul airline flights, based on time and cost savings including transport to and from airports.

Short-haul flights at risk currently generate ~\$100 billion, or 20%, of all airline revenues globally.

Priced at \$0.50 per mile, a robotaxi service would be less expensive than more than half of short-haul airline flights. At \$0.25 per mile, robotaxi services could be more cost effective than 95% of short-haul journeys.

The cost and time advantages should be more dramatic for group travel. An autonomous taxi for 2-3 people could be a better option than 75%-84% of short-haul airline flights.

Robotaxi Versus Short-Haul Airline Flight Cost and Time Savings*

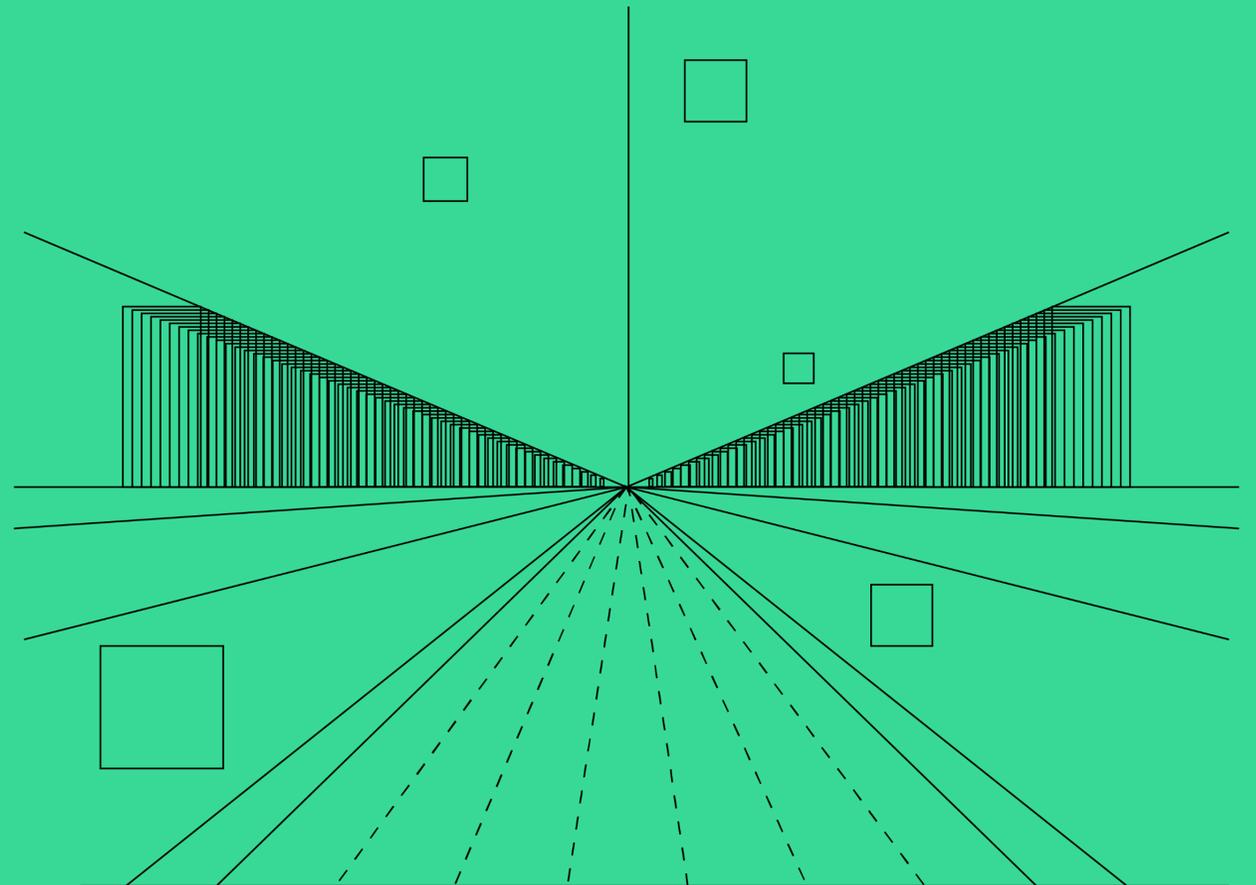


[1] Short-haul is a flight lasting anywhere from 30 minutes to 3 hours. *Single Person Short-Haul Flights / \$0.25 Per Mile Robotaxi. This graphical analysis includes the increase in traffic ARK expects with robotaxis as well as the drive time associated with flying. The classifications in the chart are based on ARK's opinion given the time and cost savings and not on actual sentiment among short-haul travellers. Sources: ARK Investment Management LLC, 2023. Google Flights, data as of 01/20/23; Miller, A. 2021; Federal Highway Administration 2020; Federal Highway Administration, data as of 12/28/22. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Autonomous Logistics

Potential To Reshape The Global Supply Chain



Research by Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

[1] Logistics (the detailed coordination of a complex operation involving many people, facilities, or supplies) that are autonomous (characterized by having the freedom to govern itself or control its own affairs). Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Like Autonomous Ride-Hail, Robots And Drones Should Have A Greater Impact In Countries With High Delivery Fees

Parcel Delivery Fees
(Average)



Food Delivery Fees*
(Average)



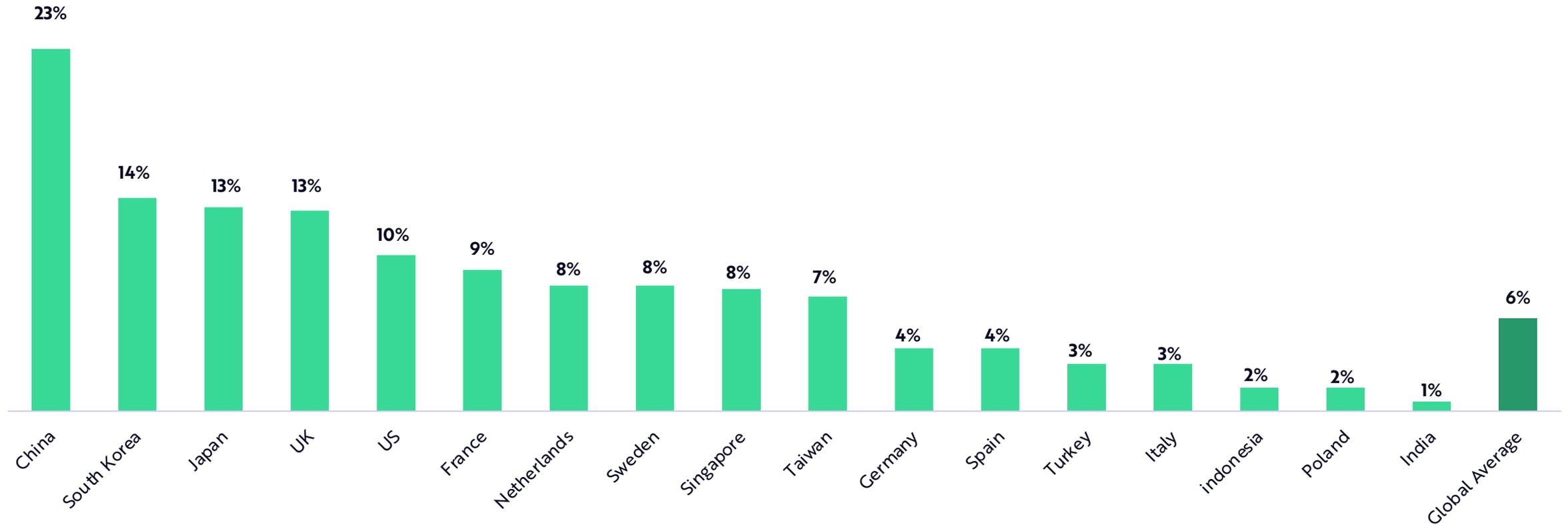
*Dotted border regions in the right-hand chart show the range of prices for platforms. Sources: ARK Investment Management LLC, 2023. Pitney Bowes Inc., data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Online Accounts For Only 6% of Grocery Sales Globally

Interestingly, shoppers in the US pick up online grocery orders 30-40% of the time, a figure that should shrink with convenient, inexpensive robotic delivery.

E-Commerce As A Percent Of Total Grocery Sales (2022)



*Figures for Japan, Spain, Italy, Poland, Sweden were extrapolated from 2018, 2019, and 2021 data, respectively. Global average is extrapolated by weighting countries by their share of global food at home. Sources: ARK Investment Management LLC, 2023. Crisp, A. 2018; Simmons, V. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Autonomous Trucks Could Strand Rail Assets

Globally, more than \$1.2 trillion per year is spent on infrastructure, with China accounting for more than half of the total.*

Annual Investment in Rail Infrastructure
(\$ Billions)



*Latest Annual Data Available for Years 2016-2020. \$1.2 trillion is the sum of investment for countries with available data. The global total likely is slightly higher. Sources: ARK Investment Management LLC, 2023. Barreto, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Robotics And 3D Printing

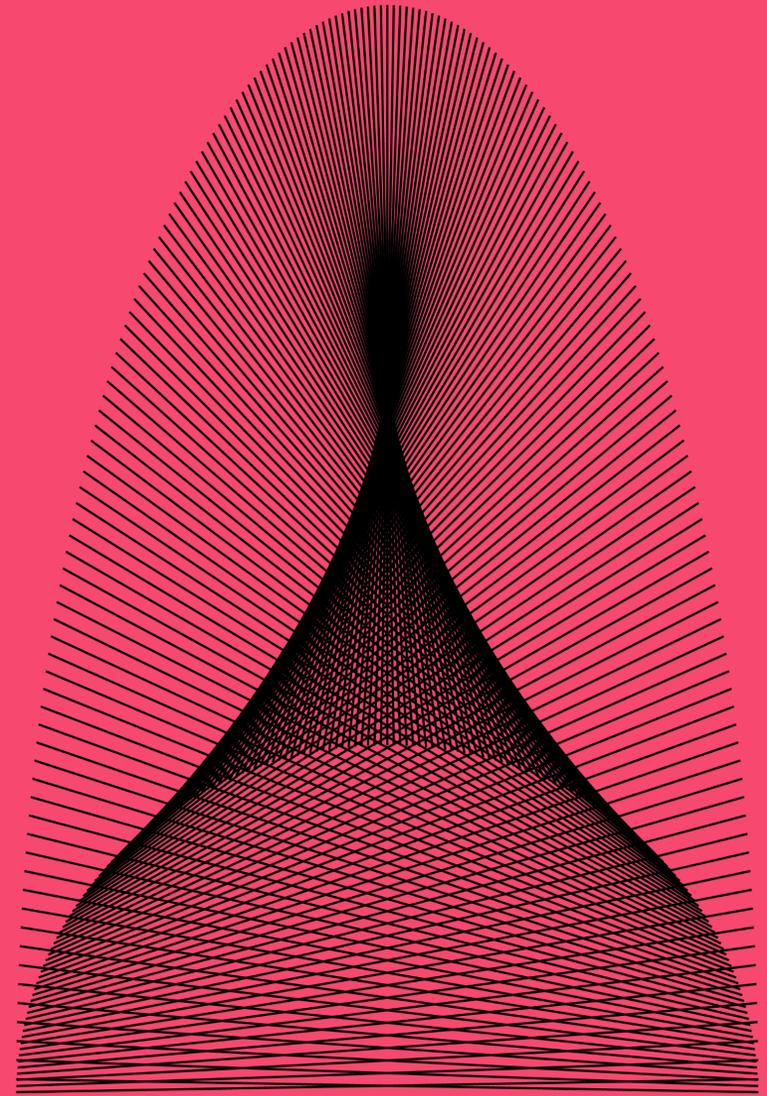
Promoting A Manufacturing Revolution

Robotics and 3D printing can collapse time from development to production, shorten supply chain footprints, reduce waste, and lower costs.

Research by Sam Korus, Director of Research, Autonomous Technology & Robotics

Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.





Risks & Disclosure Associated with Robotics And 3D Printing

Disruptive Innovation Risk. Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. Companies that initially develop a novel technology may not be able to capitalize on the technology. Companies that develop disruptive technologies may face political or legal attacks from competitors, industry groups or local and national governments. These companies may also be exposed to risks applicable to sectors other than the disruptive innovation theme for which they are chosen, and the securities issued by these companies may underperform the securities of other companies that are primarily focused on a particular theme.

Software Industry Risk. The software industry can be significantly affected by intense competition, aggressive pricing, technological innovations, and product obsolescence. Companies in the software industry are subject to significant competitive pressures, such as aggressive pricing, new market entrants, competition for market share, short product cycles due to an accelerated rate of technological developments and the potential for limited earnings and/or falling profit margins. These companies also face the risks that new services, equipment or technologies will not be accepted by consumers and businesses or will become rapidly obsolete. These factors can affect the profitability of these companies and, as a result, the value of their securities. Also, patent protection is integral to the success of many companies in this industry, and profitability can be affected materially by, among other things, the cost of obtaining (or failing to obtain) patent approvals, the cost of litigating patent infringement and the loss of patent protection for products (which significantly increases pricing pressures and can materially reduce profitability with respect to such products). In addition, many software companies have limited operating histories. Prices of these companies' securities historically have been more volatile than other securities, especially over the short term.

Internet Company Risk. Many Internet-related companies have incurred large losses since their inception and may continue to incur large losses in the hope of capturing market share and generating future revenues. Accordingly, many such companies expect to incur significant operating losses for the foreseeable future and may never be profitable. The markets in which many Internet companies compete face rapidly evolving industry standards, frequent new service and product announcements, introductions and enhancements, and changing customer demands. The failure of an Internet company to adapt to such changes could have a material adverse effect on the company's business.

Semiconductor Company Risk. Competitive pressures may have a significant effect on the financial condition of semiconductor companies and, as product cycles shorten and manufacturing capacity increases, these companies may become increasingly subject to aggressive pricing, which hampers profitability. Reduced demand for end-user products, under-utilization of manufacturing capacity, and other factors could adversely impact the operating results of companies in the semiconductor sector. Semiconductor companies typically face high capital costs and may be heavily dependent on intellectual property rights. The semiconductor sector is highly cyclical, which may cause the operating results of many semiconductor companies to vary significantly. The stock prices of companies in the semiconductor sector have been and likely will continue to be extremely volatile.

Industrials Sector Risk. The industrials sector includes companies engaged in the aerospace and defense industry, electrical engineering, machinery, and professional services. Companies in the industrials sector may be adversely affected by changes in government regulation, world events and economic conditions. In addition, companies in the industrials sector may be adversely affected by environmental damages, product liability claims and exchange rates. *Aerospace and Defense Company Risk.* Companies in the aerospace and defense industry rely to a large extent on U.S. (and other) Government demand for their products and services and may be significantly affected by changes in government regulations and spending, as well as economic conditions and industry consolidation. *Professional Services Company Risk.* Professional services companies may be materially impacted by economic conditions and related fluctuations in client demand for marketing, business, technology and other consulting services. Professional services companies' success depends in large part on attracting and retaining key employees and a failure to do so could adversely affect a company's business. There are relatively few barriers to entry into the professional services market, and new competitors could readily seek to compete in one or more market segments, which could adversely affect a professional services company's operating results through pricing pressure and loss of market share.

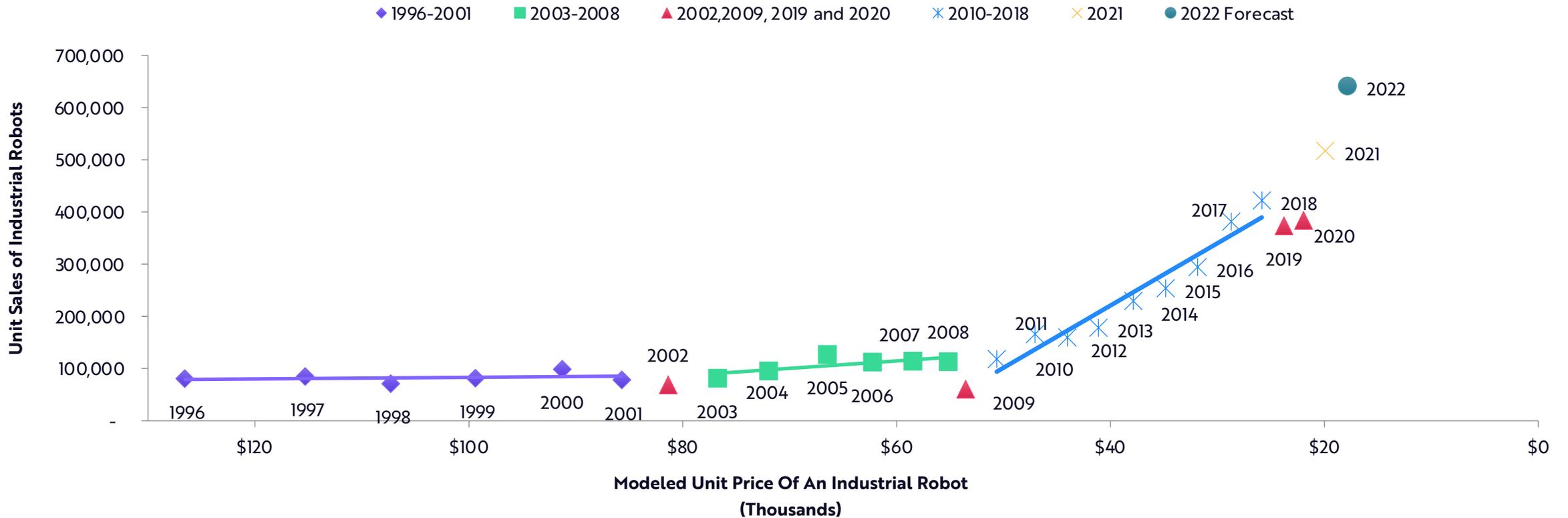
Machinery Industry Risk. The machinery industry can be significantly affected by general economic trends, including employment, economic growth, and interest rates; changes in consumer sentiment and spending; overall capital spending levels, which are influenced by an individual company's profitability and broader factors such as interest rates and foreign competition; commodity prices; technical obsolescence; labor relations legislation; government regulation and spending; import controls; and worldwide competition. Companies in this industry also can be adversely affected by liability for environmental damage, depletion of resources, and mandated expenditures for safety and pollution control.



The Adoption Of Automation Typically Accelerates During Recessions And Crises

The adoption of industrial robots accelerated after the 2002 dot-com bust and again after the 2008-2009 crisis. The responses to the China/US trade conflict in 2019 and supply chain bottlenecks from 2020 through 2022 have been the same.

Industrial Robot Price Elasticity of Demand



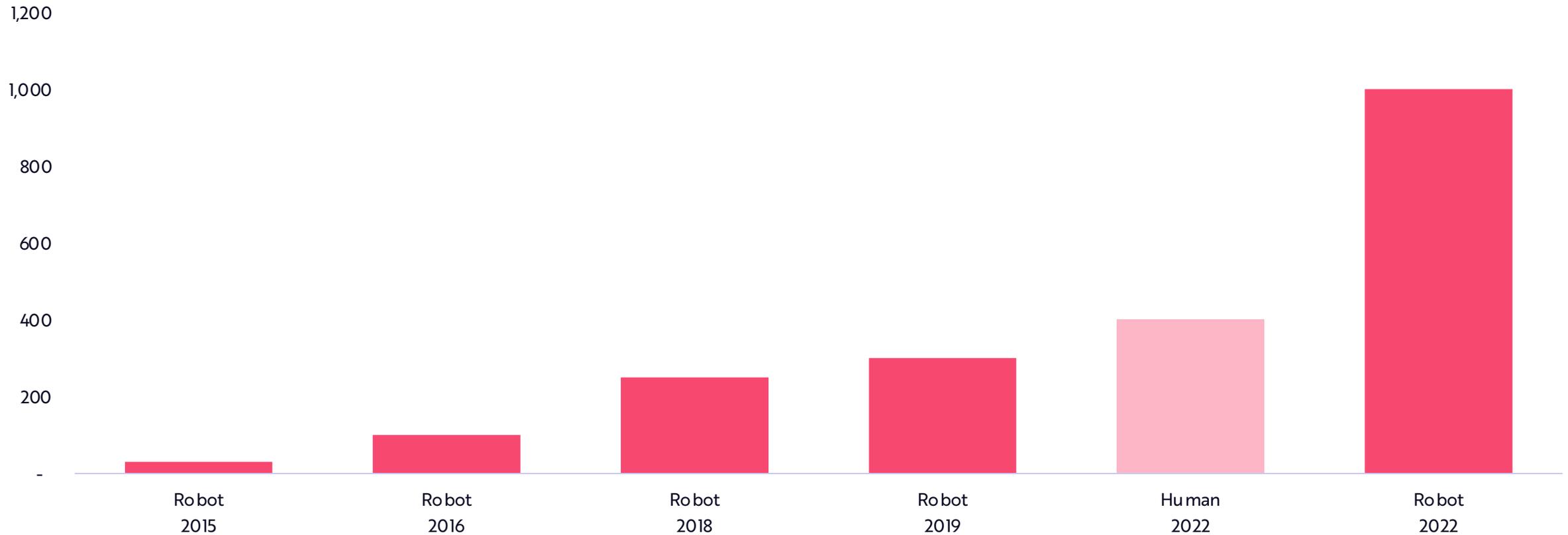
Sources: ARK Investment Management LLC, 2023. Müller, C. 2022. International Federation of Robotics. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Robot Performance Has Improved 33-Fold In The Past Seven Years

Advances in computer vision and deep learning have increased the performance of robots.

Items Picked and Placed Per Hour

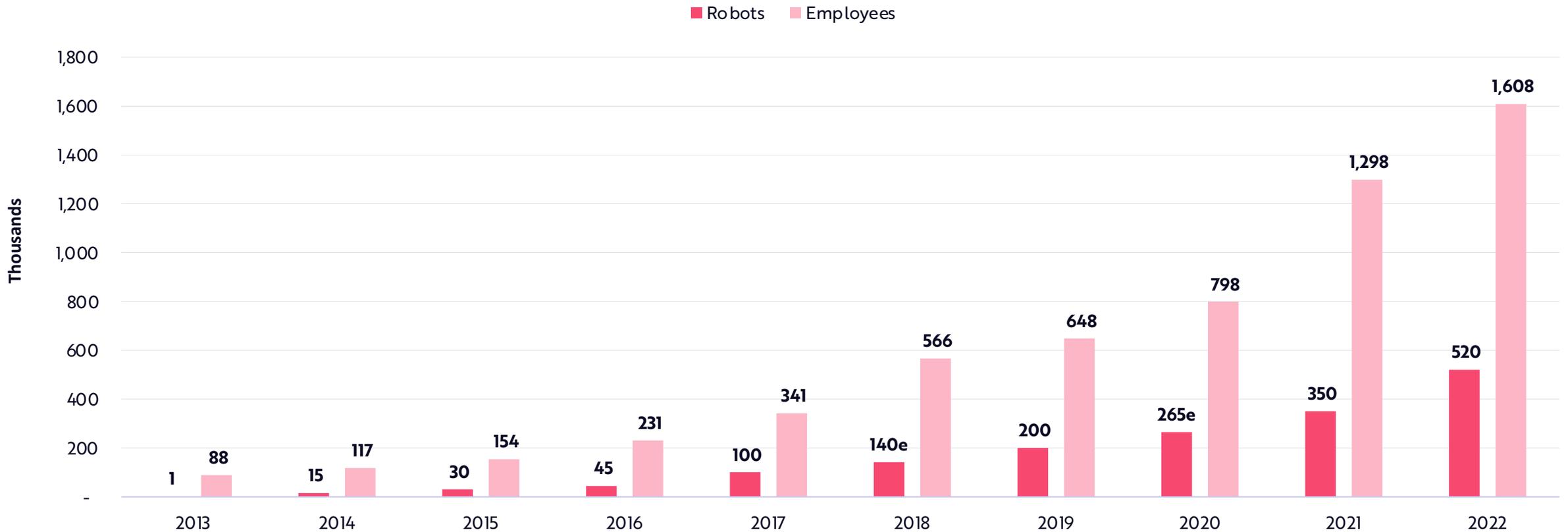




Amazon Could Be Approaching An Inflection Point In Robotics

Amazon is producing ~1,000 robots per day. Within the next few years, it could add more robots than employees per year.

Number of Amazon Robots and Employees



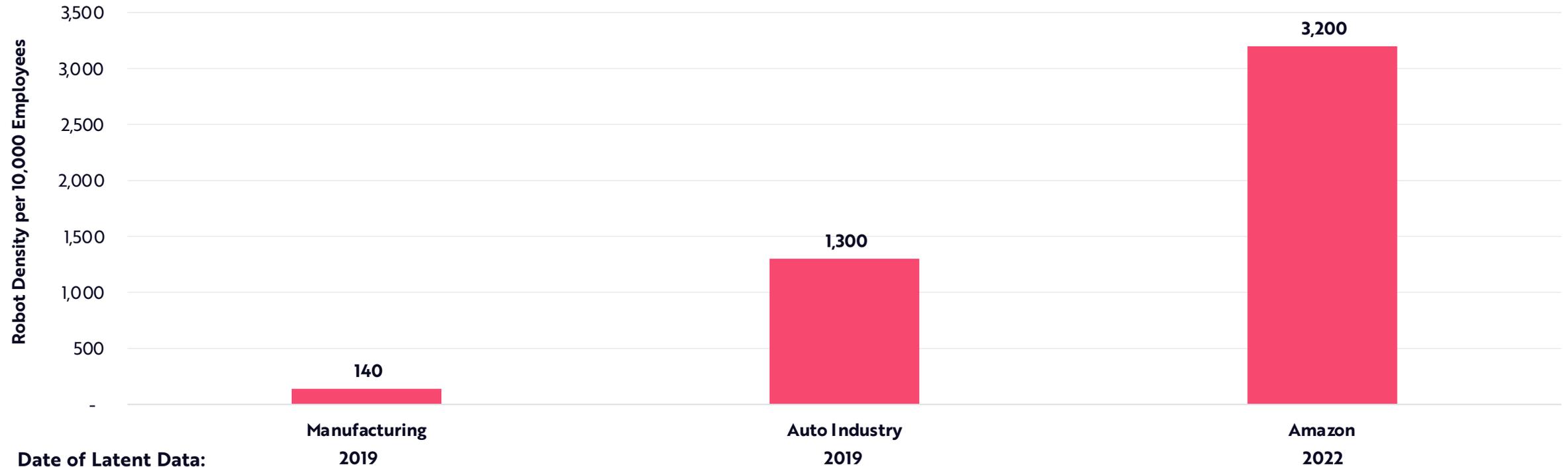
Sources: ARK Investment Management LLC, 2023. Jabil Inc. 2021. Amazon, data as of 12/31/22. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



The Opportunity For Robot Penetration In Manufacturing Is Immense

Amazon is in the early days of mass robot adoption, pointing the way for other industries. To reach Amazon's robot density, the US manufacturing industry would have to add four million robots, roughly 6X the unit sales of industrial robots globally today. What is the upper bound for robot density long term?

Automation In The US



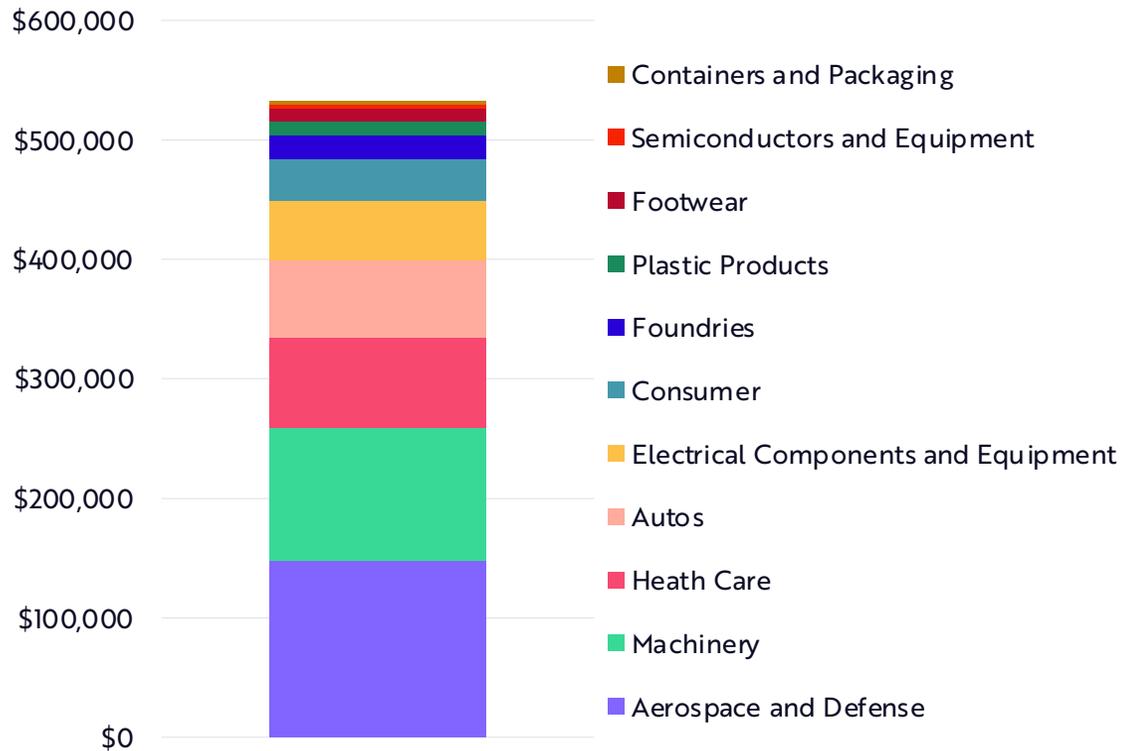


3D Printing Should Impact Many Industries

ARK estimates that 3D printing will be a \$500 billion market opportunity as applied to existing products.

3D printing is likely to enable new products and markets. Boston Dynamics' Atlas humanoid robot, for example, achieved a strength-to-weight ratio that enabled leaps and somersaults, thanks to 3D printing.

3D Printing Addressable Opportunity (2022, Millions)



Sources: ARK Investment Management LLC, 2023. S&P Global Market Intelligence, data as of 01/26/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

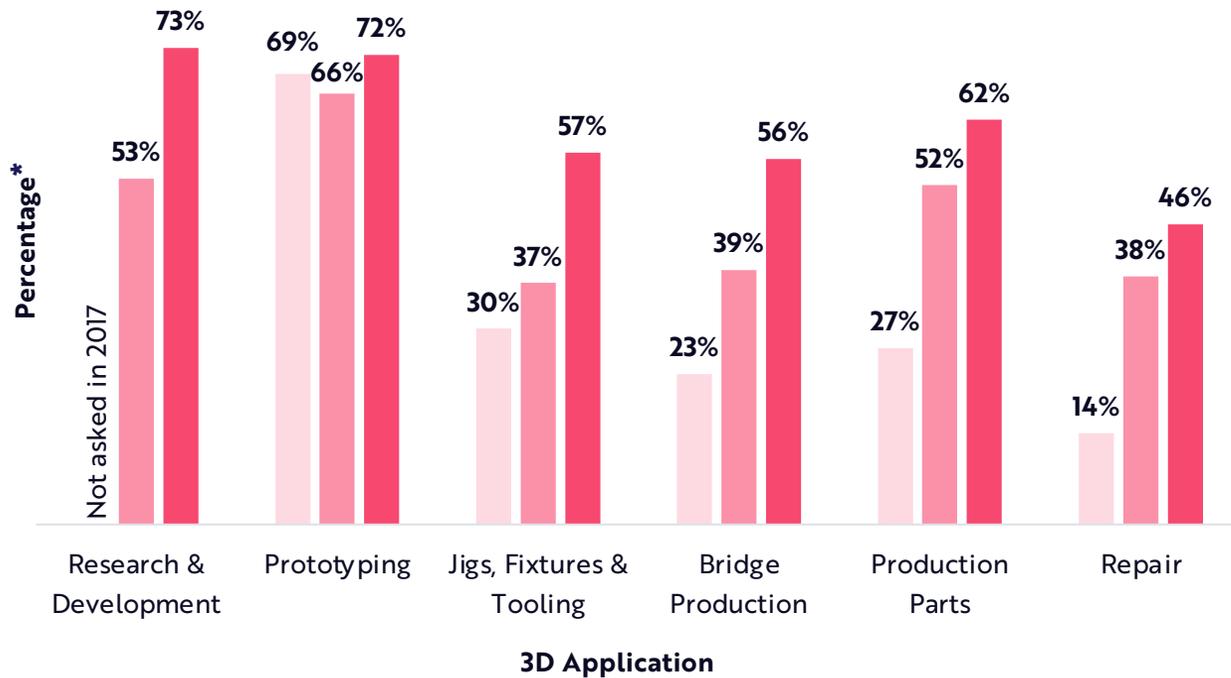


The Barriers To 3D Printing Adoption Include Materials, Costs, Know-How, And Processing

3D printing costs should be compared to those over the lifetime of a part—from design to retirement—in traditional manufacturing. While upfront costs can be higher, 3D printed parts can be produced much faster with more durability than parts manufactured traditionally.

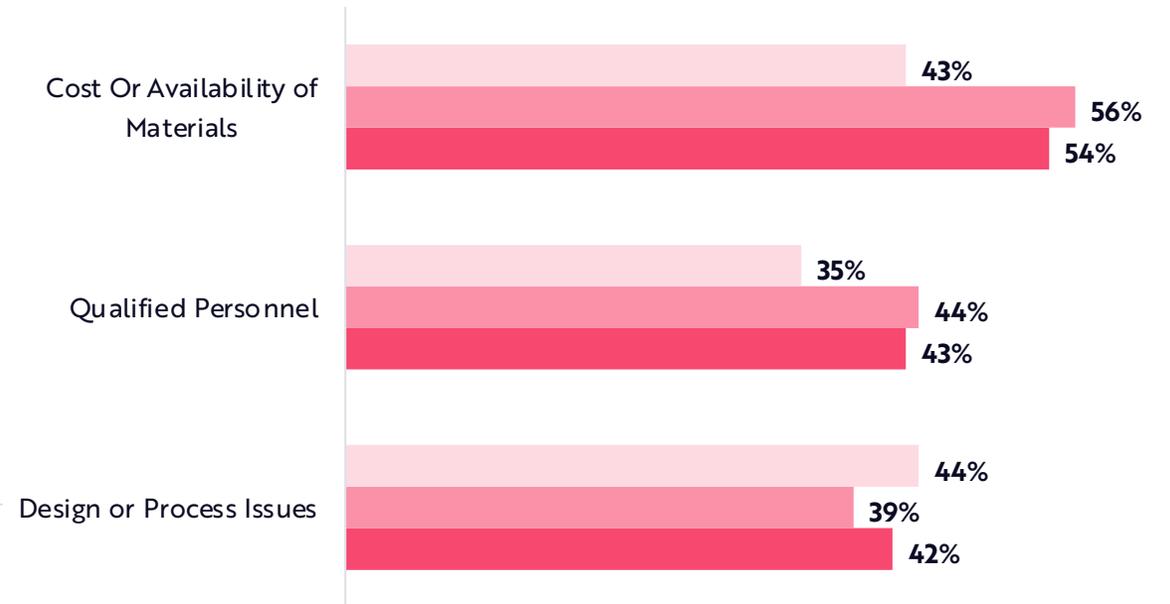
Use Of 3D Printing Across Applications And Time
 "In What Way Does Your Company Currently Use 3D Printing?"

2017 2019 2021



Top 3 Barriers To 3D Printing Adoption*
 "What Prevents Your Company From Doing More 3D Printing In Production Today?"

2017 2019 2021



*Percentage of respondents selecting an answer. Survey respondents totaled 302 individuals responsible for 3D printing decisions at manufacturing companies across the Electronics, Plastics and Packaging, Industrial Machinery, Heavy Equipment, Automotive, Healthcare, Footwear, Orthopedics, Aerospace and Defense, and Transportation industries globally. Sources: ARK Investment Management LLC, 2023. Jabil Inc. 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



In Healthcare, 3D Printing Can Make A Big Difference In The Operating Room And Beyond

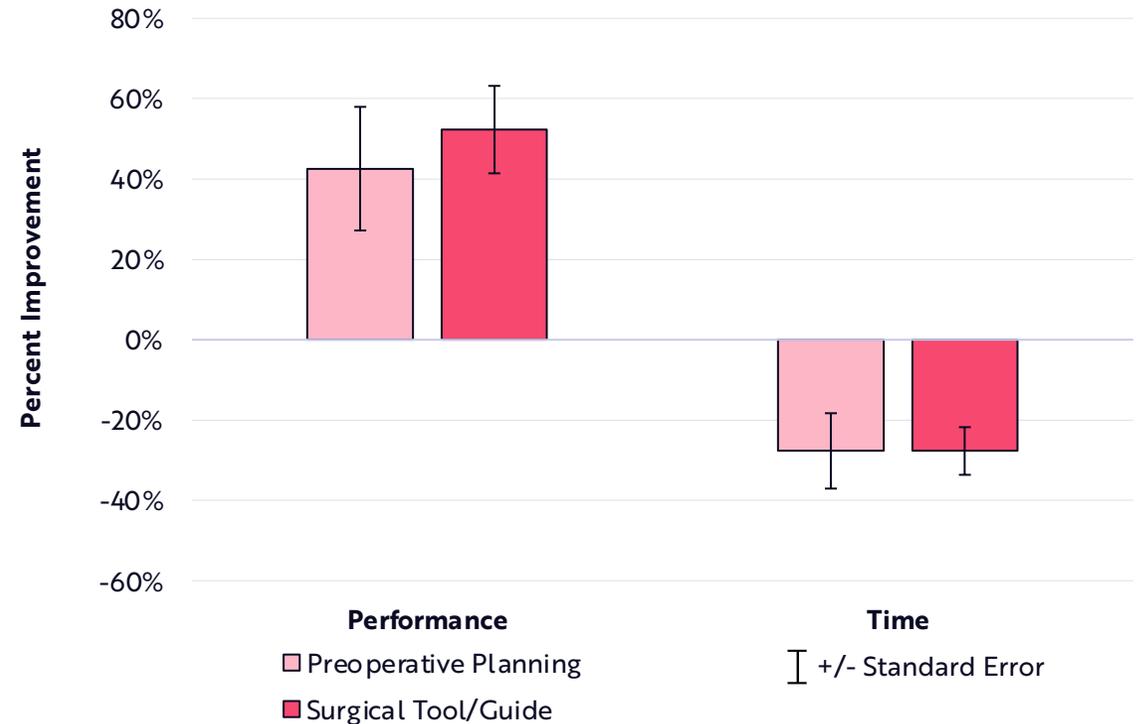
Doctors use patient-specific 3D printed models to pre-plan surgeries and customize 3D printed tools/surgical guides for procedures, shortening operating room time and improving patient outcomes.

Across a range of surgeries, 3D printed tools, guides, and models reduced operating time on average by ~30% and increased performance, measured by surgical accuracy and results, on average by ~40-50%.

According to ARK’s research, 3D printing could reduce total time spent in US operating rooms for all surgery types by 5%, saving ~\$12.5 billion. Worldwide, cost savings could approach \$80 billion based on surgery time alone, before accounting for improved accuracy, reduced complications, and faster patient recovery.

3D printing could increase access to surgery around the globe by reducing costs and increasing throughput. Health systems and services fall short of patient surgery demand by roughly 140 million cases a year.*

Surgeries: 3D Printed Tools, Guides, and Models Shorten Time And Improve Accuracy



Note: Time Savings and Accuracy Improvements Provided by 3D Printed Surgical Guides and Preoperative Planning Aides: bars represent the average percent improvement in time or performance as described in Bergmann et al. 2017 and Woodard et al. 2019, N=6-9 for each sample group. Error bars represent +/- standard error. The above analysis was conducted across medical fields; however, oral maxillofacial surgery and musculoskeletal studies were the most prevalent.

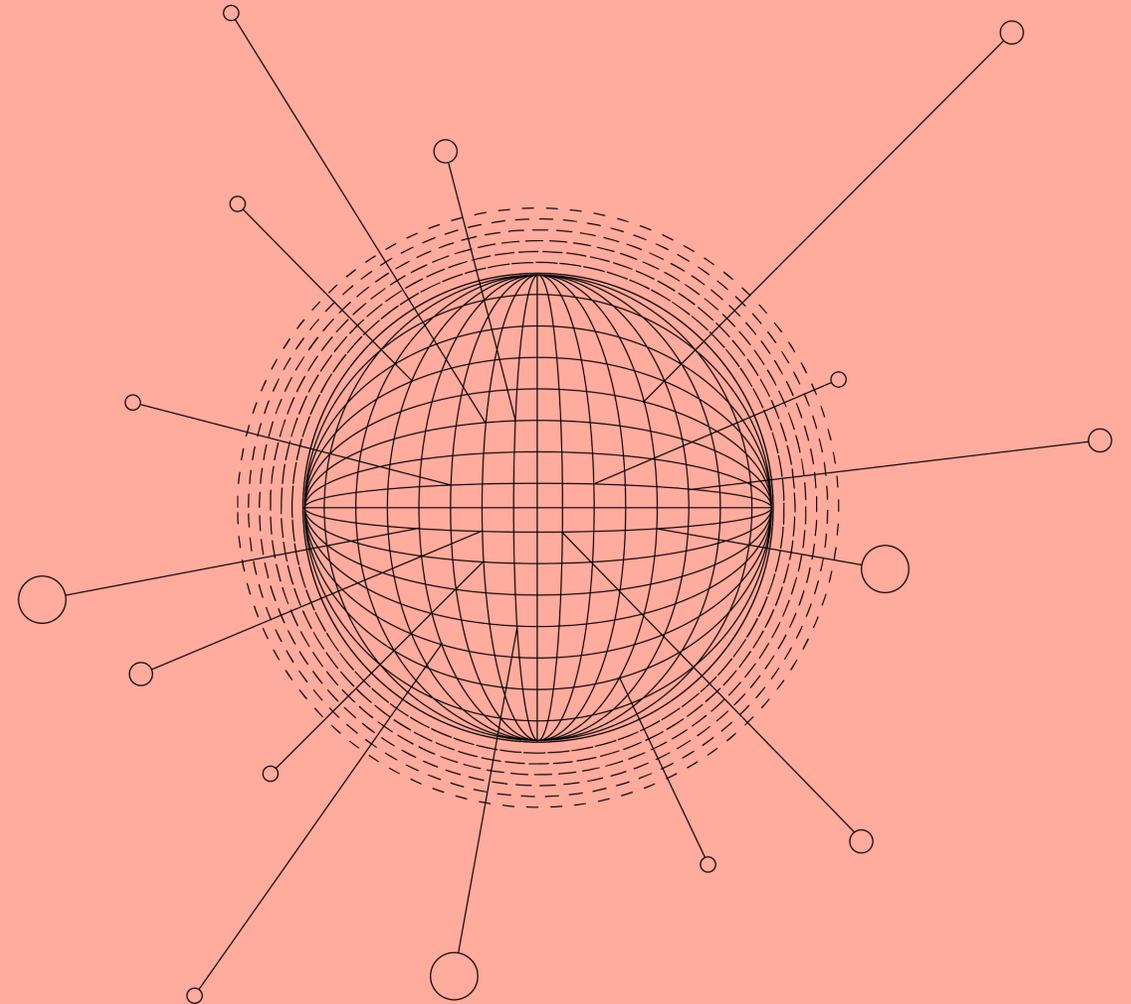
*Latest estimate available as of 2015. Sources: ARK Investment Management LLC, 2023. Diment, L. et al. 2017; Meara et al. 2015; Dobson, G. 2020. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Orbital Aerospace

Enabling Global Connectivity

Aerospace costs are declining, thanks to advancements in deep learning, mobile connectivity, sensors, 3D printing, and robotics. As a result, satellite launches and rocket landings are proliferating.



Research by Sam Korus, Director of Research, Autonomous Technology & Robotics



Definitions, Risks & Disclosure Associated with Orbital Aerospace

Aerospace is the branch of technology and industry concerned with both aviation and space flight. There are two main types of spaceflight: orbital and suborbital. An orbital flight circles the earth at least once, in a stable way. Suborbital flights are ones that may go into space, but then their path (or trajectory) carries them back to the earth.

Disruptive Innovation Risk. Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. Companies that initially develop a novel technology may not be able to capitalize on the technology. Companies that develop disruptive technologies may face political or legal attacks from competitors, industry groups or local and national governments. These companies may also be exposed to risks applicable to sectors other than the disruptive innovation theme for which they are chosen, and the securities issued by these companies may underperform the securities of other companies that are primarily focused on a particular theme.

Software Industry Risk. The software industry can be significantly affected by intense competition, aggressive pricing, technological innovations, and product obsolescence. Companies in the software industry are subject to significant competitive pressures, such as aggressive pricing, new market entrants, competition for market share, short product cycles due to an accelerated rate of technological developments and the potential for limited earnings and/or falling profit margins. These companies also face the risks that new services, equipment or technologies will not be accepted by consumers and businesses or will become rapidly obsolete. These factors can affect the profitability of these companies and, as a result, the value of their securities. Also, patent protection is integral to the success of many companies in this industry, and profitability can be affected materially by, among other things, the cost of obtaining (or failing to obtain) patent approvals, the cost of litigating patent infringement and the loss of patent protection for products (which significantly increases pricing pressures and can materially reduce profitability with respect to such products). In addition, many software companies have limited operating histories. Prices of these companies' securities historically have been more volatile than other securities, especially over the short term.

Internet Company Risk. Many Internet-related companies have incurred large losses since their inception and may continue to incur large losses in the hope of capturing market share and generating future revenues. Accordingly, many such companies expect to incur significant operating losses for the foreseeable future and may never be profitable. The markets in which many Internet companies compete face rapidly evolving industry standards, frequent new service and product announcements, introductions and enhancements, and changing customer demands. The failure of an Internet company to adapt to such changes could have a material adverse effect on the company's business.

Semiconductor Company Risk. Competitive pressures may have a significant effect on the financial condition of semiconductor companies and, as product cycles shorten and manufacturing capacity increases, these companies may become increasingly subject to aggressive pricing, which hampers profitability. Reduced demand for end-user products, under-utilization of manufacturing capacity, and other factors could adversely impact the operating results of companies in the semiconductor sector. Semiconductor companies typically face high capital costs and may be heavily dependent on intellectual property rights. The semiconductor sector is highly cyclical, which may cause the operating results of many semiconductor companies to vary significantly. The stock prices of companies in the semiconductor sector have been and likely will continue to be extremely volatile.

Industrials Sector Risk. The industrials sector includes companies engaged in the aerospace and defense industry, electrical engineering, machinery, and professional services. Companies in the industrials sector may be adversely affected by changes in government regulation, world events and economic conditions. In addition, companies in the industrials sector may be adversely affected by environmental damages, product liability claims and exchange rates. *Aerospace and Defense Company Risk.* Companies in the aerospace and defense industry rely to a large extent on U.S. (and other) Government demand for their products and services and may be significantly affected by changes in government regulations and spending, as well as economic conditions and industry consolidation. *Professional Services Company Risk.* Professional services companies may be materially impacted by economic conditions and related fluctuations in client demand for marketing, business, technology and other consulting services. Professional services companies' success depends in large part on attracting and retaining key employees and a failure to do so could adversely affect a company's business. There are relatively few barriers to entry into the professional services market, and new competitors could readily seek to compete in one or more market segments, which could adversely affect a professional services company's operating results through pricing pressure and loss of market share.

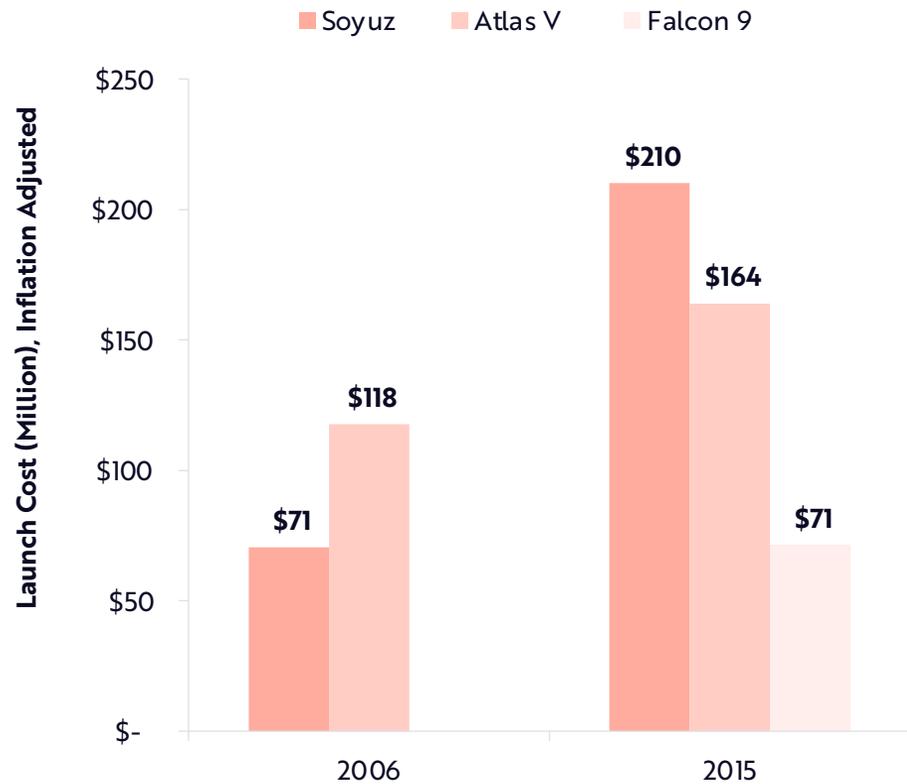
Machinery Industry Risk. The machinery industry can be significantly affected by general economic trends, including employment, economic growth, and interest rates; changes in consumer sentiment and spending; overall capital spending levels, which are influenced by an individual company's profitability and broader factors such as interest rates and foreign competition; commodity prices; technical obsolescence; labor relations legislation; government regulation and spending; import controls; and worldwide competition. Companies in this industry also can be adversely affected by liability for environmental damage, depletion of resources, and mandated expenditures for safety and pollution control.



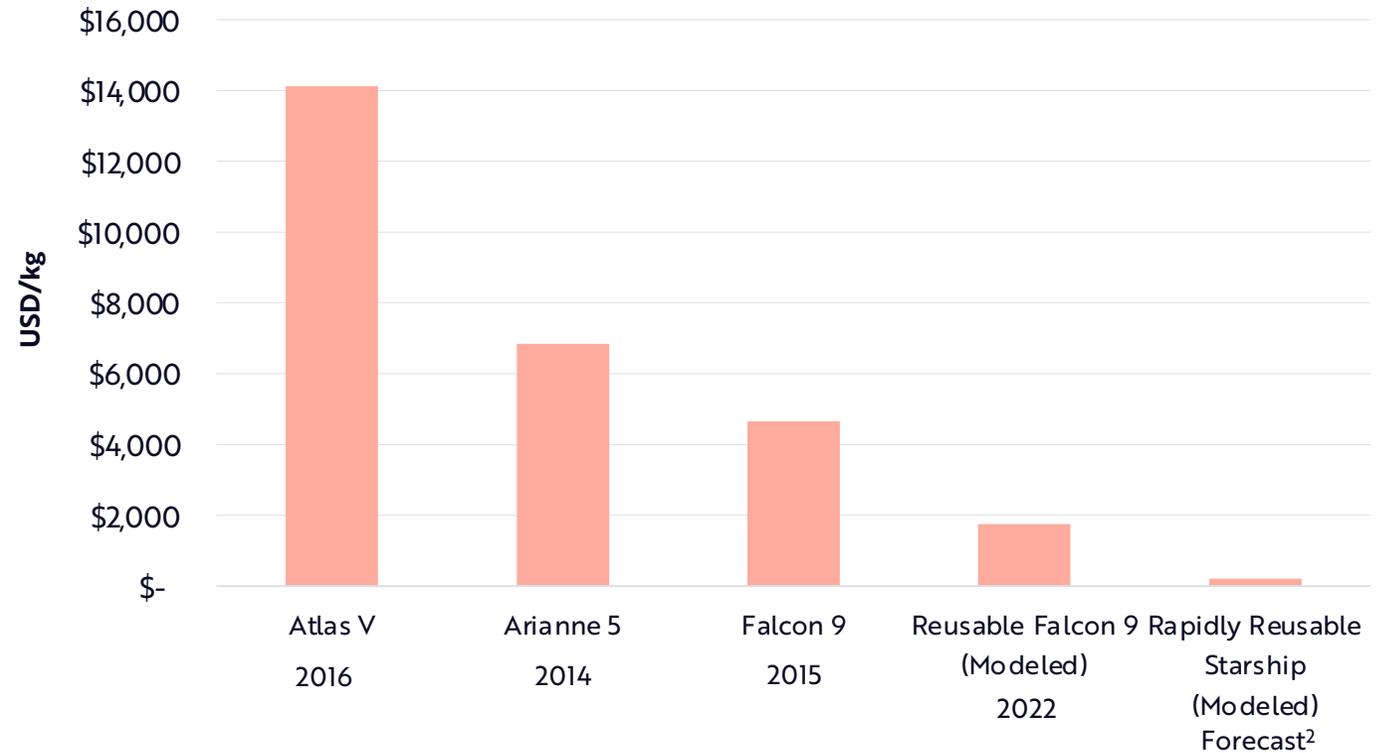
Reusable Rockets Could Lower Launch Costs

SpaceX put an end to soaring launch costs with its Falcon 9 reusable rocket. Falcon 9 has flown the same booster 14 times. Thanks to reusable rockets, SpaceX nearly doubled its launches to 61 rockets in 2022.

Historical Rocket Launch Costs¹



Low Earth Orbit Rocket Launch Costs



[1] Soyuz is a family of expendable Russian and Soviet carrier rockets developed by OKB-1 and manufactured by Progress Rocket Space Centre in Samara, Russia. Atlas V is an expendable launch system and the fifth major version in the Atlas launch vehicle family. It was originally designed by Lockheed Martin, now being operated by United Launch Alliance, a joint venture between Lockheed Martin and Boeing. Ariane 5 is a European heavy-lift space launch vehicle developed and operated by Arianespace for the European Space Agency. [2] Starship is a fully-reusable super heavy-lift launch vehicle under development by SpaceX.

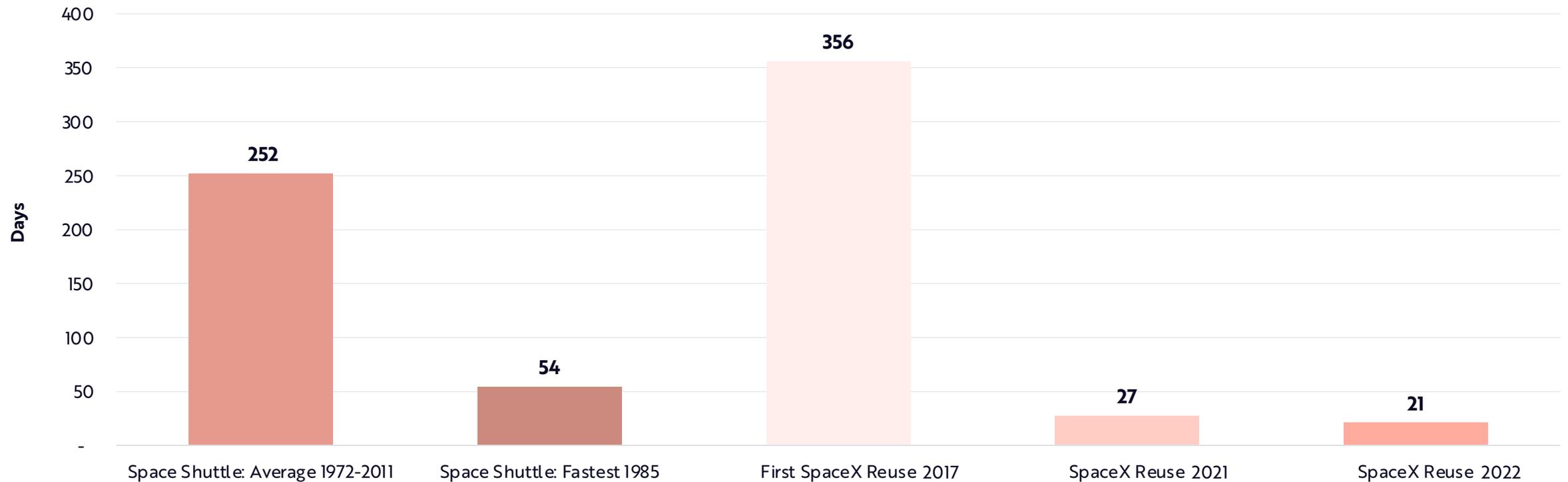
Sources: ARK Investment Management LLC, 2023. SpaceX, data as of 01/12/23; Svitak, A. 2011; Martin, P. 2013; United Launch Alliance, data as of 01/19/23; de Selding, P. 2014. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



SpaceX Is Refurbishing Rockets In Record Time

Thanks primarily to its rapid turnaround time, the first stage of the Falcon 9 costs less than \$1 million to refurbish, according to our model. In contrast, each Space Shuttle launch cost ~\$1.5 billion.

Rocket Turnaround Time



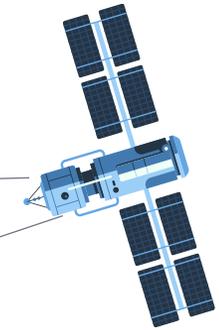
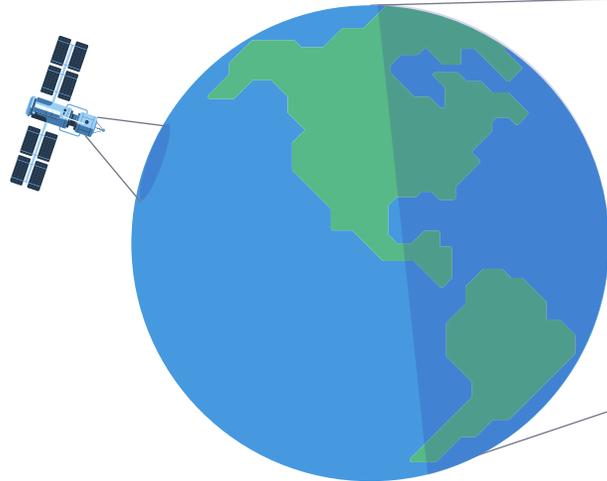


Lower Satellite Launch Costs Should Enable Continuous Global Coverage With Low Latency

While satellites launched into geostationary orbit (GEO) technically offered global coverage, latency limited a compelling broadband internet experience. Today, companies are launching thousands of low-cost satellites into low earth orbit (LEO) and enabling continuous global coverage with low latency and direct-to-mobile device connectivity.

LEO

~300 miles
<40 ms latency*



GEO

~22,000 miles
700 ms latency*

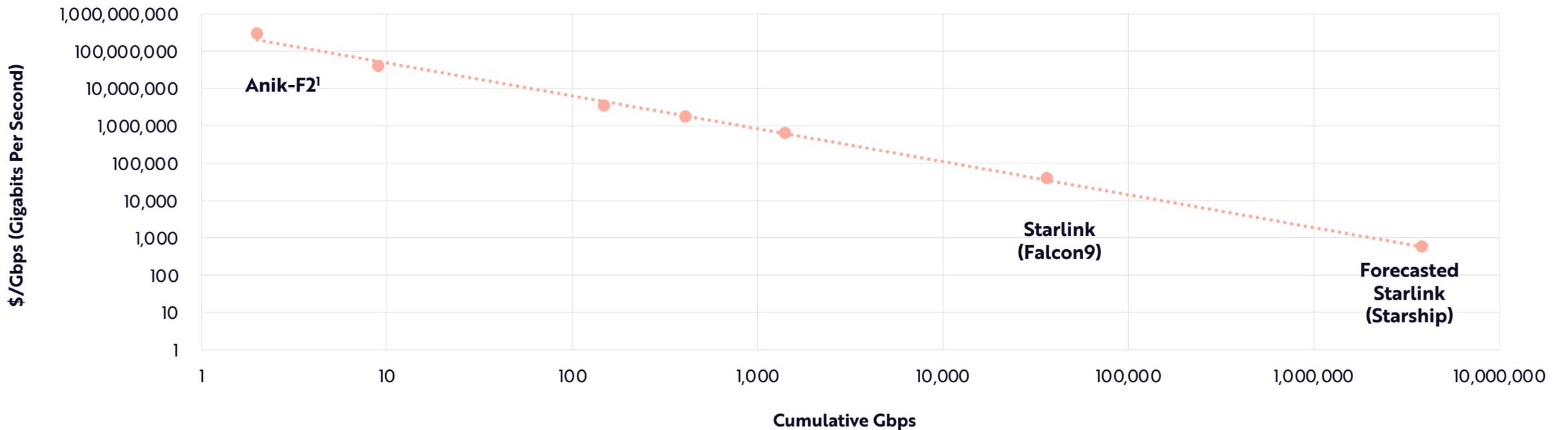
*Latency is measured in milliseconds (ms). Latency is the time delay over a communications link, and is primarily determined by the distance data must travel between a user and the server. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



According To Wright’s Law, Satellite Bandwidth Costs Should Decline Roughly 45% For Every Cumulative Doubling In Gigabits Per Second In Orbit

Since 2004, the cost of satellite bandwidth has dropped 7,500-fold, from \$300,000,000 to \$40,000/ Gigabits per second (Gbps). Thanks to Starship,* costs could fall another 40-fold to ~\$1,000/Gbps during the next five years. According to ARK’s research, 1 Gbps can serve 200 customers. At a capital cost of ~\$1,000/Gbps, SpaceX could recoup its Starship investment with a one-time charge of \$5 per customer.**

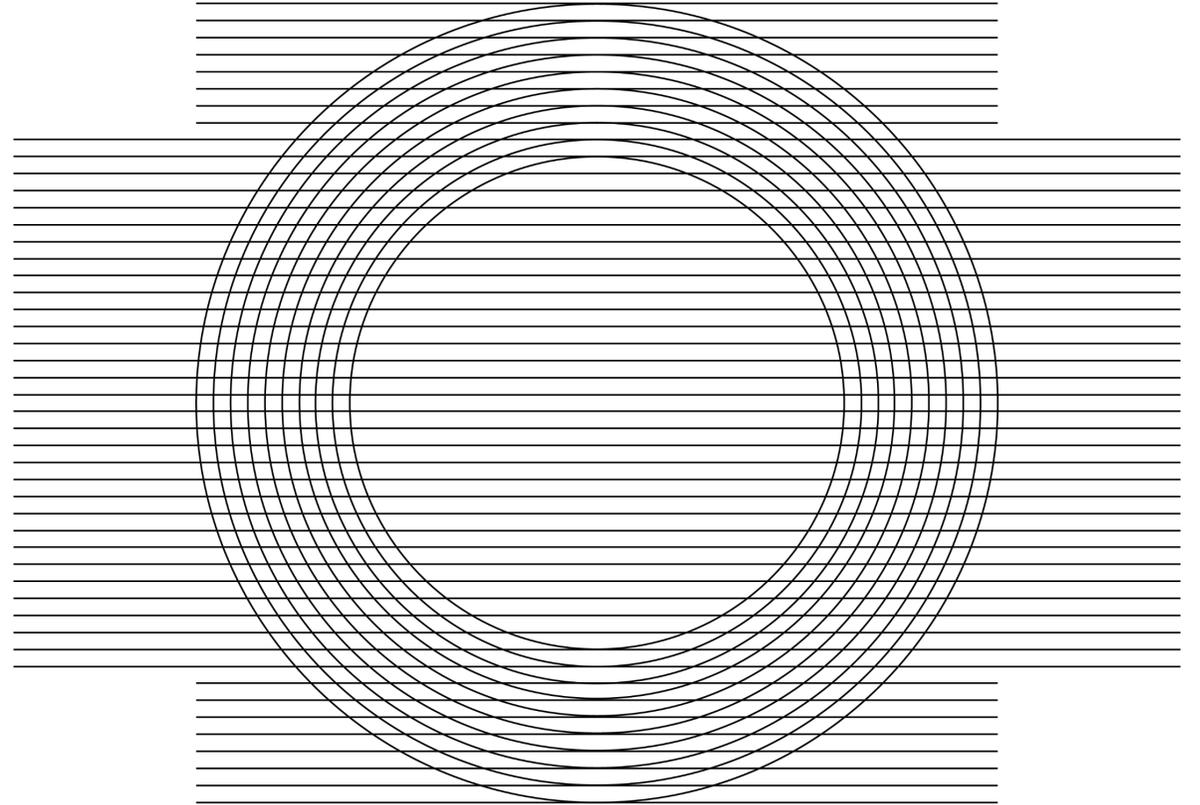
Satellite Bandwidth Cost Decline



[1] Launched by Telesat Canada, Anik F2 was the heaviest commercial telecommunications satellite ever launched (at the time). *Starship is SpaceX’s next generation rocket and satellites. **This assumes an oversubscription ratio of 20: 20x more people are paying for the service than are actively using it at a given time. Note also that this calculation does not incorporate satellite lifespans, satellite utilization, and ground-based infrastructure costs, all of which will impact costs and pricing decisions. Sources: ARK Investment Management LLC, 2023. VanderMeulen, R. et al. 2015. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.



Works Cited





- 8MarketCap. Gold Market Cap. Data as of 01/17/23. <https://8marketcap.com>
- AAA 2021. "Your Driving Costs 2021." AAA. <https://newsroom.aaa.com/wp-content/uploads/2021/08/2021-YDC-Brochure-Live.pdf>
- Abbosh, C. et al. 2017. "Phylogenetic ctDNA analysis depicts early stage lung cancer evolution." National Library of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5812436/>
- Adams, D. et al. 2018. "Patisiran, an RNAi Therapeutic, for Hereditary Transthyretin Amyloidosis." The New England Journal of Medicine. <https://www.nejm.org/doi/full/10.1056/nejmoa1716153>
- Afonso, C. 2022. "Hertz CEO says their Teslas are saving 50-60% on maintenance costs VS ICE models." Electric Vehicles. <https://myevsorg.wordpress.com/2022/08/02/hertz-ceo-says-their-teslas-are-saving-50-60-on-maintenance-costs-vs-ice-models/>
- Alphabet. Investor Relations. Data as of 12/30/22. <https://abc.xyz/investor/>
- Altruda, C. 2022. "Legal US Sports Betting Revenue, Handle And Tax Totals Since PASPA Repeal." Sports Handle. <https://sportshandle.com/sports-betting-revenue/>
- Amazon 2022. "10 years of Amazon robotics: how robots help sort packages, move product, and improve safety." Amazon. <https://www.aboutamazon.com/news/operations/10-years-of-amazon-robotics-how-robots-help-sort-packages-move-product-and-improve-safety#:~:text=We%20have%20more%20than%20520%2C000,sort%20centers%20and%20air%20hubs.>
- Amazon. Company Filings. Data as of 12/31/22. Amazon SEC Filings
- Anan, L. et al. 2020. "US digital payments: Achieving the next phase of consumer engagement." McKinsey & Company. <https://www.mckinsey.com/industries/financial-services/our-insights/banking-matters/us-digital-payments-achieving-the-next-phase-of-consumer-engagement>
- Anan, L. et al. 2022. "Consumer trends in digital payments." McKinsey & Company. <https://www.mckinsey.com/industries/financial-services/our-insights/banking-matters/consumer-trends-in-digital-payments>
- Ant Group 2023. "H Share IPO." Ant Group. <https://www1.hkexnews.hk/listedco/listconews/sehk/2020/1026/2020102600165.pdf>
- Apple. iPhone 3GS - Technical Specifications. Data as of 07/26/17. https://support.apple.com/kb/sp565?locale=en_US
- Apple. iPhone 6s - Technical Specifications. Data as of 04/15/21. https://support.apple.com/kb/sp726?locale=en_US
- Apple. iPhone 14. Data as of 01/27/23. <https://www.apple.com/iphone-14/specs/>
- Apple. List of iPhone models. Data as of 01/27/23. https://apple.fandom.com/wiki/List_of_iPhone_models
- Arizona Department of Gaming. Current ADG Reports. Data as of 01/25/23. <https://gaming.az.gov/resources/reports#current-adg-reports>
- Arrington, M. 2007. "YouTube Revenues: \$15 million per year, or per month?." TechCrunch. <https://techcrunch.com/2007/03/06/youtube-revenues-15-million-per-year-or-per-month/>
- ASCO. Special Series: Liquid Biopsies. Data as of 01/19/23. <https://ascopubs.org/po/collections/liquid-biopsies>
- Automation.com 2021. "US Robot Density in Car Industry Ranks 7th Worldwide." Automation.com. <https://www.automation.com/en-us/articles/march-2021/us-robot-density-car-industry-ranks-7th-worldwide>
- Avanzini, S. et al. 2020. "A mathematical model of ctDNA shedding predicts tumor detection size." American Association for the Advancement of Science. <https://www.science.org/doi/10.1126/sciadv.abc4308>
- Baid, G. et al. 2022. "Deep Consensus improves the accuracy of sequences with a gap-aware sequence transformer." Springer Nature Limited. <https://www.nature.com/articles/s41587-022-01435-7>
- Bank for International Settlements. Global Debt Market Cap. Data as of 01/25/23. <https://stats.bis.org/statx/srs/table/cl?f=pdf>
- Barreto, M. et al. 2022. "Spending on Transport Infrastructure." OECD. <https://www.itf-oecd.org/infrastructure-investment-data-reveal-contrasts-between-countries>
- Békés, M. et al. 2022. "PROTAC targeted protein degraders: the past is prologue." Springer Nature Limited. <https://www.nature.com/articles/s41573-021-00371-6>
- Bellan, R. et al. 2022. "Musk says Tesla aspires to mass produce robotaxis by 2024." TechCrunch. <https://techcrunch.com/2022/04/20/elon-musk-mass-produce-robotaxi-by-2024/>
- Bellan, R. 2022. "Waymo is expanding its driverless program in Phoenix." TechCrunch. <https://techcrunch.com/2022/05/18/waymo-is-expanding-its-driverless-program-in-phoenix/#:~:text=While%20Waymo%20wouldn't%20share,300%20cars%20in%20the%20city.>
- Biomedtracker. Clinical Pipeline of RNA-Based Therapies Over Time. Data as of 01/17/23. <https://www.biomedtracker.com/index.cfm>
- Biomedtracker. Gene Editing Programs by Disease Area. Data as of 01/17/23. <https://www.biomedtracker.com/index.cfm>
- Biomedtracker. Innovative Drug Candidates Have More Attractive Risk-Adjusted NPVs According to ARK's Valuation Framework. Data as of 01/17/23. <https://www.biomedtracker.com/index.cfm>
- Biomedtracker. Maturity of TPD Landscape. Data as of 01/17/23. <https://www.biomedtracker.com/index.cfm>
- Biomedtracker. The Market Seems to Undervalue Innovative Therapeutics Relative to Traditional Medicines. Data as of 01/17/23. <https://www.biomedtracker.com/index.cfm>
- Bleeding Edge. Articles. Data as of 01/23/23. <https://bleedingedge.ai>
- Block, Inc. Investor Relations. Data as of 12/29/22. <https://investors.block.xyz/overview/default.aspx>
- Block, Inc.. Quarterly Results. Data as of 01/19/23. <https://investors.block.xyz/overview/default.aspx>
- Bloomberg Finance L.P.. Opportunities generated.. Data as of 01/19/23. <https://about.bnef.com/>
- Bloomberg. Despite Severe Drawdowns, Bitcoin Has Outperformed Every Major Asset Class Over Longer Time Horizons. Data as of 01/27/23.
- Bloomberg. Global Equities Market Cap. Data as of 01/25/23.
- Bloomberg. Global M2 Market Cap. Data as of 01/25/23.
- Bokhorst, L. et al. 2015. "Compliance Rates with the Prostate Cancer Research International Active Surveillance (PRIAS) Protocol and Disease Reclassification in Noncompliers." Elsevier B.V.. <https://www.sciencedirect.com/science/article/abs/pii/S0302283815005151?via%3Dihub>
- Bolt, J. et al. 2022. "Maddison Project Database 2020." Groningen Growth and Development Centre. <https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2020>
- BP p.l.c. 2022. "Oil demand." BP p.l.c.. <https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/oil-demand.html>
- Brohan, A. et al. 2022. "RT-1: Robotics Transformer for Real-World Control at Scale." Robotics at Google. <https://robotics-transformer.github.io/assets/rt1.pdf>
- Brown, D. et al. 2021. "Clinical development times for innovative drugs." Nature. <https://www.nature.com/articles/d41573-021-00190-9>
- Bureau of Transportation Statistics 2017. "Appendix F. Estimating Transport costs." Bureau of Transportation Statistics. https://web.archive.org/web/20170125014817/https://ntl.bts.gov/lib/4000/4300/4318/ccf_apxF.pdf
- Bureau of Transportation Statistics. Freight Facts and Figures. Data as of 01/27/23. <https://www.bts.gov/product/freight-facts-and-figures>
- Bureau of Transportation Statistics. Table 3-21: Average Freight Revenue Per Ton-mile (Current cents). Data as of 02/03/17. https://www.bts.gov/archive/publications/national_transportation_statistics/table_03_21
- Carroll, A. 2022. "A new genome sequencing tool powered with our technology." Google. <https://blog.google/technology/health/a-new-genome-sequencing-tool-powered-with-our-technology/>



- Carter, N. 2022. "The Status of Proof of Reserve as of Year End 2022." Medium. https://medium.com/@nic__carter/the-status-of-proof-of-reserve-as-of-year-end-2022-48120159377c
- Chen, B. 2020. "Up to 91% More Expensive: How Delivery Apps Eat Up Your Budget." The New York Times. <https://www.nytimes.com/2020/02/26/technology/personaltech/ubereats-doordash-postmates-grubhub-review.html>
- Chen, Y. et al. 2022. "Quantifying Regional Methane Emissions in the New Mexico Permian Basin with a Comprehensive Aerial Survey." ACS Publications. <https://pubs.acs.org/doi/10.1021/acs.est.1c06458>
- China Internet Watch 2022. "Alipay." China Internet Watch. <https://www.chinainternetwatch.com/tag/alipay/>
- Choo, L. 2022. "The Crypto Bowl is the beginning of a blockchain advertising bonanza." Protocol. <https://www.protocol.com/fintech/super-bowl-crypto-bowl>
- Clarivate. RNA Technology Patents Granted Over Time. Data as of 01/17/23. <https://clarivate.com/>
- Colao, J. 2012. "Snapchat: The Biggest No-Revenue Mobile App Since Instagram." Forbes. <https://www.forbes.com/sites/jjcolao/2012/11/27/snapchat-the-biggest-no-revenue-mobile-app-since-instagram/?sh=f5a0ee372000>
- Cozzi, L. et al. 2022. "World Energy Outlook 2022." IEA. <https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf>
- Crisp, A. 2018. "IGD: online set to be fastest growing Asia channel with 194% growth predicted by 2022." The Institute of Grocery Distribution. <https://www.igd.com/articles/article-viewer/t/igd-online-set-to-be-fastest-growing-asia-channel-with-194-growth-predicted-by-2022/i/19947>
- CryptoSlam. Avalanche Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/avalanche>
- CryptoSlam. Blockchains by NFT Sales Volume. Data as of 01/25/23. <https://www.cryptoslam.io/blockchains>
- CryptoSlam. BNB Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/bnb>
- CryptoSlam. Cardano Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/cardano>
- CryptoSlam. Ethereum Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/ethereum>
- CryptoSlam. Flow Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/flow>
- CryptoSlam. ImmutableX Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/immutablex>
- CryptoSlam. NFT Trading Volume. Data as of 01/17/23. <https://www.cryptoslam.io>
- CryptoSlam. Panini Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/panini>
- CryptoSlam. Polygon Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/polygon>
- CryptoSlam. Ronin Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/ronin>
- CryptoSlam. Solana Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/solana>
- CryptoSlam. WAX Sales Volume Data, Graphs & Charts. Data as of 01/02/23. <https://www.cryptoslam.io/blockchains/wax>
- de Selding, P. 2014. "Former Arianespace Chief Says SpaceX Has Advantage on Cost." SpaceNews. <https://spacenews.com/39906former-arianespace-chief-says-spacex-has-advantage-on-cost/>
- De, N. et al. 2022. "Three Arrows Capital Files for Bankruptcy in New York Tied to British Virgin Islands Proceeding." CoinDesk. <https://www.coindesk.com/business/2022/07/01/three-arrows-capital-files-for-bankruptcy-in-new-york-tied-to-british-virgin-islands-proceeding/>
- DefiLlama. AAVE V2 (AAVE). Data as of 01/03/23. <https://defillama.com/protocol/aave-v2>
- DeLong, B. 1998. "Estimating World GDP, One Million B.C. - Present." University of California at Berkeley. <http://holtz.org/Library/Social%20Science/Economics/Estimating%20World%20GDP%20by%20DeLong/Estimating%20World%20GDP.htm>
- Desjardins, J. 2020. "All of the World's Money and Markets in One Visualization." Visual Capitalist. <https://www.visualcapitalist.com/all-of-the-worlds-money-and-markets-in-one-visualization-2020/>
- Diment, L. et al. 2017. "Clinical efficacy and effectiveness of 3D printing: a systematic review." BMJ Publishing Group Ltd. <https://bmjopen.bmj.com/content/7/12/e016891>
- DJI. Phantom 2 Vision+. Data as of 01/27/23. <https://www.dji.com/phantom-2-vision-plus/info>
- Dobson, G. 2020. "Trauma of major surgery: A global problem that is not going away." National Library of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7388795/>
- Dune Analytics. Mints By Category ETH + Solana. Data as of 01/23/23. <https://dune.com/queries/1921295>
- Dune Analytics. Total NFT Mints. Data as of 01/17/23. <https://dune.com/queries/1886799?d=11>
- Dune Analytics. Transactions by Chain Charts (OP, Arbi, ETH). Data as of 01/17/23. <https://dune.com/queries/1873519/3083010>
- Edmunds.com, Inc. 2022 Tesla Model 3 Cost to Own. Data as of 01/27/23. <https://www.edmunds.com/tesla/model-3/2022/cost-to-own/?style=401884809>
- Edmunds.com, Inc. 2022 Toyota Camry Cost to Own. Data as of 01/27/23. <https://www.edmunds.com/toyota/camry/2022/cost-to-own/?style=401903004>
- FDIC. Bank Data & Statistics. Data as of 01/17/23. <https://www.fdic.gov/bank/statistical/>
- Federal Highway Administration 2020. "Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation." Federal Highway Administration. https://ops.fhwa.dot.gov/congestion_report/executive_summary.htm#congestion_worse
- Federal Highway Administration. Travel Monitoring. Data as of 12/28/22. https://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm
- Ferguson, D. 2020. "Introducing R2, Nuro's Next Generation Self-Driving Vehicle." Medium. <https://medium.com/nuro/introducing-r2-nuros-next-generation-self-driving-vehicle-a9974ff6c2e0>
- FFIEC. Federal Financial Institutions Examination Council Central Data Repository's Public Data Distribution. Data as of 01/17/23. <https://cdr.ffiec.gov/public/ManageFacsimiles.aspx>
- FIS 2020. "Global Payment Report January 2020." FIS. <https://offers.worldpayglobal.com/rs/850-JOA-856/images/GPR-2020.pdf?>
- FIS 2021. "The Global Payment Report 2021." FIS. <https://offers.worldpayglobal.com/rs/850-JOA-856/images/1297411%20GPR%20DIGITAL%20ENGLISH%20SINGLES%20RGB%20FNL11.pdf>
- FIS 2022. "The Global Payment Report For Financial Institutions and Merchants." FIS. https://offers.worldpayglobal.com/rs/850-JOA-856/images/ENGR2022.pdf?_gl=1*d05119*_ga*MzgwNTY2MTUzLjE2Njg1NDUyMDU.*_ga_SKZCV3S405*MTY2ODcwMDYzOC4yLjEuMTY2ODcwMDYIOS4wLjAuMA..
- Flashbots. Transparency dashboard. Data as of 01/17/23. <https://transparency.flashbots.net/>
- GitHub. Copilot · Your AI pair programmer. Data as of 01/27/23. <https://github.com/features/copilot>
- Glasner, J. 1999. "Iridium Cuts Prices." Wired. <https://www.wired.com/1999/06/iridium-cuts-prices/>
- Glassnode. Bitcoin Mean Hash Rate. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=mining.HashRateMean&s=1278892800&u=1673568000&zoom=>



- Glassnode. Bitcoin Price [USD]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=market.PriceUsdClose&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin Realized Cap [USD]. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=market.MarketcapRealizedUsd&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin Realized Price [USD]. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=market.PriceRealizedUsd&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin: Adjusted Percent Supply in Profit. Data as of 01/20/23. <https://studio.glassnode.com/workbench/btc-supply-percent-in-profit-adjusted>
- Glassnode. Bitcoin: Circulating Supply [BTC]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=BTC&category=&ema=0&m=supply.Current&mAvg=0&mMedian=0&modal=loginForm&zoom=all>
- Glassnode. Bitcoin: Lightning Network Capacity [BTC]. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=lightning.NetworkCapacitySum&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin: Net Transfer Volume from/to Exchanges [BTC] - All Exchanges. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=transactions.TransfersVolumeExchangesNet>
- Glassnode. Bitcoin: Number of Addresses with a Non-Zero Balance. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=addresses.NonZeroCount&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin: Number of Addresses. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=addresses.Count>
- Glassnode. Bitcoin: Number of Transactions. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=transactions.Count>
- Glassnode. Bitcoin: Percent of Supply Last Active 1+ Years Ago. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=supply.ActiveMore1YPercent&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin: Realized Profit and Loss. Data as of 01/20/23. <https://studio.glassnode.com/workbench/btc-realized-pnl>
- Glassnode. Bitcoin: Total Miner Revenue [BTC] - All Miners. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=mining.RevenueSum>
- Glassnode. Bitcoin: Total Supply Held by Long-Term Holders. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=supply.LthSum&s=1278892800&u=1673568000&zoom=>
- Glassnode. Bitcoin: Total Transfer Volume [BTC]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=transactions.TransfersVolumeSum>
- Glassnode. Bitcoin: Total Transfer Volume [BTC]. Data as of 01/20/23. <https://studio.glassnode.com/metrics?a=BTC&category=&m=transactions.TransfersVolumeSum>
- Glassnode. Ethereum: Burned Supply [ETH]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=ETH&category=&ema=0&m=supply.Burned&mAvg=0&mMedian=0&modal=loginForm&zoom=all>
- Glassnode. Ethereum: Circulating Supply [ETH]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=ETH&category=&ema=0&m=supply.Current&mAvg=0&mMedian=0&modal=loginForm&zoom=all>
- Glassnode. Ethereum: Gas Usage by Transaction Type (Absolute) (90d Moving Average). Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=ETH&category=Fees&ema=0&m=fees.TxTypesBreakdownSum&Avg=90&mMedian=0&modal=loginForm>
- Glassnode. Ethereum: Issuance [ETH]. Data as of 01/17/23. <https://studio.glassnode.com/metrics?a=ETH&category=&m=supply.Issued&modal=loginForm>
- Goldstein, T. 2022. "I estimate the cost of running ChatGPT is \$100K per day, or \$3M per month. This is a back-of-the-envelope calculation. I assume nodes are always in use with a batch size of 1. In reality they probably batch during high volume, but have GPUs sitting fallow during low volume.." Twitter. <https://twitter.com/tomgoldsteincs/status/1600196995389366274>
- Google Flights. Shorthaul Flight v Robotaxi. Data as of 01/26/23. <https://www.google.com/travel/flights>
- Gopalakrishnan, K. et al. 2022. "RT-1: Robotics Transformer for real-world control at scale." Google. <https://ai.googleblog.com/2022/12/rt-1-robotics-transformer-for-real.html>
- Grail. GRAIL's multi-cancer early detection test. Data as of 01/19/23. <https://grail.com/our-products/>
- Gregson, R. 1999. "Iridium Results Beat Expectations, but Road Ahead Still Bumpy." RCR Wireless News. <https://www.rcrwireless.com/19990201/archived-articles/iridium-results-beat-expectations-but-road-ahead-still-bumpy>
- Hall, J. 2022. "UK hits double-digit inflation for the first time in 40 years." CoinTelegraph. <https://cointelegraph.com/news/uk-hits-double-digit-inflation-for-the-first-time-in-40-years>
- Haque, I. et al. 2018. "Limitations on Mutation Detection for Early Detection of Cancer." Freenome Inc. https://static1.squarespace.com/static/54e4c4c4e4b06b5b9b5b6e2c/t/5ea81cc8eac6e000b6eba4c0/1588075724785/2018_AACR_Poster_2.pdf
- Hasenstab, B. 1998. "Cell phone plan debuts." Cable News Network. <https://money.cnn.com/1998/05/07/technology/attwireless/>
- Hoffmann, J. et al. 2022. "Training Compute-Optimal Large Language Models." arXiv. <https://arxiv.org/abs/2203.15556>
- IAB 2022. "2021 Video Ad Spend & 2022 Outlook May 2022." IAB. <https://www.iab.com/wp-content/uploads/2022/05/2022-IAB-Video-Ad-Spend-Report.pdf>
- IEA 2021. "Oil 2021 Analysis and forecast to 2026." IEA. https://iea.blob.core.windows.net/assets/1fa45234-bac5-4d89-a532-768960f99d07/Oil_2021-PDF.pdf
- Insider Intelligence. Connected TV Ad Spending. Data as of 12/22/22.
- Insider Intelligence. Connected TV Households. Data as of 01/12/23.
- Insider Intelligence. Digital Video Viewers. Data as of 01/02/23.
- Insider Intelligence. Meta Ad Revenues. Data as of 12/22/22.
- Insider Intelligence. Retail Ecommerce Sales Worldwide, 2022-2026. Data as of 01/27/23. www.emarketer.com
- Insider Intelligence. Retail Ecommerce Sales. Data as of 01/02/23.
- Insider Intelligence. TikTok Ad Revenues. Data as of 12/22/22.
- Insider Intelligence. TV Viewers and Penetration. Data as of 01/12/23.
- Insider Intelligence. YouTube Ad Revenues. Data as of 12/22/22.
- International Fund for Agricultural Development 2022. "12 reasons why remittances are important." International Fund for Agricultural Development. [https://www.ifad.org/en/web/latest/-/12-reasons-why-remittances-are-important#:~:text=A%20staggering%20one%20billion%20people,average\)%20benefit%20from%20these%20flows.](https://www.ifad.org/en/web/latest/-/12-reasons-why-remittances-are-important#:~:text=A%20staggering%20one%20billion%20people,average)%20benefit%20from%20these%20flows.)
- Iqbal, M. 2022. "Snapchat Revenue and Usage Statistics (2022)." Business of Apps. <https://www.businessofapps.com/data/snapchat-statistics/>



- Iqbal, M. 2022. "TikTok Revenue and Usage Statistics (2022)." Business of Apps. <https://www.businessofapps.com/data/tik-tok-statistics/>
- IQVIA Inc 2022. "Global Oncology Trends 2022." IQVIA Inc. <https://www.iqvia.com/insights/the-iqvia-institute/reports/global-oncology-trends-2022>
- Irle, R. 2022. "Global EV Sales for 2022 H1." EV-Volumes. <http://ev-volumes.com>
- Irle, R. 2022. "Global EV Sales for 2022 H1." EV-Volumes. <https://www.ev-volumes.com/>
- Irvine, A. 2019. "Paying for CRISPR Cures: The Economics of Genetic Therapies." Innovative Genomics Institute. <https://innovativegenomics.org/news/paying-for-crispr-cures/>
- Jabil Inc. 2021. "3D Printing Trends: Six Major Developments." Jabil Inc.. <https://www.jabil.com/blog/3d-printing-trends-show-positive-outlook.html>
- Jang, E. et al. 2022. "BC-Z: Zero-Shot Task Generalization with Robotic Imitation Learning." arXiv. <https://arxiv.org/abs/2202.02005>
- Johnson, P. 2022. "1/ Last year, stablecoins settled >\$7tn on-chain. Current run-rate is ~\$9tn/yr. This is significantly more than Mastercard (~\$2.2tn), Amex (~\$1tn), and Discover (<\$200bn). In 2023, on-chain stablecoin volumes will surpass the largest card network, Visa, which processes ~\$12tn/yr.." Twitter. <https://twitter.com/TheChicagoVC/status/1605596279295201280>
- Kalliamvakou, E. 2022. "Research: quantifying GitHub Copilot's impact on developer productivity and happiness." GitHub, Inc.. <https://github.blog/2022-09-07-research-quantifying-github-copilots-impact-on-developer-productivity-and-happiness/>
- Kane, M. 2022. "US: The Number Of EV Models With 300+ Miles Of Range Tripled in 2022." InsideEVs. <https://insideevs.com/news/607517/us-number-models-300miles-range-2022/>
- Kasparov, G. et al. 2017. "Why the rise of authoritarianism is a global catastrophe." Washington Post. <https://www.washingtonpost.com/news/democracy-post/wp/2017/02/13/why-the-rise-of-authoritarianism-is-a-global-catastrophe/>
- Kaspi. 3Q 2022 Results. Data as of 01/17/23. https://ir.kaspi.kz/media/3Q_2022_Presentation.pdf
- Kaur, D. 2022. "Ten years later, Alipay is still the most popular digital wallet in the world." Tech Wire Asia. <https://techwireasia.com/2022/08/ten-years-later-alipay-is-still-the-most-popular-digital-wallet-in-the-world/>
- Kemp, S. 2012. "DIGITAL 2012: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2012-global-digital-overview>
- Kemp, S. 2013. "DIGITAL 2013: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2013-global-digital-overview>
- Kemp, S. 2014. "DIGITAL 2014: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2014-global-digital-overview>
- Kemp, S. 2015. "DIGITAL 2015: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2015-global-digital-overview>
- Kemp, S. 2016. "DIGITAL 2016: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2016-global-digital-overview>
- Kemp, S. 2017. "DIGITAL 2017: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2017-global-digital-overview>
- Kemp, S. 2018. "DIGITAL 2018: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2018-global-digital-overview>
- Kemp, S. 2019. "DIGITAL 2019: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2019-global-digital-overview>
- Kemp, S. 2020. "DIGITAL 2020: GLOBAL DIGITAL OVERVIEW." Kepios. <https://datareportal.com/reports/digital-2020-global-digital-overview>
- Kemp, S. 2021. "DIGITAL 2021: GLOBAL OVERVIEW REPORT." Kepios. <https://datareportal.com/reports/digital-2021-global-overview-report>
- Kemp, S. 2022. "DIGITAL 2022: GLOBAL OVERVIEW REPORT." Kepios. <https://datareportal.com/reports/digital-2022-global-overview-report>
- Kilcarr, S. 2014. "Big rigs, big costs." Endeavor Business Media, LLC.. <http://fleetowner.com/blog/big-rigs-big-costs>
- Koppal, T. 2020. "Understanding the nuances of targeted protein degradation." YouTube. <https://www.youtube.com/watch?v=hZPLBByAKQ>
- Korus, S. 2018. "Auto Capital Spending Suggests That EV Forecasts Are Much Too Low." ARK Investment Management LLC. <https://ark-invest.com/articles/analyst-research/ev-forecasts/>
- Kuzmichenok, V. 2021. "Yandex Buys Uber Out of Food Delivery Partnership in \$1Bn Deal." The Moscow Times. <https://www.themoscowtimes.com/2021/08/31/yandex-buys-uber-out-of-food-delivery-partnership-in-1bn-deal-a74935>
- Lee, T. 2022. "Waymo finally launches an actual public, driverless taxi service." Condé Nast. <https://arstechnica.com/cars/2020/10/waymo-finally-launches-an-actual-public-driverless-taxi-service/>
- Lee, W. et al. 2022. "Adaptive 3D Printing for In Situ Adjustment of Mechanical Properties." Wiley-VCH GmbH. <https://onlinelibrary.wiley.com/doi/epdf/10.1002/aisy.202200229>
- Li, C. 2020. "OpenAI's GPT-3 Language Model: A Technical Overview." Lambda. <https://lambdalabs.com/blog/demystifying-gpt-3>
- Lienert, P. 2018. "Global carmakers to invest at least \$90 billion in electric vehicles." Reuters. <https://www.reuters.com/article/us-autoshow-detroit-electric/global-carmakers-to-invest-at-least-90-billion-in-electric-vehicles-idUSKBN1F42NW>
- Lienert, P. 2022. "A Reuters analysis of 37 global automakers found that they plan to invest nearly \$1.2 trillion in electric vehicles and batteries through 2030." Reuters Graphics. <https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzypr/index.html>
- Lienert, P. et al. 2021. "Exclusive: Global carmakers now target \$515 billion for EVs, batteries." Reuters. <https://www.reuters.com/business/autos-transportation/exclusive-global-carmakers-now-target-515-billion-evs-batteries-2021-11-10/>
- Lifson, M. et al. 2022. "Is there enough room in space for tens of billions of satellites, as Elon Musk suggests? We don't think so." SpaceNews. <https://spacenews.com/op-ed-is-there-enough-room-in-space-for-tens-of-billions-of-satellites-as-elon-musk-suggests-we-dont-think-so/>
- Lindeborg, R. et al. 2021. "Cost of Clinical Trials: A Breakdown (Infographic)." Clinical Research. <https://www.clinicalresearch.io/blog/industry-trends/cost-of-clinical-trials-breakdown/>
- Lopez, L. 2022. "PacBio Announces Revio, a Revolutionary New Long Read Sequencing System Designed to Provide 15 Times More HiFi Data and Human Genomes at Scale for Under \$1,000." PacBio. https://www.pacb.com/press_releases/pacbio-announces-revio-a-revolutionary-new-long-read-sequencing-system-designed-to-provide-15-times-more-hifi-data-and-human-genomes-at-scale-for-under-1000/
- Mackay, M. et al. 2022. "Dual tissue and plasma testing to improve detection of actionable variants in patients with solid cancers." American Society of Clinical Oncology. https://ascopubs.org/doi/abs/10.1200/JCO.2022.40.16_suppl.3017
- Malone, C. 2007. "Gene Regulation in Eukaryotes." California State University of Northridge. <https://www.csun.edu/~cmalone/pdf360/>



- Malwa, S. 2023. "Ethereum Name Service Recorded Over 2.8M Domain Registrations in 2022." Yahoo. https://autos.yahoo.com/ethereum-name-recorded-over-2-075720583.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAEIS15_Gsif9zAC4o4CGwJwQxxS401ItNpifnL_2AWPLHnkg_Xm5OI-E4MC-dllBeU40bfsAiVwF3h9-LoZECxqnJSx-JyTilozj9ReCa2UzI3szOM4AdraATfEn5zeVDwYzZEjvonOcl29HNWcKukFzzT4ddM5Rk9CEf84nLxbX
- Martin, P. 2013. "NASA's Efforts to Maximize Research on the International Space Station." OIG. <https://oig.nasa.gov/audits/reports/FY13/IG-13-019.pdf>
- Mathios, D. et al. 2021. "Detection and characterization of lung cancer using cell-free DNA fragmentomes." Springer Nature Limited. <https://www.nature.com/articles/s41467-021-24994-w>
- McKinsey & Company 2021. "The rise and rise of the global balance sheet." McKinsey & Company. <https://www.mckinsey.com/-/media/mckinsey/industries/financial%20services/our%20insights/the%20rise%20and%20rise%20of%20the%20global%20balance%20sheet%20how%20productively%20are%20we%20using%20our%20wealth/mgi-the-rise-and-rise-of-the-global-balance-sheet-full-report-vf.pdf>
- McKinsey & Company 2022. "The 2022 McKinsey Global Payments Report." McKinsey & Company. <https://www.mckinsey.com/-/media/mckinsey/industries/financial%20services/our%20insights/the%202022%20mckinsey%20global%20payments%20report/the-2022-mckinsey-global-payments-report.pdf>
- Meara, J. et al. 2015. "Global Surgery 2030." The Lancet Commission on Global Surgery. https://www.lancetglobalsurgery.org/_files/ugd/346076_713dd3f8bb594739810d84c1928ef61a.pdf
- Mensah, G. et al. 2017. "Decline in Cardiovascular Mortality: Possible Causes and Implications." National Library of Medicine. <https://pubmed.ncbi.nlm.nih.gov/28104770/>
- Mensah, G. et al. 2018. "Decline in Cardiovascular Mortality: Possible Causes and Implications." National Library of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5268076/>
- Messari. Launch and Initial Token Distribution. Data as of 01/25/23. <https://messari.io/>
- Meta Platforms, Inc.. Corporate filings. Data as of 12/30/22. <https://investor.fb.com/financials/?section=secfilings>
- Michuda, J. et al. 2022. "Use of clinical RNA-sequencing in the detection of actionable fusions compared to DNA-sequencing alone." American Society of Clinical Oncology. https://ascopubs.org/doi/abs/10.1200/JCO.2022.40.16_suppl.3077
- Miller, A. 2021. "Airport Deserts – Exploring The Distance Between Airports And The Cities They Serve [Data Study]." Upgraded Points. <https://upgradedpoints.com/travel/airports/airport-deserts-data-study/>
- Morrison, R. et al. 2015. "Most U.S. Households Do Their Main Grocery Shopping at Supermarkets and Supercenters Regardless of Income." Economic Research Service. <https://www.ers.usda.gov/amber-waves/2015/august/most-us-households-do-their-main-grocery-shopping-at-supermarkets-and-supercenters-regardless-of-income>
- MPayPass 2020. "China Payment and Clearing Association released the "2019 Mobile Payment User Survey Report"." MPayPass. <https://m.mpaypass.com.cn/news/202001/06142719.html>
- MPayPass 2021. "China Payment and Clearing Association released the "2020 Mobile Payment User Survey Report"." MPayPass. <https://m.mpaypass.com.cn/news/202101/12171328.html>
- MPayPass 2022. "China Payment and Clearing Association released the 2021 mobile payment user survey report." MPayPass. <https://m.mpaypass.com.cn/news/202204/19131610.html>
- MPayPass 2022. "Payment and Clearing Association of China Releases 2022 Survey Report on Mobile Payment User Usage." MPayPass. <https://m.mpaypass.com.cn/news/202212/13181900.html>
- Müller, C. 2022. "Executive Summary World Robotics 2022 Industrial Robots." VDMA Services GmbH. https://ifr.org/img/worldrobotics/Executive_Summary_WR_Industrial_Robots_2022.pdf
- Musunuru, K. et al. 2021. "In vivo CRISPR base editing of PCSK9 durably lowers cholesterol in primates." Nature. <https://www.nature.com/articles/s41586-021-03534-y>
- Nalley, S. et al. 2021. "International Energy Outlook 2021 (IEO2021)." U.S. Energy Information Administration. <https://www.eia.gov/outlooks/ieo/>
- Nalley, S. et al. 2022. "Annual Energy Outlook 2022." U.S. Energy Information Administration. <https://www.eia.gov/outlooks/aeo/>
- Nansen. ETH2. Data as of 01/17/23. <https://pro.nansen.ai/eth2-deposit-contract>
- Nasir, M. et al. 2022. "From drug target inhibition to degradation: a TACTical strategy." Springer Nature Limited. <https://www.nature.com/articles/d43747-022-00173-8>
- Natera, Inc. Why circulating tumor DNA (ctDNA) for MRD assessment?. Data as of 01/19/23. <https://www.natera.com/oncology/signatera-advanced-cancer-detection/>
- National Cancer Institute. All Cancer Sites Combined. Data as of 01/19/23. https://seer.cancer.gov/statistics-network/explorer/application.html?site=1&data_type=1&graph_type=2&compareBy=sex&chk_sex_3=3&chk_sex_2=2&rate_type=2&race=1&age_range=1&hdn_stage=101&advopt_precision=1&advopt_show_ci=on&hdn_view=0&advopt_show_apc=on&advopt_display=2#graphArea
- New Hampshire Lottery Commission. Financial Reports. Data as of 01/25/23. <https://www.nhlottery.com/About-Us/Financial-Reports>
- No Source Type Provided
- O'Neill, A. 2022. "The Ethereum Merge Is Successful – How Will It Impact Traders and the Global Crypto Market?." The Daily Hodl. <https://dailyhodl.com/2022/10/01/the-ethereum-merge-is-successful-how-will-it-impact-traders-and-the-global-crypto-market/#:~:text=it%20was%20a%20success%20%E2%80%93%20as,officially%20upgraded%20into%20Ethereum%202.0.>
- OECD Data. Hours worked. Data as of 12/28/22. <https://data.oecd.org/emp/hours-worked.htm>
- OpenAI. DALL-E 2. Data as of 01/23/23. <https://openai.com/dall-e-2/>
- PA Gaming Control Board. Gaming Revenue Fiscal Year 2022/2023. Data as of 01/25/23. <https://gamingcontrolboard.pa.gov/?p=320>
- Pandaily 2022. "XPeng Plans to Develop Fully Unmanned Driving in Three Years." Pandaily. <https://pandaily.com/xpeng-plans-to-develop-fully-unmanned-driving-in-three-years/>
- Parker, J. et al. 2021. "Does biomarker use in oncology improve clinical trial failure risk? A large-scale analysis." National Library of Medicine. <https://pubmed.ncbi.nlm.nih.gov/33620160/>
- Personalis Inc. Delivering Industry-Leading Sensitivity to Detect Residual Disease and Recurrence at the Earliest Timepoints. Data as of 01/19/23. <https://www.personalis.com/next-personal/>
- Piovarči, J. et al. 2022. "Closed-Loop Control of Direct Ink Writing via Reinforcement Learning." arXiv. <https://arxiv.org/pdf/2201.11819.pdf>
- PitchBook. 3D Printing Enterprise Value Stock Screen. Data as of 01/26/23. pitchbook.com
- PitchBook. Autonomous Ridehail Enterprise Value. Data as of 01/26/23. [www.pitchbook.com](https://pitchbook.com)
- Pitney Bowes Inc.. Pitney Bowes Parcel Shipping Index. Data as of 01/27/23. <https://www.pitneybowes.com/us/shipping-index.html>
- Pitney Bowes. Pitney Bowes Parcel Shipping Index. Data as of 01/27/23. <https://www.pitneybowes.com/us/shipping-index.html>
- PLAYWV. West Virginia Sports Betting Revenue. Data as of 12/30/22. <https://www.playwv.com/revenue/>
- Ponciano, J. 2022. "Crypto Lender Genesis Suspends Withdrawals: FTX Collapse Created 'Unprecedented Market Turmoil.'" Forbes. <https://www.forbes.com/sites/jonathanponciano/2022/11/16/crypto-lender-genesis-suspends-withdrawals-ftx-collapse-created-unprecedented-market-turmoil/?sh=29b93971782d>



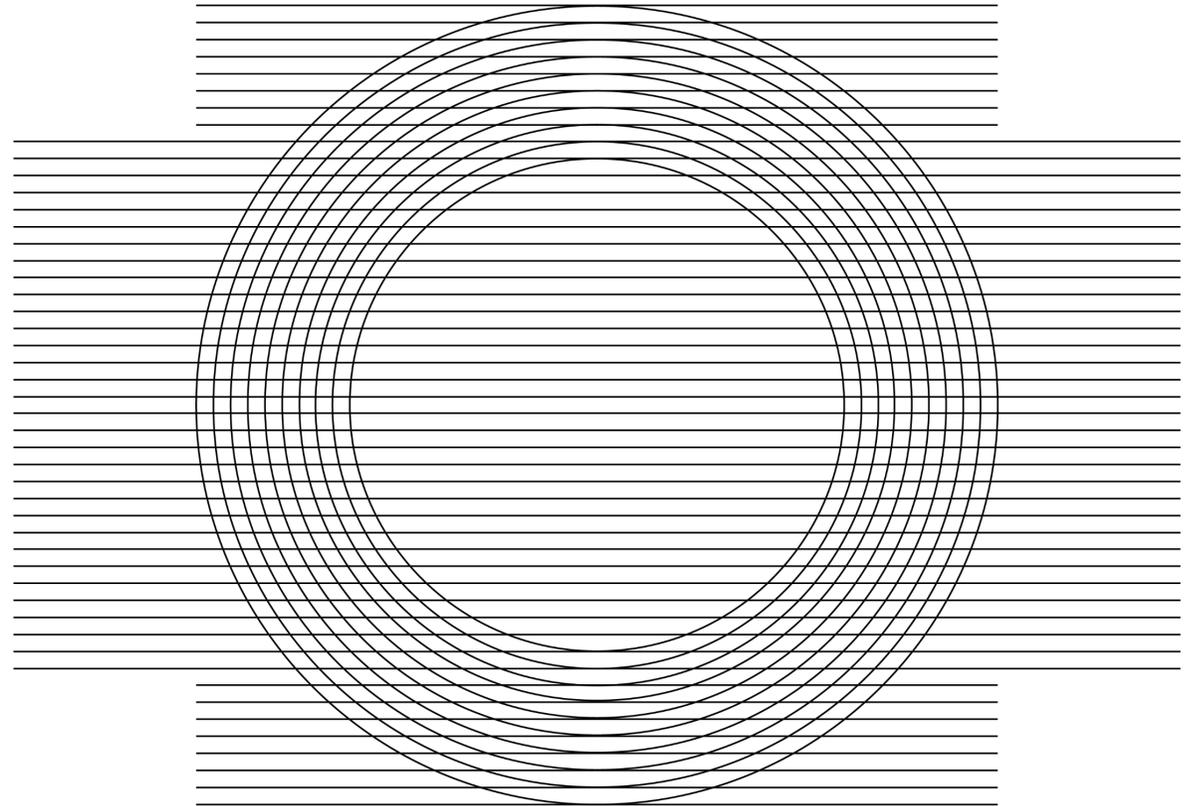
- Ponnezhath, M. et al. 2022. "Major crypto lender Celsius files for bankruptcy." Reuters. <https://www.reuters.com/technology/crypto-lender-celsius-files-bankruptcy-2022-07-14/>
- Property Rights Alliance. International Property Rights Index 2022. Data as of 01/25/23. <https://www.internationalpropertyrightsindex.org/>
- Quilty, C. et al. 2020. "Flat Panel Antennas: The Next Big Thing or an Elusive Unicorn?." Quilty Analytics. Quilty Analytics
- Raval, A. 2022. "Illumina to showcase the transformational impact of comprehensive genomic profiling in unlocking precision medicine for cancer patients, at ASCO." Illumina. <https://www.illumina.com/company/news-center/press-releases/2022/3424cbc9-3dd5-498a-aa0b-4627310badef.html>
- Rawstron, A. et al. 2015. "Minimal residual disease in myeloma by flow cytometry: independent prediction of survival benefit per log reduction." American Society of Hematology. <https://ashpublications.org/blood/article/125/12/1932/33718/Minimal-residual-disease-in-myeloma-by-flow>
- Roach, J. 2022. "Pinch-grasping robot handles items with precision." Amazon. <https://www.amazon.science/latest-news/pinch-grasping-robot-handles-items-with-precision>
- Robbins, D. et al. 2020. "Nx-2127, a Degradator of BTK and IMiD Neosubstrates, for the Treatment of B-Cell Malignancies." ASH Publications. <https://ashpublications.org/blood/article/136/Supplement%201/34/472476/Nx-2127-a-Degradator-of-BTK-and-IMiD-Neosubstrates>
- Roberts, T. 2022. "Space Launch to Low Earth Orbit: How Much Does It Cost?." Center for Strategic and International Studies. <https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost/>
- Roblox. Gucci Town. Data as of 12/30/22. <https://www.roblox.com/games/7830918930/Gucci-Town>
- Roblox. NIKELAND [SNOWBALL FIGHT]. Data as of 12/30/22. <https://www.roblox.com/games/7462526249/NIKELAND-NEW-3V3#!/about>
- Roblox. Tommy Play. Data as of 12/30/22. <https://www.roblox.com/games/9129288160/FASHION-SHOW-Tommy-Play>
- Roblox. Vans World [GIFTS]. Data as of 12/30/22. <https://www.roblox.com/games/6679274937/Vans-World>
- Roblox. Walmart Land. Data as of 12/30/22. <https://www.roblox.com/games/10895555747/Walmart-Land>
- Roser, M. et al. 2019. "Cancer." Our World in Data. <https://ourworldindata.org/cancer#cancer-survival-rates>
- Rowland, T. et al. 2022. "GRAIL Announces Final Results From the PATHFINDER Multi-Cancer Early Detection Screening Study at ESMO Congress 2022." Grail. <https://grail.com/press-releases/grail-announces-final-results-from-the-pathfinder-multi-cancer-early-detection-screening-study-at-esmo-congress-2022/>
- Rusinek, I. et al. 2022. "Detection and monitoring of circulating tumor DNA using affordable high-depth whole genome sequencing on a new sequencing platform." Ultima Genomics. <https://cdn.sanity.io/files/l7780ks7/production/f1794a36e12464e7ec57f7da7468df1c6ef5488.pdf>
- S&P Capital IQ. Capital IQ Equity Screening Report. Data as of 01/26/23. [capitaliq.com](https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html)
- S&P Global Market Intelligence. 3D Printing Addressable Market. Data as of 01/26/23. [capitaliq.com](https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html)
- S&P Global Market Intelligence. 3D Printing Enterprise Value Stock Screen. Data as of 01/26/23. [capitaliq.com](https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html)
- S&P Global Market Intelligence. Global Advertising Expenditure Forecast. Data as of 01/25/23.
- S&P Global Market Intelligence. Global gaming revenue, Q3 2022. Data as of 01/25/23.
- S&P Global Market Intelligence. Market Cap Attributable to Robotics. Data as of 01/26/23. [capitaliq.com](https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html)
- S&P Global. Automotive Industry Forecast: Light Vehicle Sales. Data as of 12/28/22. <https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html>
- S&P Global. Automotive Industry Forecast: Light Vehicle Sales. Data as of 12/29/22. <https://www.spglobal.com/mobility/en/products/automotive-light-vehicle-sales-forecasts.html>
- Samarasinghe, K. et al. 2021. "Targeted protein degradation: A promise for undruggable proteins." National Library of Medicine. <https://pubmed.ncbi.nlm.nih.gov/34004187/>
- Sandor, K. et al. 2022. "The Fall of Terra: A Timeline of the Meteoric Rise and Crash of UST and LUNA." CoinDesk. <https://www.coindesk.com/learn/the-fall-of-terra-a-timeline-of-the-meteoric-rise-and-crash-of-ust-and-luna/>
- Sensor Tower Inc. Sensor Tower Usage Active Users Unified. Data as of 01/25/23.
- Sigalos, M. 2022. "Sam Bankman-Fried steps down as FTX CEO as his crypto exchange files for bankruptcy." CNBC. <https://www.cnbc.com/2022/11/11/sam-bankman-frieds-cryptocurrency-exchange-ftx-files-for-bankruptcy.html>
- Sigalos, M. et al. 2022. "Crypto firm BlockFi files for bankruptcy as FTX fallout spreads." CNBC. <https://www.cnbc.com/2022/11/28/blockfi-files-for-bankruptcy-as-ftx-fallout-spreads.html>
- Simmons, V. et al. 2022. "The next S-curve of growth: Online grocery to 2030." McKinsey Insights. <https://www.mckinsey.com/industries/retail/our-insights/the-next-s-curve-of-growth-online-grocery-to-2030>
- Singer, U. et al. 2022. "Make-A-Video: Text-to-Video Generation without Text-Video Data." Meta. <https://makeavideo.studio>
- Snap Inc. Corporate filings. Data as of 12/30/22. <https://investor.snap.com/financials/quarterly-results/default.aspx>
- SpaceX. Falcon 9 First Orbital Class Rocket Capable of Reflight. Data as of 01/12/23. <https://www.spacex.com/vehicles/falcon-9/>
- SpaceX. Upcoming Launch Starlink Mission. Data as of 01/12/23. <http://www.spacex.com/about/capabilities>
- Stability 2022. "Stable Diffusion 2.0 Release." Stability. <https://stability.ai/blog/stable-diffusion-v2-release>
- Starlink. Order Starlink. Data as of 01/12/23. <https://www.starlink.com/>
- State of Colorado. Sports Betting Monthly Reports. Data as of 01/25/23. <https://sbg.colorado.gov/sports-betting-monthly-reports>
- Statista. Digital Music - Worldwide. Data as of 01/25/23. <https://www.statista.com/outlook/dmo/digital-media/digital-music/worldwide#revenue>
- Statista. Video-on-Demand - Worldwide. Data as of 01/25/23. <https://www.statista.com/outlook/dmo/digital-media/video-on-demand/worldwide#revenue>
- Svitak, A. 2011. "Rising Engine Costs, Uncertainty Drive Up Atlas 5 Prices for NASA." SpaceNews. <https://spacenews.com/rising-engine-costs-uncertainty-drive-atlas-5-prices-nasa/>
- TechNode 2022. "Baidu can start charging for fully driverless robotaxis in Wuhan and Chongqing." TechNode. <https://technode.com/2022/08/08/baidu-can-start-charging-for-fully-driverless-robotaxis-in-wuhan-and-chongqing/>
- TechNode 2022. "Pony.ai to start charging money for its robotaxi services in Guangzhou." TechNode. <https://technode.com/2022/04/24/pony-ai-to-start-charging-money-for-its-robotaxi-services-in-guangzhou/>
- TechnoPixel 2022. "Ethereum Majorly Passes First Major Test For PoS." TechnoPixel. <https://www.technopixel.org/ethereum-majorly-passes-first-major-test-for-pos/>
- Tejpaul, B. et al. 2022. "Coinbase selected by BlackRock; provide Aladdin clients access to crypto trading and custody via Coinbase Prime." Coinbase. <https://www.coinbase.com/blog/coinbase-selected-by-blackrock-provide-aladdin-clients-access-to-crypto-trading-and-custody-via>
- Tepper, T. 2022. "Federal Funds Rate History 1990 to 2022." Forbes. <https://www.forbes.com/advisor/investing/fed-funds-rate-history/>
- Tesla 2022. "Tesla AI Day 2022." Tesla. https://www.youtube.com/watch?v=ODSjsviD_SU
- The Block. DEX to CEX Spot Trade Volume (%). Data as of 01/17/23. <https://www.theblock.co/data/decentralized-finance/dex-non-custodial/dex-to-cex-spot-trade-volume>
- The Block. DEX to CEX Spot Trade Volume. Data as of 01/17/23. <https://www.theblock.co/data/decentralized-finance/dex-non-custodial/dex-to-cex-spot-trade-volume>



- The Block. DEX Volume. Data as of 01/17/23. <https://www.theblock.co/data/decentralized-finance/dex-non-custodial/dex-volume-monthly>
- The Block. Ethereum Lending Market Liquidations. Data as of 01/17/23. <https://www.theblock.co/data/decentralized-finance/cryptocurrency-lending/lending-market-liquidations-daily>
- The World Bank 2016. "2 Billion: Number of Adults Worldwide Without Access to Formal Financial Services." The World Bank. <https://www.worldbank.org/en/news/video/2016/03/10/2-billion-number-of-adults-worldwide-without-access-to-formal-financial-services>
- The World Bank 2021. "The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19." The World Bank. <https://www.worldbank.org/en/publication/globalindex>
- The World Bank Group. GDP, PPP (constant 2017 international \$). Data as of 01/27/23. <https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.KD>
- The World Bank. Final consumption expenditure (current US\$). Data as of 12/30/22. <https://data.worldbank.org/indicator/NE.CON.GOVV.CD>
- The World Bank. GDP (current US\$). Data as of 12/30/22. <https://data.worldbank.org/indicator/NE.CON.TOTL.CD>
- The World Bank. GDP per capita (current US\$). Data as of 12/30/22. <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>
- The World Bank. Population, total. Data as of 01/19/23. <https://data.worldbank.org/indicator/SP.POP.TOTL>
- The World Bank. Population, total. Data as of 01/20/23. <https://data.worldbank.org/indicator/SP.POP.TOTL>
- Tie, J. et al. 2022. "Circulating Tumor DNA Analysis Guiding Adjuvant Therapy in Stage II Colon Cancer." The New England Journal of Medicine. <https://www.nejm.org/doi/full/10.1056/NEJMoa2200075>
- Token Terminal. Master Protocol Revenue. Data as of 01/03/22.
- TradingView. Total Crypto Market Cap. Data as of 01/17/23. tradingview.com
- Tsotsis, A. 2012. "Facebook's IPO: An End To All The Revenue Speculation." TechCrunch. <https://techcrunch.com/2012/02/01/facebook-ipo-facebook-ipo-facebook-ipo/>
- Twitter, Inc.. Corporate filings. Data as of 12/30/22. <https://investor.twitterinc.com/financial-information/sec-filings/default.aspx>
- UCS 2022. "UCS Satellite Database." UCS. <https://www.ucusa.org/resources/satellite-database>
- Unified. Sensor Tower Total Time Spent. Data as of 01/02/23.
- United Launch Alliance. Atlas V. Data as of 01/19/23. <https://web.archive.org/web/20161203124622/https://www.rocketbuilder.com/start/configure>
- Unstoppable Domains. Domains Registered. Data as of 01/16/23. <https://unstoppabledomains.com/about>
- US Department of the Treasury 2022. "U.S. Treasury Sanctions Notorious Virtual Currency Mixer Tornado Cash." US Department of the Treasury. <https://home.treasury.gov/news/press-releases/jy0916>
- Vadas, A. et al. 2021. "Special Report: The Evolution of Biomarker Use in Clinical Trials for Cancer Treatments." The Journal of Precision Medicine. <https://www.thejournalofprecisionmedicine.com/the-journal-of-precision-medicine/special-report-the-evolution-of-biomarker-use-in-clinical-trials-for-cancer-treatments/>
- VanderMeulen, R. et al. 2015. "High Capacity Satellite Communications - Cost-effective Bandwidth Technology." Space Symposium, Technical Track. https://www.spacesymposium.org/wp-content/uploads/2017/10/R.VanderMeulen_31st_Space_Symposium_Tech_Track_paper.pdf
- Venigalla, A. et al. 2022. "Mosaic LLMs (Part 2): GPT-3 quality for <\$500k." Mosaic ML. <https://www.mosaicml.com/blog/gpt-3-quality-for-500k>
- Virginia Lottery. Sports Betting. Data as of 12/30/22. <https://www.valottery.com/aboutus/casinosandsportsbetting/sportsbetting>
- Welch, D. 2022. "GM's Cruise Expands Robotaxi Service to Phoenix and Austin Even With Safety Probe." Bloomberg L.P. <https://www.bloomberg.com/news/articles/2022-12-20/gm-s-cruise-expands-robotaxi-service-amid-federal-safety-probe?sref=1f7Aj053>
- Wessling, B. 2022. "Cruise starts daytime robotaxi rides in San Francisco." WTWH Media LLC. <https://www.therobotreport.com/cruise-starts-daytime-robotaxi-rides-in-san-francisco/>
- Wetterstrand, K. 2021. "The Cost of Sequencing a Human Genome." National Human Genome Research Institute. <https://www.genome.gov/about-genomics/fact-sheets/Sequencing-Human-Genome-cost>
- White, J. et al. 2017. "Ford to cut costs \$14 billion, invest in trucks, electric cars: CEO." Reuters. <https://www.reuters.com/article/us-ford-motor-ceo/ford-to-cut-costs-14-billion-invest-in-trucks-electric-cars-ceo-idUSKCNIC82NL>
- Wikipedia 2023. "Size of Wikipedia." Wikipedia. https://en.wikipedia.org/wiki/Wikipedia:Size_of_Wikipedia
- Wilhelm, A. 2013. "What Are The Revenue Targets Snapchat Must Meet To Be Worth \$3 Billion?." TechCrunch. <https://techcrunch.com/2013/11/13/what-are-the-revenue-targets-snapchat-must-meet-to-be-worth-3-billion/>
- Winton, B. 2021. "Solar Battery Bitcoin." GitHub, Inc.. <https://github.com/ARKInvest/SolarBatteryBitcoin>
- World Health Organization. Global health estimates: Leading causes of DALYs. Data as of 01/17/23. <https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/global-health-estimates-leading-causes-of-dalys>
- Worldpay, LLC 2017. "Global Payment Report." Worldpay, LLC. <https://idoc.pub/documents/global-payment-report-2017-worldpay-6ngevv9p6jlv>
- Worldpay, LLC 2018. "Global Payments Report." Worldpay, LLC. https://offers.worldpayglobal.com/rs/850-JOA-856/images/Global%20Payments%20Report_Digital%202018.pdf
- Wouters, O. et al. 2020. "Estimated Research and Development Investment Needed to Bring a New Medicine to Market, 2009-2018." JAMA Network. <https://jamanetwork.com/journals/jama/fullarticle/2762311>
- Wyoming Gaming Commission. Online Sports Wagering Revenue Reports. Data as of 12/30/22. <https://gaming.wyo.gov/resources/revenue-reports/osw>
- Z Holdings. Investor Relations. Data as of 01/17/23. https://www.z-holdings.co.jp/en/ir/library/indicator/main/0/teaserItems/00/linkList/0/link/en2022q2_kpi.xlsx
- Zhang, P. 2022. "Baidu's robotaxi platform Apollo Go provides 196,000 rides in Q1, up over 11 times from a year ago." CnEVPPost. <https://cnevpost.com/2022/05/26/baidus-robotaxi-platform-apollo-go-provides-196000-rides-in-q1-up-over-11-times-from-a-year-ago/>
- Zhao, Y. et al. 2011. "NELSON lung cancer screening study." National Library of Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3266562/>
- Zviran, A. et al. 2020. "Genome-wide cell-free DNA mutational integration enables ultra-sensitive cancer monitoring." National Library of Medicine. <https://pubmed.ncbi.nlm.nih.gov/32483360/>



Disclosures





For more research on disruptive innovation visit www.ark-funds.com

©2021-2026, ARK Investment Management LLC. No part of this material may be reproduced in any form, or referred to in any other publication, without the express written permission of ARK Investment Management LLC ("ARK").

Please note, companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so and/or may face political or legal attacks from competitors, industry groups, or local and national governments.

ARK aims to educate investors and to size the potential opportunity of Disruptive Innovation, noting that risks and uncertainties may impact our projections and research models. Investors should use the content presented for informational purposes only, and be aware of market risk, disruptive innovation risk, regulatory risk, and risks related to Deep Learning, Digital Wallets, Battery Technology, Autonomous Technologies, Drones, DNA Sequencing, CRISPR, Robotics, 3D Printing, Bitcoin, Blockchain Technology, etc. Cryptocurrency Risk. Cryptocurrencies (also referred to as "virtual currencies" and "digital currencies") are digital assets designed to act as a medium of exchange. Cryptocurrency is an emerging asset class. There are thousands of cryptocurrencies, the most well-known of which is bitcoin. Cryptocurrency generally operates without central authority (such as a bank) and is not backed by any government. Cryptocurrency is not legal tender. Federal, state and/or foreign governments may restrict the use and exchange of cryptocurrency, and regulation in the U.S. is still developing. The market price of bitcoin and other cryptocurrencies have been subject to extreme fluctuations. Similar to fiat currencies (i.e., a currency that is backed by a central bank or a national, supra-national or quasi-national organization), cryptocurrencies are susceptible to theft, loss and destruction. Cryptocurrency exchanges and other trading venues on which cryptocurrencies trade are relatively new and, in most cases, largely unregulated and may therefore be more exposed to fraud and failure than established, regulated exchanges for securities, derivatives and other currencies. Cryptocurrency exchanges may stop operating or permanently shut down due to fraud, technical glitches, hackers or malware, which may also affect the price of cryptocurrencies. Cryptocurrency Tax Risk. Many significant aspects of the U.S. federal income tax treatment of investments in bitcoin and other cryptocurrencies are uncertain and still evolving.

The content of this presentation is for informational purposes only and is subject to change without notice. This presentation does not constitute, either explicitly or implicitly, any provision of services or products by ARK and investors are encouraged to consult counsel and/or other investment professionals as to whether a particular investment management service is suitable for their investment needs. All statements made regarding companies or securities are strictly beliefs and points of view held by ARK and are not endorsements by ARK of any company or security or recommendations by ARK to buy, sell or hold any security. Historical results are not indications of future results. Certain of the statements contained in this presentation may be statements of future expectations and other forward-looking statements that are based on ARK's current views and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in such statements. The matters discussed in this presentation may also involve risks and uncertainties described from time to time in ARK's filings with the U.S. Securities and Exchange Commission. ARK assumes no obligation to update any forward-looking information contained in this presentation. Certain information was obtained from sources that ARK believes to be reliable; however, ARK does not guarantee the accuracy or completeness of any information obtained from any third party. ARK and its clients as well as its related persons may (but do not necessarily) have financial interests in securities or issuers that are discussed.

ARK Investment Management LLC



Disruptive Innovation Risk. Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. Companies that initially develop a novel technology may not be able to capitalize on the technology. Companies that develop disruptive technologies may face political or legal attacks from competitors, industry groups or local and national governments. These companies may also be exposed to risks applicable to sectors other than the disruptive innovation theme for which they are chosen, and the securities issued by these companies may underperform the securities of other companies that are primarily focused on a particular theme.

Cryptocurrency Risk. Cryptocurrencies (also referred to as “virtual currencies” and “digital currencies”) are digital assets designed to act as a medium of exchange. Cryptocurrency is an emerging asset class. There are thousands of cryptocurrencies, the most well-known of which is bitcoin. Cryptocurrency generally operates without central authority (such as a bank) and is not backed by any government. Cryptocurrency is not legal tender. Federal, state and/or foreign governments may restrict the use and exchange of cryptocurrency, and regulation in the U.S. is still developing. The market price of bitcoin and other cryptocurrencies have been subject to extreme fluctuations. Similar to fiat currencies (i.e., a currency that is backed by a central bank or a national, supra-national or quasi-national organization), cryptocurrencies are susceptible to theft, loss and destruction. Cryptocurrency exchanges and other trading venues on which cryptocurrencies trade are relatively new and, in most cases, largely unregulated and may therefore be more exposed to fraud and failure than established, regulated exchanges for securities, derivatives and other currencies. Cryptocurrency exchanges may stop operating or permanently shut down due to fraud, technical glitches, hackers or malware, which may also affect the price of cryptocurrencies. Cryptocurrency Tax Risk. Many significant aspects of the U.S. federal income tax treatment of investments in bitcoin and other cryptocurrencies are uncertain and still evolving.

Financial Technology Risk. Companies that are developing financial technologies that seek to disrupt or displace established financial institutions generally face competition from much larger and more established firms. Fintech Innovation Companies may not be able to capitalize on their disruptive technologies if they face political and/or legal attacks from competitors, industry groups or local and national governments. Blockchain technology is new and many of its uses may be untested. Blockchain and Digital commodities and their associated platforms are largely unregulated, and the regulatory environment is rapidly evolving. As a result, companies engaged in such blockchain activities may be exposed to adverse regulatory action, fraudulent activity or even failure.

Information Technology Sector Risk. The information technology sector includes companies engaged in internet software and services, technology hardware and storage peripherals, electronic equipment instruments and components, and semiconductors and semiconductor equipment. Information technology companies face intense competition, both domestically and internationally, which may have an adverse effect on profit margins. These companies may have limited product lines, markets, financial resources or personnel. The products of information technology companies may face rapid product obsolescence due to technological developments and frequent new product introduction, unpredictable changes in growth rates and competition for the services of qualified personnel. Failure to introduce new products, develop and maintain a loyal customer base, or achieve general market acceptance for their products could have a material adverse effect on a company's business. Companies in the information technology sector are heavily dependent on intellectual property and the loss of patent, copyright and trademark protections may adversely affect the profitability of these companies.

Software Industry Risk. The software industry can be significantly affected by intense competition, aggressive pricing, technological innovations, and product obsolescence. Companies in the software industry are subject to significant competitive pressures, such as aggressive pricing, new market entrants, competition for market share, short product cycles due to an accelerated rate of technological developments and the potential for limited earnings and/or falling profit margins. These companies also face the risks that new services, equipment or technologies will not be accepted by consumers and businesses or will become rapidly obsolete. These factors can affect the profitability of these companies and, as a result, the value of their securities. Also, patent protection is integral to the success of many companies in this industry, and profitability can be affected materially by, among other things, the cost of obtaining (or failing to obtain) patent approvals, the cost of litigating patent infringement and the loss of patent protection for products (which significantly increases pricing pressures and can materially reduce profitability with respect to such products). In addition, many software companies have limited operating histories. Prices of these companies' securities historically have been more volatile than other securities, especially over the short term.

Internet Company Risk. Many Internet-related companies have incurred large losses since their inception and may continue to incur large losses in the hope of capturing market share and generating future revenues. Accordingly, many such companies expect to incur significant operating losses for the foreseeable future and may never be profitable. The markets in which many Internet companies compete face rapidly evolving industry standards, frequent new service and product announcements, introductions and enhancements, and changing customer demands. The failure of an Internet company to adapt to such changes could have a material adverse effect on the company's business.



Semiconductor Company Risk. Competitive pressures may have a significant effect on the financial condition of semiconductor companies and, as product cycles shorten and manufacturing capacity increases, these companies may become increasingly subject to aggressive pricing, which hampers profitability. Reduced demand for end-user products, under-utilization of manufacturing capacity, and other factors could adversely impact the operating results of companies in the semiconductor sector. Semiconductor companies typically face high capital costs and may be heavily dependent on intellectual property rights. The semiconductor sector is highly cyclical, which may cause the operating results of many semiconductor companies to vary significantly. The stock prices of companies in the semiconductor sector have been and likely will continue to be extremely volatile.

Industrials Sector Risk. The industrials sector includes companies engaged in the aerospace and defense industry, electrical engineering, machinery, and professional services. Companies in the industrials sector may be adversely affected by changes in government regulation, world events and economic conditions. In addition, companies in the industrials sector may be adversely affected by environmental damages, product liability claims and exchange rates. **Aerospace and Defense Company Risk.** Companies in the aerospace and defense industry rely to a large extent on U.S. (and other) Government demand for their products and services and may be significantly affected by changes in government regulations and spending, as well as economic conditions and industry consolidation. **Professional Services Company Risk.** Professional services companies may be materially impacted by economic conditions and related fluctuations in client demand for marketing, business, technology and other consulting services. Professional services companies' success depends in large part on attracting and retaining key employees and a failure to do so could adversely affect a company's business. There are relatively few barriers to entry into the professional services market, and new competitors could readily seek to compete in one or more market segments, which could adversely affect a professional services company's operating results through pricing pressure and loss of market share.

Machinery Industry Risk. The machinery industry can be significantly affected by general economic trends, including employment, economic growth, and interest rates; changes in consumer sentiment and spending; overall capital spending levels, which are influenced by an individual company's profitability and broader factors such as interest rates and foreign competition; commodity prices; technical obsolescence; labor relations legislation; government regulation and spending; import controls; and worldwide competition. Companies in this industry also can be adversely affected by liability for environmental damage, depletion of resources, and mandated expenditures for safety and pollution control.

Health Care Sector Risk. The health care sector may be affected by government regulations and government health care programs, restrictions on government reimbursement for medical expenses, increases or decreases in the cost of medical products and services and product liability claims, among other factors. Many health care companies are: (i) heavily dependent on patent protection and intellectual property rights and the expiration of a patent may adversely affect their profitability; (ii) subject to extensive litigation based on product liability and similar claims; and (iii) subject to competitive forces that may make it difficult to raise prices and, in fact, may result in price discounting. Many health care products and services may be subject to regulatory approvals. The process of obtaining such approvals may be long and costly, and delays or failure to receive such approvals may negatively impact the business of such companies. Additional or more stringent laws and regulations enacted in the future could have a material adverse effect on such companies in the health care sector. In addition, issuers in the health care sector include issuers having their principal activities in the biotechnology industry, medical laboratories and research, drug laboratories and research and drug manufacturers, which have the additional risks described below.

Biotechnology Company Risk. A biotechnology company's valuation can often be based largely on the potential or actual performance of a limited number of products and can accordingly be greatly affected if one of its products proves, among other things, unsafe, ineffective or unprofitable. Biotechnology companies are subject to regulation by, and the restrictions of, the U.S. Food and Drug Administration, the U.S. Environmental Protection Agency, state and local governments, and foreign regulatory authorities.

Pharmaceutical Company Risk. Companies in the pharmaceutical industry can be significantly affected by, among other things, government approval of products and services, government regulation and reimbursement rates, product liability claims, patent expirations and protection and intense competition.



Investors should carefully consider the investment objectives and risks as well as charges and expenses of an ARK ETF before investing. This and other information are contained in the ARK ETFs' prospectuses, which may be obtained by visiting www.ark-funds.com. The prospectus should be read carefully before investing.

An investment in an ARK ETF is subject to risks and you can lose money on your investment in an ARK ETF. There can be no assurance that the ARK ETFs will achieve their investment objectives. The ARK ETFs' portfolios are more volatile than broad market averages. The ARK ETFs also have specific risks, which are described below. More detailed information regarding these risks can be found in the ARK ETFs' prospectuses. The principal risks of investing in the ARK ETFs include: Equity Securities Risk. The value of the equity securities the ARK ETF holds may fall due to general market and economic conditions. Concentration Risk: The Fund's assets may be concentrated in a particular industry or group of industries to the extent the Index concentrates in a particular industry or group of industries. Foreign Securities Risk. Investments in the securities of foreign issuers involve risks beyond those associated with investments in U.S. securities. Health Care Sector Risk. The health care sector may be affected by government regulations and government health care programs. Industrials Sector Risk. Companies in the industrials sector may be adversely affected by changes in government regulation, world events, economic conditions, environmental damages, product liability claims and exchange rates. Information Technology Sector Risk. Information technology companies face intense competition, both domestically and internationally, which may have an adverse effect on profit margins. Detailed information regarding the specific risks of the ARK ETFs can be found in the ARK ETFs' prospectuses.

Additional risks of investing in ARK ETFs include market, management, concentration and non-diversification risks, as well as fluctuations in market value and net asset value ("NAV"). Shares of ETFs are bought and sold at market price (not NAV) and are not individually redeemed from the ETF. ETF shares may only be redeemed directly with the ETF at NAV by Authorized Participants, in very large creation units. There can be no guarantee that an active trading market for ETF shares will develop or be maintained, or that their listing will continue or remain unchanged. Buying or selling ETF shares on an exchange may require the payment of brokerage commissions and frequent trading may incur brokerage costs that detract significantly from investment returns.

The information herein is general in nature and should not be considered financial, legal or tax advice. An investor should consult a financial professional, an attorney or tax professional regarding the investor's specific situation.

ARK Investment Management LLC is the investment adviser to the ARK ETFs.

Foreside Fund Services, LLC, distributor.