JANUARY 31, 2024

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BIG IDEAS 2024

BIG IDEAS 2024

ARK INVEST

Annual Research Report

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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.

RISK OF INVESTING IN INNOVATION

RAPID PACE OF CHANGE →

EXPOSURE ACROSS SECTORS AND MARKET CAP →

UNCERTAINTY AND UNKNOWNS →

DISRUPTIVE INNOVATION

← **REGULATORY HURDLES**

← **POLITICAL OR LEGAL PRESSURE**

← **COMPETITIVE LANDSCAPE**

→ **Aim for a cross-sector understanding of technology and combine top-down and bottom-up research.**

→ **Aim to understand the regulatory, market, sector, and company risks. (See Disclosure Page)**

Sources: ARK Investment Management LLC, 2023.

Big Ideas 2024

Disrupting The Norm, Defining The Future

ARK Invest proudly presents "Big Ideas 2024: Disrupting the Norm, Defining the Future." A tradition since 2017, Big Ideas offers a comprehensive analysis of technological convergence and its potential to revolutionize industries and economies.

ARK seeks to deliver long-term capital appreciation by investing in the leaders, enablers, and beneficiaries of disruptive innovation. With a belief that innovation is key not only to growth but also to resilience, ARK emphasizes the necessity of a strategic allocation to innovation in every investor's portfolio. This approach aims to tap into the exponential growth opportunities often overlooked in broad-based indices, while simultaneously providing a hedge against the risks posed by incumbents facing disruption.

We hope you enjoy Big Ideas 2024.

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Research By:

Brett Winton
Chief Futurist
ARK Venture Investment
Committee Member

Technological Convergence

According to ARK's research, convergence among disruptive technologies will define this decade. Five major technology platforms—Artificial Intelligence, Public Blockchains, Multiomic Sequencing, Energy Storage, and Robotics—are coalescing and should transform global economic activity.

Technological convergence could create tectonic macroeconomic shifts more impactful than the first and second industrial revolutions. Globally, real economic growth could accelerate from 3% on average during the past 125 years to more than 7% during the next 7 years as robots reinvigorate manufacturing, robotaxis transform transportation, and artificial intelligence amplifies knowledge worker productivity.

Five Innovation Platforms Are Converging And Defining This Technological Era

Public Blockchains

Upon large-scale adoption, all money and contracts likely will migrate onto Public Blockchains that enable and verify digital scarcity and proof of ownership. 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** would 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.

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.

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 potentially 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.

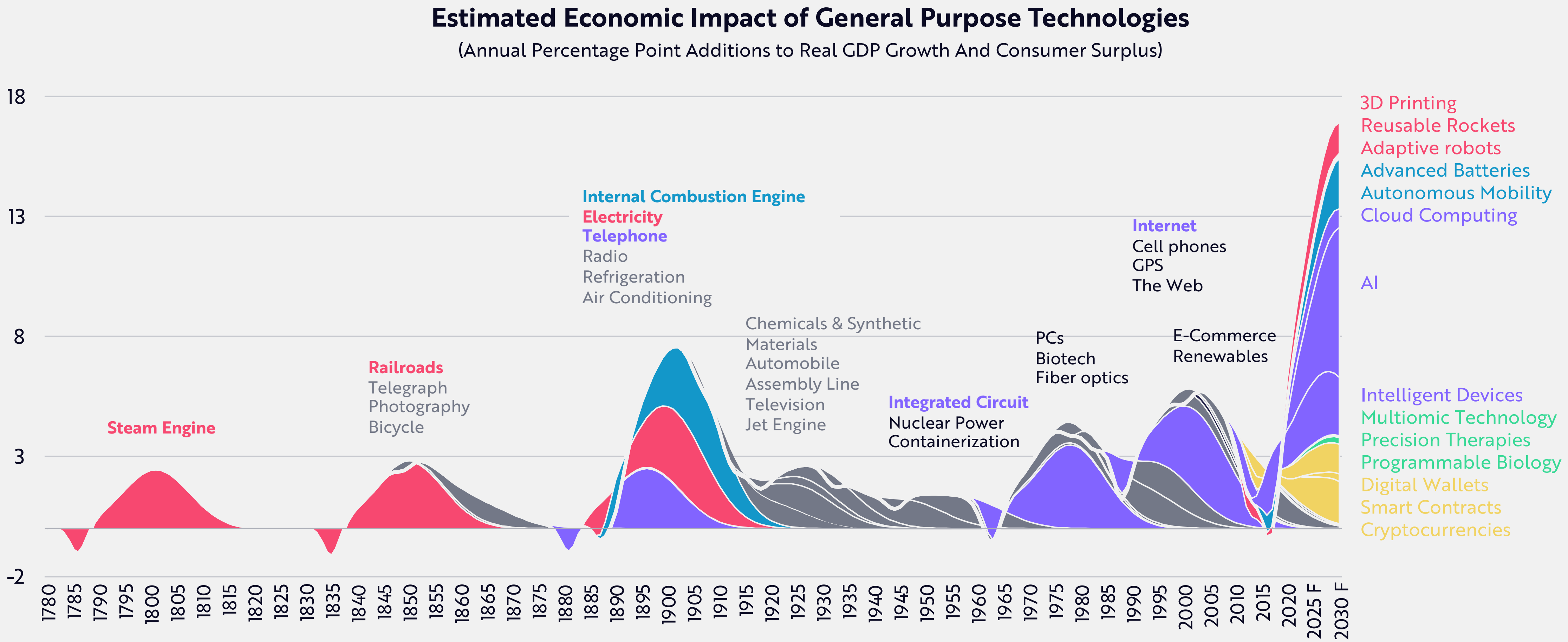
Energy Storage

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 could 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

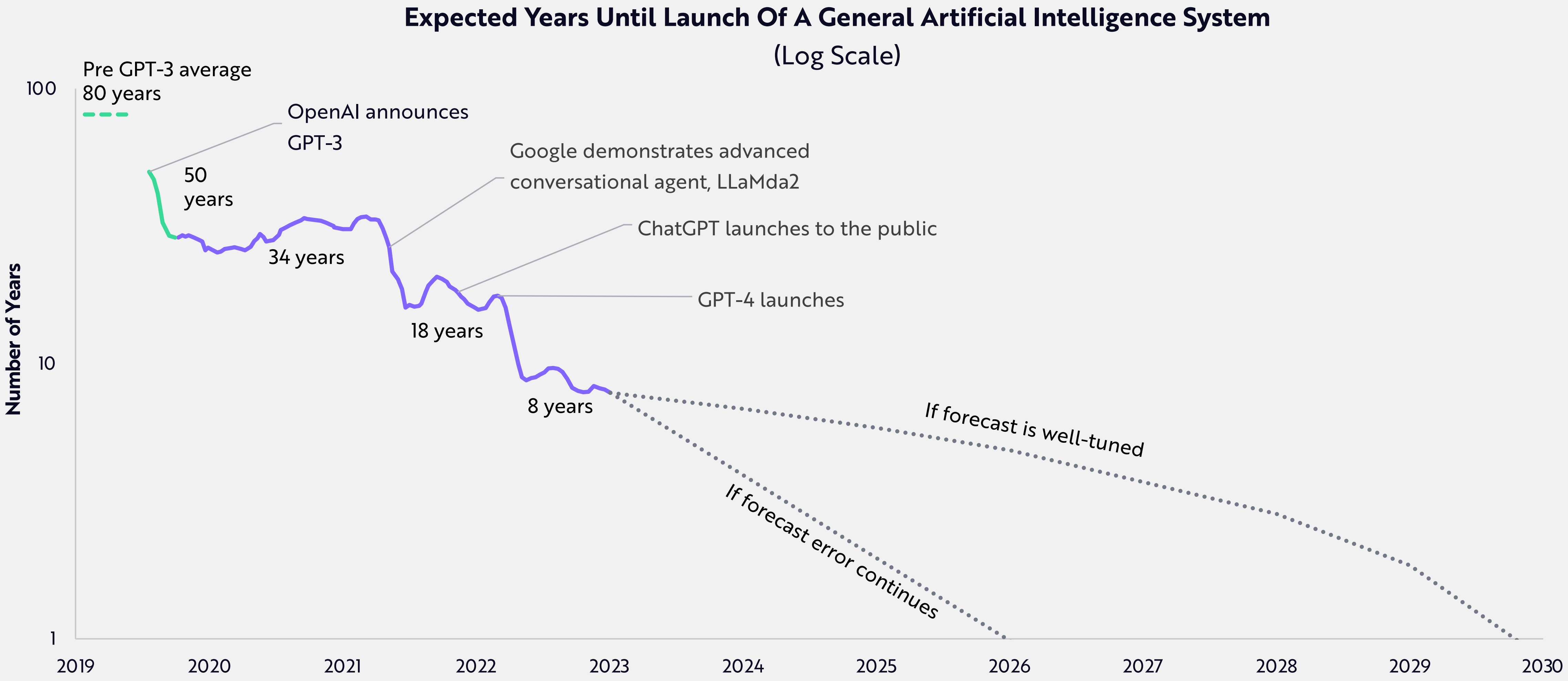
Catalyzed by artificial intelligence, **Adaptive Robots** can operate alongside humans and navigate legacy infrastructure, changing the way products are made and sold. **3D Printing** should contribute to the digitization of manufacturing, increasing not only the performance and precision of end-use 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 uninterruptible 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.

Converging Technologies Are Generating A Historic Technological Wave



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying sources, including Bekar et al. 2017, which may be provided upon request. The chart uses GPT 4 prompting to survey a comprehensive list of general purpose technologies using the identification framework detailed therein. Where available, academic literature is also used to assess attributable economic impact. A GPT-4 scoring rubric assesses technology-by-technology impacts. The impact measured directly is matched against the scoring to tune all scores to produce technology-by-technology estimates of economic impact (even when direct measures of economic impact are unattainable). Consistent with General Purpose Technology theory, these technologies are assumed to go through a period of investment in which economic impact is negative before productivity advances begin to realize into economic data. All technologies are assumed to have the same diffusion and realization cycle. If recent technologies are assumed to diffuse more quickly, the current wave would appear steeper. 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 Accelerating Faster Than Forecasters Anticipated



Sources: ARK Investment Management LLC, 2024, based on data from Metaculus, including benchmark details, as of January 3, 2024. Benchmark broadly requires the successful passage of an adversarial two-hour Tuning test, broad success on a Q&A knowledge and logic benchmark, and the successful interpretation of and execution complex model car assembly instruction, all within a single system. Green lines are derived estimates for time to general purpose AI (strongly formulated) based upon forecasts for a weaker benchmark. 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.

Research By:
Frank Downing
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Artificial Intelligence

Scaling Global Intelligence And Redefining Work

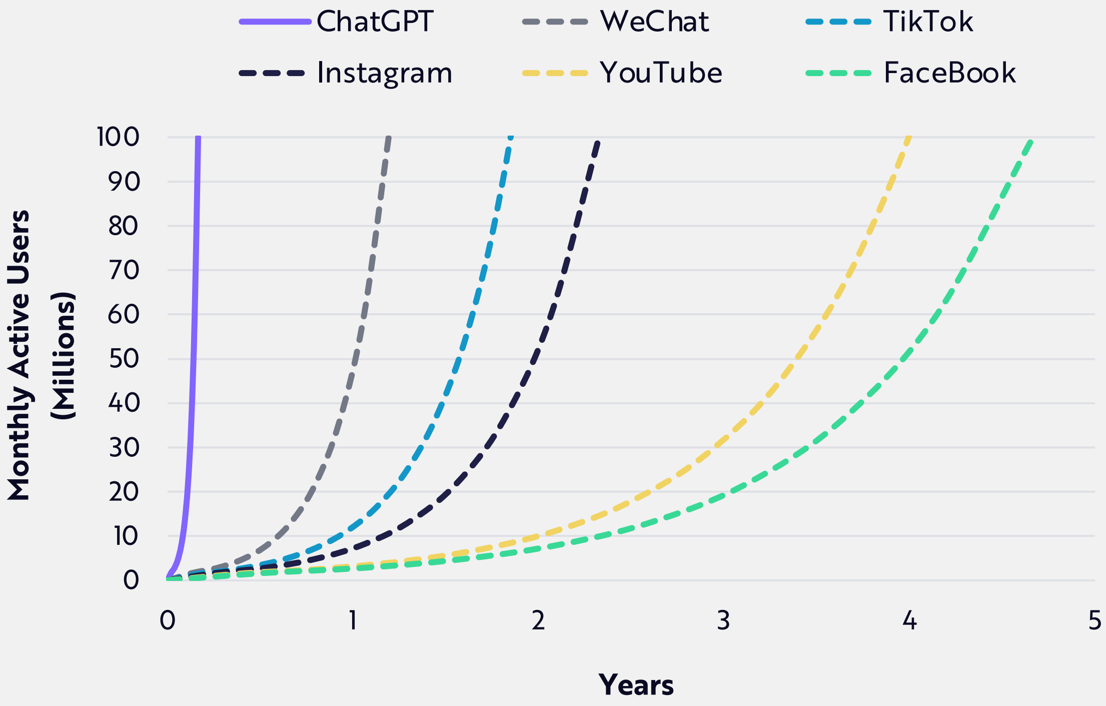
With superhuman performance on a wide range of tests, AI models like GPT-4 should catalyze an unprecedented boom in productivity. Jolted by ChatGPT's "iPhone" like moment, enterprises are scrambling to harness the potential of artificial intelligence (AI).

AI promises more than efficiency gains, thanks to rapidly falling costs and open-source models. If knowledge worker productivity were to quadruple by 2030, as we believe is likely, growth in real GDP could accelerate and break records during the next five to ten years.

ChatGPT Delighted Consumers And Amazed Enterprises

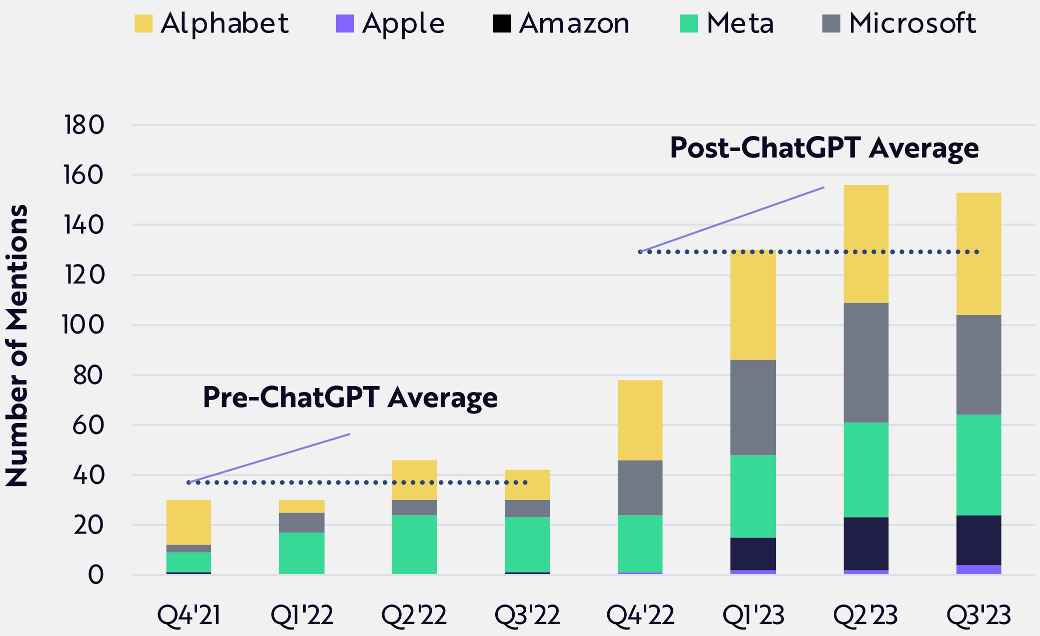
Building on years of progress since Google invented transformer architecture in 2017, ChatGPT catalyzed the public's understanding of generative AI. No longer a tool just for developers, ChatGPT's simple chat interface enabled anyone speaking any language to harness the power of large language models (LLMs). In 2023, enterprises scrambled to understand and deploy generative AI.

ChatGPT Users Hit 100 Million Users In Two Months



*values between 0 and 100 million users are estimates

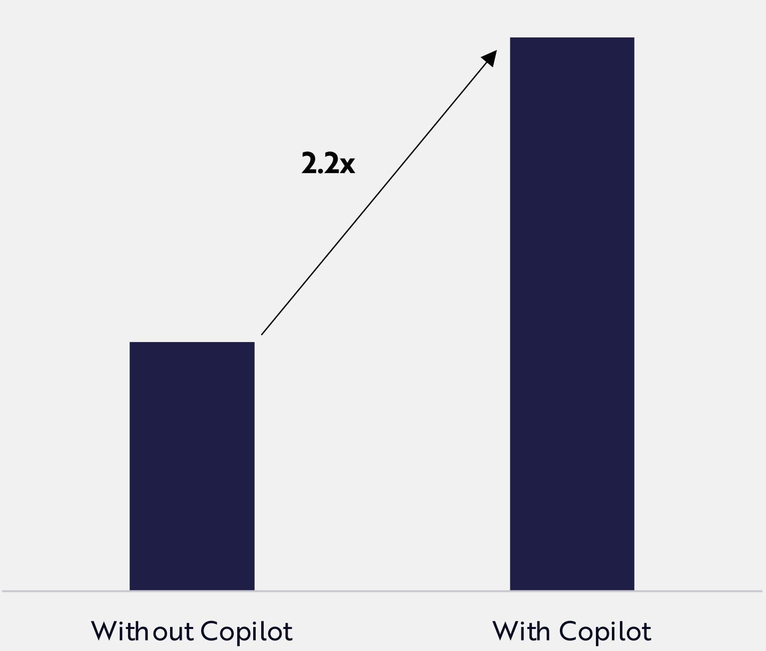
The Number of AI Mentions Tripled On Earnings Calls



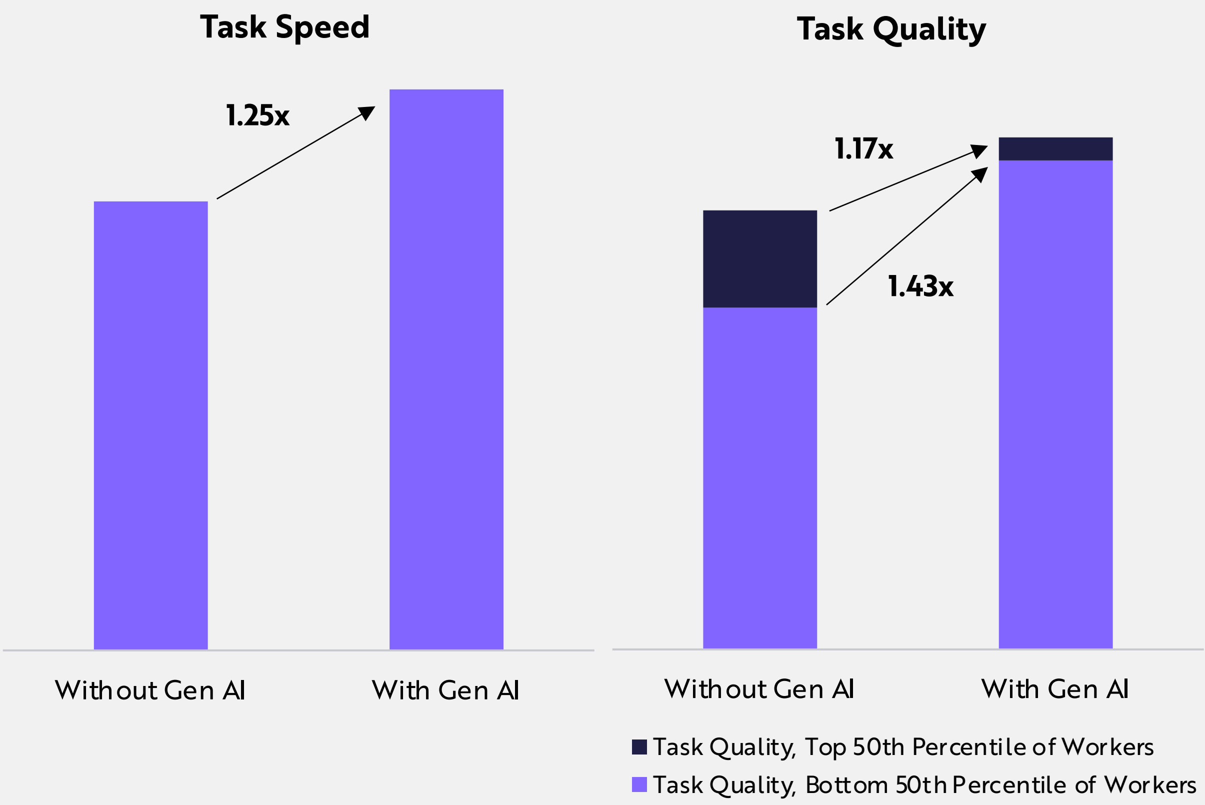
AI Already Has Boosted Productivity Significantly

Coding assistants like GitHub Copilot and Replit AI are early success stories that have boosted the productivity and job satisfaction of software developers. AI-powered assistants are increasing the performance of knowledge workers and, interestingly, benefiting underperforming workers relatively more than high performers.

Productivity of Developers On Coding Tasks Using Github Copilot in 2023



Productivity of Consultants Using Gen AI In 2023

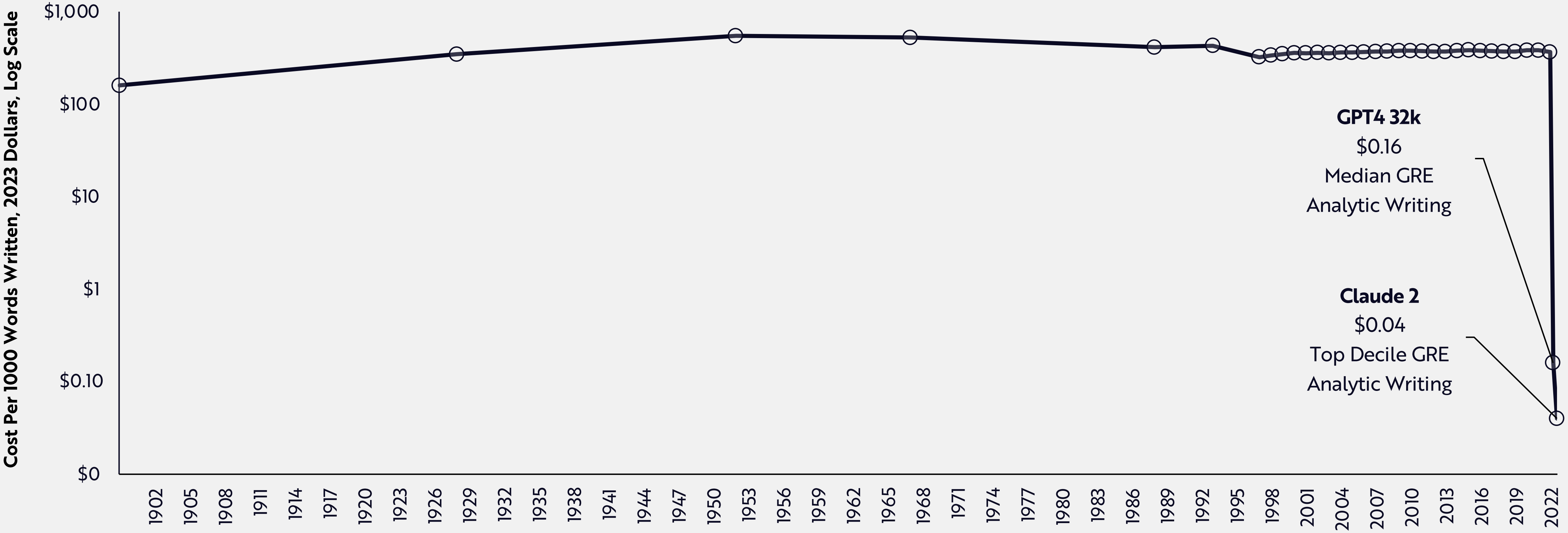


Sources: ARK Investment Management LLC, 2024. The data used to analyze productivity were collected from several different studies with varying numbers of participants and definitions of task quality. The sources used are Dell'Acqua et al. 2023 and GitHub 2022. Forecasts are inherently limited and cannot 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.

The Cost Of Authoring The Written Word Has Collapsed

Over the past century, the cost of authoring written content has been relatively constant in real terms. During the past two years, as the writing quality of LLMs has improved, the cost has collapsed.

The Cost of Authoring Written Content



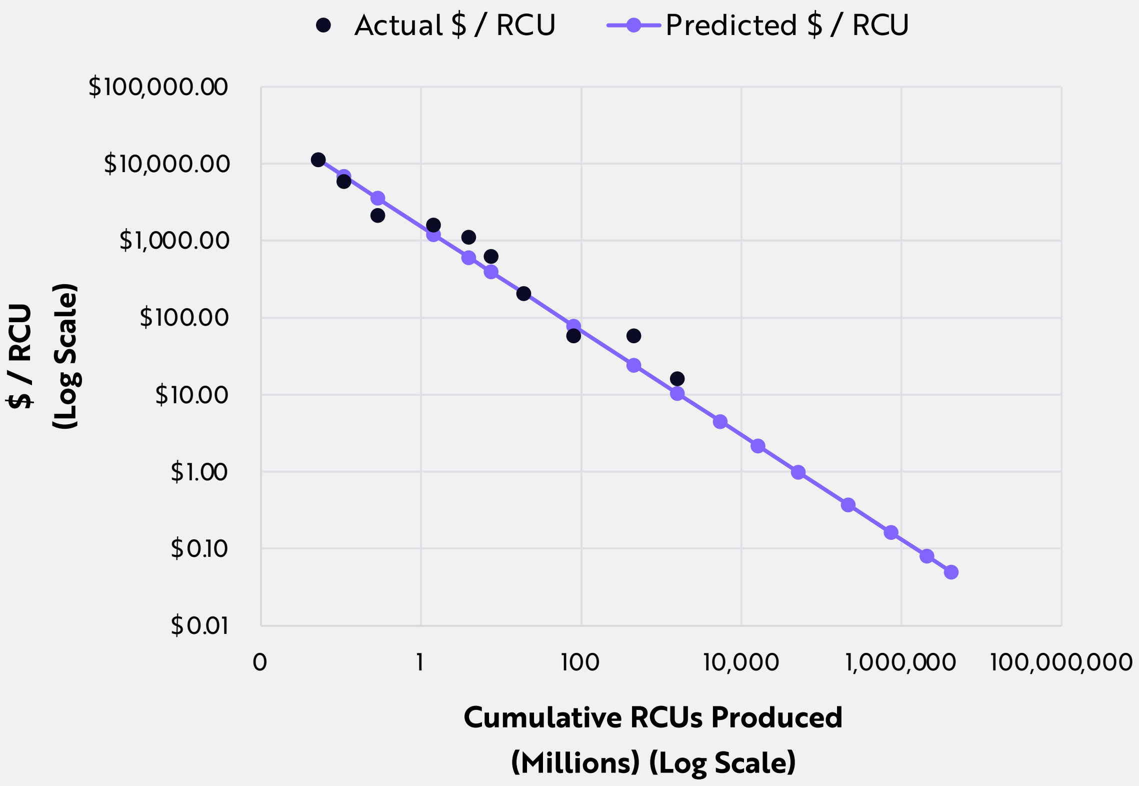
Post 1997 assumes constant words per employed writer over time

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan 9, 2024, which are available upon request. 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.

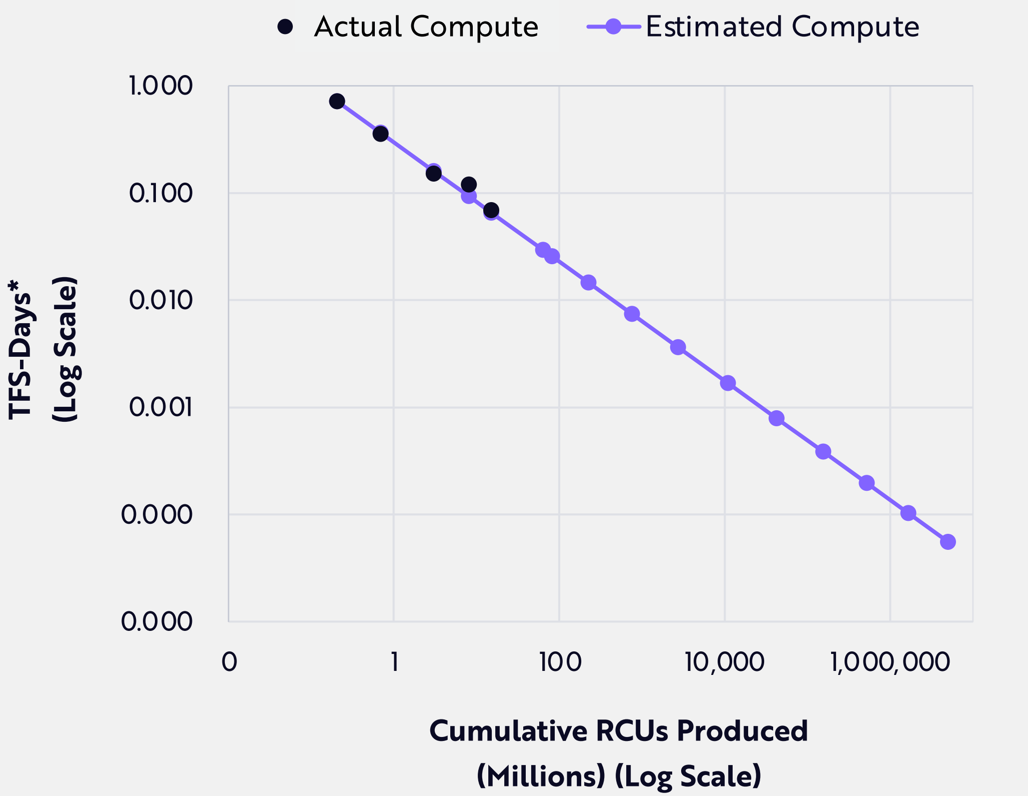
Training Costs Should Continue To Fall 75% Per Year

According to Wright's Law, improvements in accelerated compute hardware should reduce AI-relative compute unit (RCU) production costs by **53%** per year, while algorithmic model enhancements could lower training costs further by **47%** per year. In other words, the convergence of hardware and software could drive AI training costs down by 75% at an annual rate through 2030.

AI Training Hardware Cost



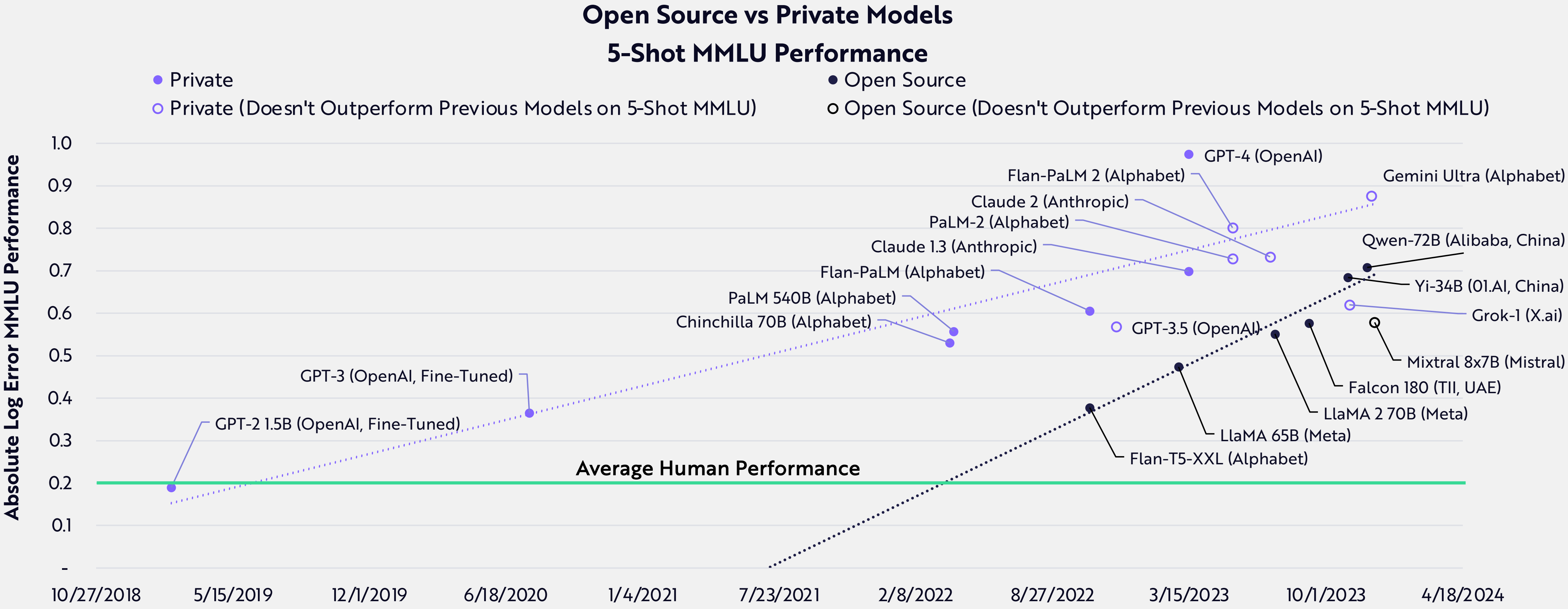
AI Software Training Cost Using Neural Networks



*TFS-Days is a measure of compute required to train a model. Wright's Law states that for every cumulative doubling of units produced, cost will fall by a constant percentage. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan. 9, 2024, which are available upon request. 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 Open-Source Community Is Competing With Private Models

Challenging closed-source models from OpenAI and Google, the open-source community and its corporate champion, Meta, are democratizing access to generative AI. On balance, the performance of open-source models is improving faster than that of closed-source models, helped recently by models from China.



Note: The chart's trendlines are fit to the most performant open- or closed-source models on 5-Shot MMLU (Massive Multitask Language Understanding) at the time of their release. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan. 9, 2024, which are available upon request. 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.

Research By:
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Research Associate

Bitcoin Allocation

Growing The Role Of Bitcoin In Investment Portfolios

Important Information

Bitcoin is a relatively new asset class, and the market for bitcoin is subject to rapid changes and uncertainty. Bitcoin is largely unregulated and bitcoin investments may be more susceptible to fraud and manipulation than more regulated investments. Bitcoin is subject to unique and substantial risks, including significant price volatility and lack of liquidity, and theft.

Bitcoin is subject to rapid price swings, including as a result of actions and statements by influencers and the media, changes in the supply of and demand for bitcoin, and other factors. There is no assurance that bitcoin will maintain its value over the long term.

The information provided on the following slides is based on ARK's research and is not intended to be investment advice. ARK researches the utility of bitcoin as an investment in order to determine its potential future value as presented on the following slides. This material does not constitute, either explicitly or implicitly, any provision of services or products by ARK, and investors should determine for themselves whether a particular investment management service is suitable for their investment needs. ARK strongly encourages any investor considering an investment in bitcoin or any other digital asset to consult with a financial professional before investing. All statements made regarding bitcoin are strictly beliefs and points of view held by ARK and are not recommendations by ARK to buy, sell or hold bitcoin. Historical results are not indications of future results.

Important Terms and Concepts

The research presented on the following slides contains some terms and concepts that may not be familiar to some readers, so below we provide explanations to help provide a basis for evaluating the research.

- **Sharpe Ratio** is a well-known and well-reputed measure of **risk-adjusted return** on an investment or portfolio, which indicates how well an investment performs in comparison to the rate of return on a risk-free investment such as U.S. government treasury bonds or bills. Sharpe ratio is calculated by first calculating the expected return on an investment portfolio or individual investment and then subtracting the risk-free rate of return. Normally, a higher Sharpe Ratio indicates good investment performance, given the risk, while a Sharpe Ratio less than 1 is considered less than good. Sharpe ratio is used in our research to determine, hypothetically, at what allocation percentage bitcoin would maximize the risk-adjusted return of an overall portfolio consisting of other commonly used asset classes.
- **Efficient Frontier** is the set of optimal portfolios that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. In other words, it graphically represents portfolios that maximize returns for the risk assumed. Portfolios that lie below the efficient frontier are considered sub-optimal because they do not provide enough return for the level of risk, and portfolios that cluster to the right of the efficient frontier are also considered sub-optimal because they have a higher level of risk for the defined rate of return. The Efficient Frontier chart is used in this section to illustrate that the simulated portfolio we constructed with an allocation to bitcoin lies along the efficient frontier as compared to the portfolios consisting of single asset classes which would be considered sub-optimal.
- **Compound Annual Growth Rate ("CAGR")** is the average annual amount an investment grows over a period of years assuming profits are reinvested during the period. In other words, it breaks an investment's total return over a number of years into a single average rate. CAGR is typically used to compare assets or portfolios over a longer time period by using an average as opposed to analyzing each year individually as returns from year to year may be uneven. We use CAGR in our research to determine the expected return of a portfolio or asset class over a period of years, typically 5 years.
- **Standard Deviation** is a measure of risk, or volatility, in a portfolio by indicating how much the investment will deviate from its expected return. An investment with higher volatility means a higher standard deviation, and therefore more risk. We use standard deviation to determine the amount of return that would be commensurate with certain levels of risk.

Digital Assets Like Bitcoin Are A New Asset Class

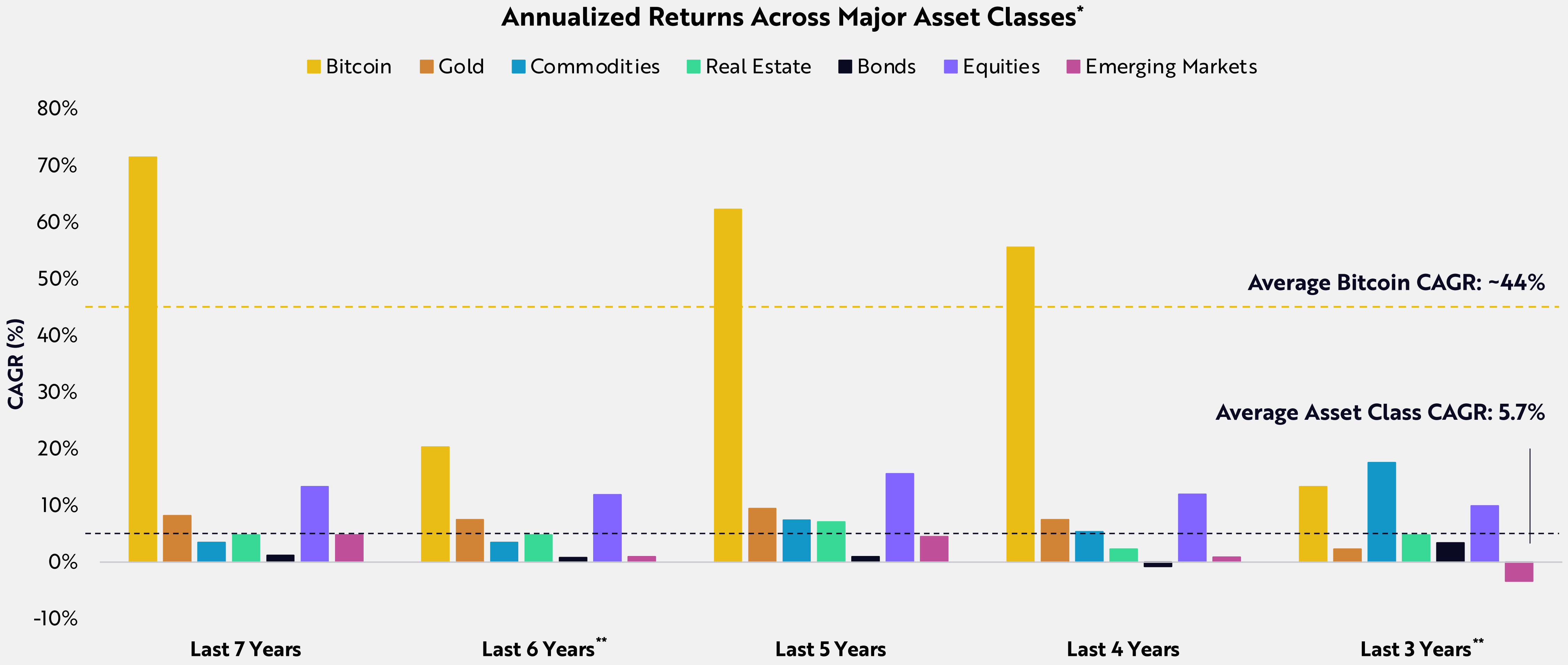
According to ARK's research, bitcoin has emerged as an independent asset class worthy of a strategic allocation in institutional portfolios.

	Bitcoin	Commodities (Including Gold)	Real Estate	Bonds	Equities (Including Emerging Markets)
History	Created during the Global Financial Crisis in 2009 by an individual or group under the pseudonym Satoshi Nakamoto	Origins trace back thousands of years to commodities like gold being used as a store of value	Earliest known private property rights took shape in ancient Greece and Rome	Earliest known bond was issued by the city of Venice in the 12^{th} century, but the concept of debt/lending can be traced back to ancient Mesopotamia	Origins trace back to the 1600s with the establishment of the Amsterdam Stock Exchange
Investability	Highly liquid and accessible to anyone with access to the internet. Traded on crypto exchanges and through spot ETFs	Fairly liquid and accessible through physical coins and ETFs through banks and brokers.	Illiquid, purchased directly or through REITs	Highly liquid. Traded on bond markets, accessible through brokers	Highly liquid. Traded on stock exchanges, accessible through brokers
Basis Of Value	Tied to demand for a decentralized, independent monetary system powered by open-source software	Tied to supply and demand, influenced by global economic conditions	Tied to interest rates, property markets, and local economic factors	Tied to interest rate policies and credit risk	Tied to expectations of future cash flow
Correlation Of Returns	Low correlation with traditional asset classes	Typically inversely correlated with asset classes, especially during economic uncertainty	Typically low to moderate correlation with stocks and bonds	Inversely correlated recently, but not always throughout economic history, with equities	Correlated with the health of global economy and market sentiment
Governance	Decentralized and community-driven, leveraging open-source software for decision making	Governed by mining regulation	Governed by local and national property laws	Governed by issuance terms set by government or corporations	Governed by company management and regulated by government agencies
Use Cases	Scarce digital store of value, its currency native to the internet	Industrial activity, wealth preservation, and hedging	Personal residence, rental income	Fixed income investment, with regular interest payments and return of principal at maturity	Company ownership, often with voting rights and dividends

Sources: ARK Investment Management LLC, 2024 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 Has Outperformed Every Major Asset Over Longer Time Horizons

During the last seven years, bitcoin's annualized return has averaged ~44%, while that of other major assets has averaged 5.7%.



*Asset classes are represented by the following instruments: S&P 500 Index, Bloomberg U.S. Aggregate Bond Index, FTSE NAREIT Equity REITs Index, Gold Price, S&P GSCI Commodity Index, and MSCI Emerging Markets Index. **"Last 6 Years" includes 2018, 2021, and 2022; "Last 3 Years" includes 2021 and 2022, all years of market downturn or relatively low returns for bitcoin. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. 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.

Generally, Bitcoin Investors With A Long-Term Time Horizon Have Benefited Over Time

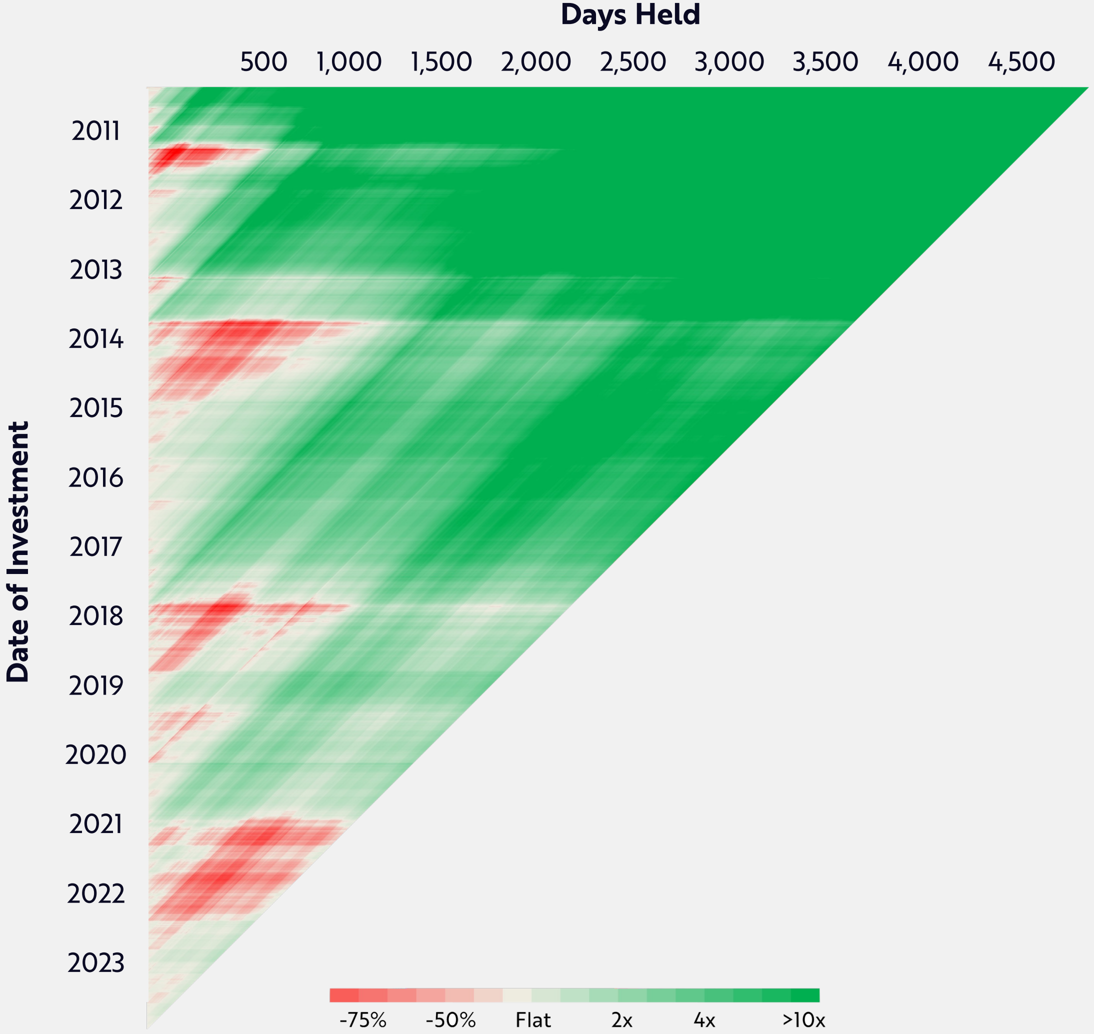
"Time, Not Timing"*

Bitcoin's volatility can obfuscate its long-term returns. While significant appreciation or depreciation can occur over the short term, a long-term investment horizon has been key to investing in bitcoin.

Instead of "when," the better question is "for how long?"

Historically, investors who bought and held bitcoin for at least 5 years have profited, no matter when they made their purchases.

Bitcoin Realized Returns



*Adage first put forth in this configuration by Mizuho Financial Group. Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. 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 Correlation To Traditional Assets Is Low

Historically, bitcoin's price movements have not correlated highly to those of other asset classes. During the past five years, the correlation of bitcoin's returns relative to traditional asset classes has averaged only 0.27.

Asset Class Correlation Matrix[1,2]

(12-Month As Of December 2023)

- High correlation: coefficient value lies between ± 0.66 and ±1
- Moderate correlation: coefficient value lies between ± 0..4 and ± 0.66
- Low correlation: coefficient value lies below ± 0.4

	Bitcoin	Gold	Commodities	Real Estate	Bonds	Equities	Emerging Markets
Bitcoin		0.2	0.1	0.4	0.26	0.41	0.23
Gold	0.2		-0.03	0.28	0.46	0.26	0.34
Commodities	0.1	-0.03		0.42	-0.12	0.43	0.5
Real Estate	0.4	0.28	0.42		0.57	0.86	0.68
Bonds	0.26	0.46	-0.12	0.57		0.48	0.46
Equities	0.41	0.26	0.43	0.86	0.48		0.73
Emerging Markets	0.23	0.34	0.5	0.68	0.46	0.73	
AVERAGE	**0.27**	**0.25**	**0.21**	**0.53**	**0.35**	**0.53**	**0.49**

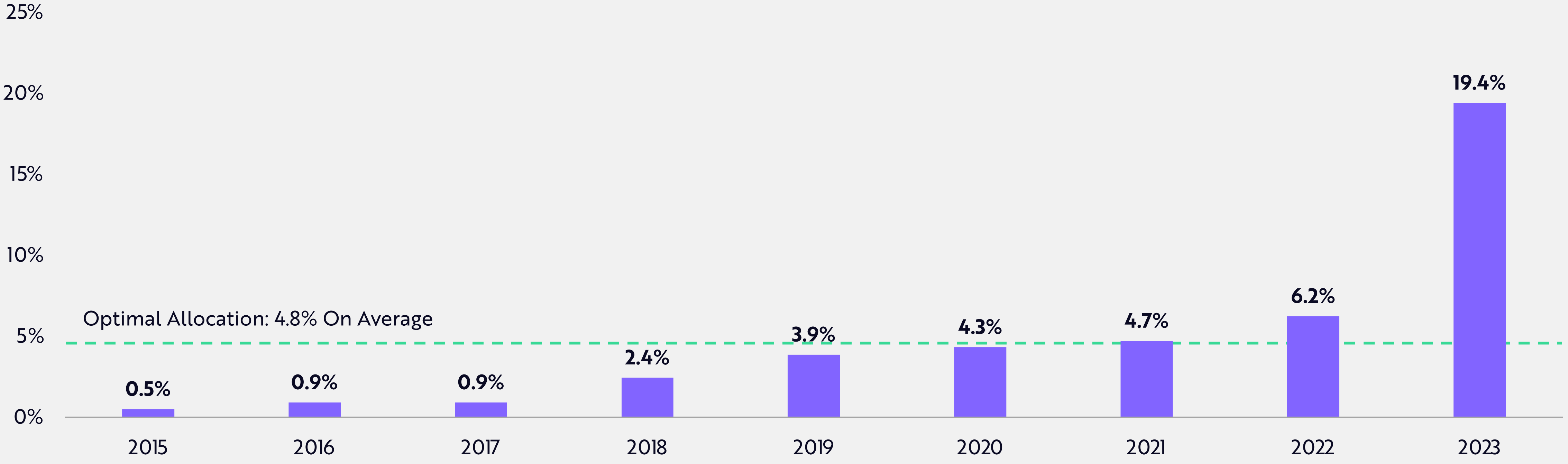
[1] A correlation of 1 connotes that assets perfectly move in tandem; 0 means their movement is completely independent from each other; -1 suggests that they move in perfectly opposite directions. [2] Asset classes are represented by the following instruments: S&P 500 Index, Bloomberg U.S. Aggregate Bond Index, FTSE NAREIT Equity REITs Index, Gold Price, S&P GSCI Commodity Index, and MSCI Emerging Markets Index. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. 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.

On A 5-Year Rolling Basis, An Allocation To Bitcoin Would Have Maximized Risk-Adjusted Returns During The Past 9 Years

According to our analysis, in 2015, the optimal allocation to maximize risk-adjusted returns[1]—on a 5-year time horizon[3]—would have been 0.5%. Since then, on the same basis, the average allocation to bitcoin would have been 4.8%, and in 2023 alone, 19.4%.

Allocation Into Bitcoin By Year To Maximize Risk-adjusted Returns[2]

(Maximization By Sharpe Ratio, Rolling 5-Year Time Horizon[3,4])



[1] Risk-adjusted returns given by the Sharpe ratio, which divides expected returns minus the risk-free rate by the standard deviation of the asset. [2] For asset class representation in this calculation, please refer to the previous slide. [3] 5 years were used since, in our view, they represent a sample of a long-term time horizon.. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. 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 Could Play An Important Role In Maximizing Risk-Adjusted Returns

Focused on the volatility and return profiles of traditional asset classes, ARK's research suggests that a portfolio seeking to maximize risk-adjusted returns[1] would have allocated 19.4% to bitcoin in 2023.

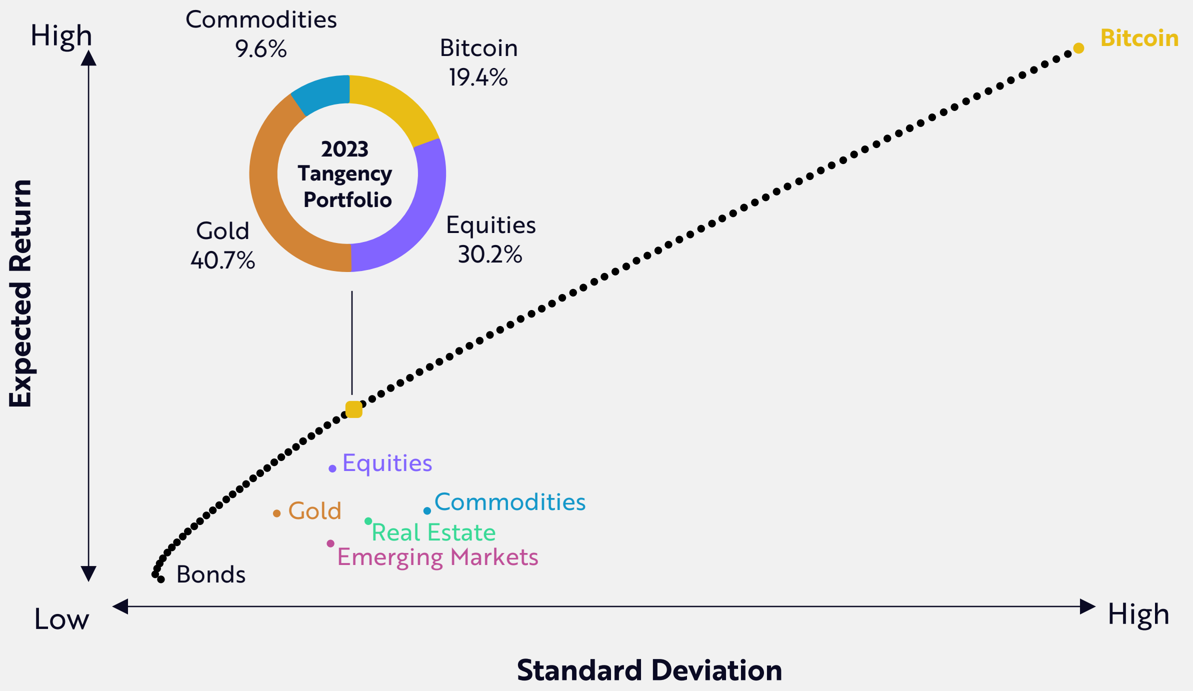
Simulated Optimal Portfolio Allocation Targets By Year[2,3]

(Rolling 5-Year As Of End Of Every Year[6])

	Bitcoin	Gold	Commodities	Bonds	Equities
2015	0.5%	0%	0%	82.5%	16.9%
2016	0.9%	0%	0%	62.1%	36.9%
2017	0.9%	0%	0%	58.7%	40.3%
2018	2.4%	0%	0%	77.3%	20.2%
2019	3.9%	1.4%	0%	70.4%	24.2%
2020	4.3%	4.1%	0%	75.6%	15.8%
2021	4.7%	7.3%	0%	65.3%	22.6%
2022	6.2%	52.8%	9.1%	0%	31.8%
2023	**19.4%**	**40.7%**	**9.6%**	**0%**	**30.3%**

2023 Simulated Portfolio Optimization[3,4,5]

Based On Monthly Asset Class Returns (No Limit, Rolling 5-Year[6])



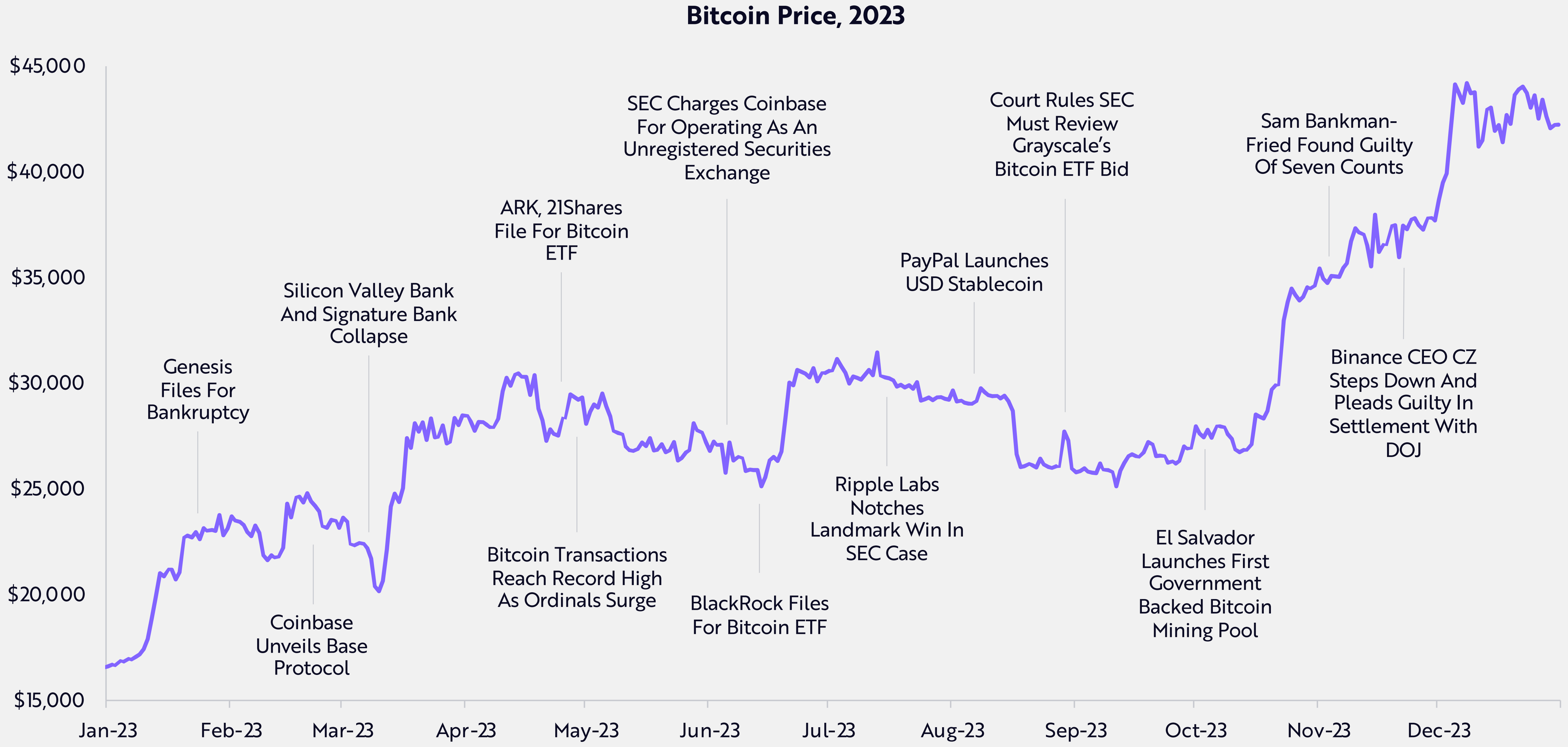
[1] Measurement of returns of an asset against its risk (in this case, volatility). [2] Real Estate and Emerging Markets are calculated out of these tangency portfolios given their low participation in maximizing risk-adjusted returns relative to the other asset classes included in this table. [3] Asset classes are represented by the following instruments: S&P 500 Index, Bloomberg U.S. Aggregate Bond Index, FTSE NAREIT Equity REITs Index, Gold Price, S&P GSCI Commodity Index, and MSCI Emerging Markets Index. [4] This simulation, also known as "efficient frontier", is a set of theoretical investment portfolios expected to provide the highest returns at multiple levels of risk. [5] The dots under the efficient frontier in the chart represent portfolios comprised of a single asset class. [6] 5 years were used since, in our view, they represent a sample of a long-term time horizon. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. 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.

Research By:
Yassine Elmandjra
Director of Digital Assets
David Puell
Research Associate

Bitcoin In 2023

Demonstrating Resilience And Recovery After Challenges In 2022

In 2023, Bitcoin's Price Surged 155%, Increasing Its Market Cap To $827 Billion



Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. 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.

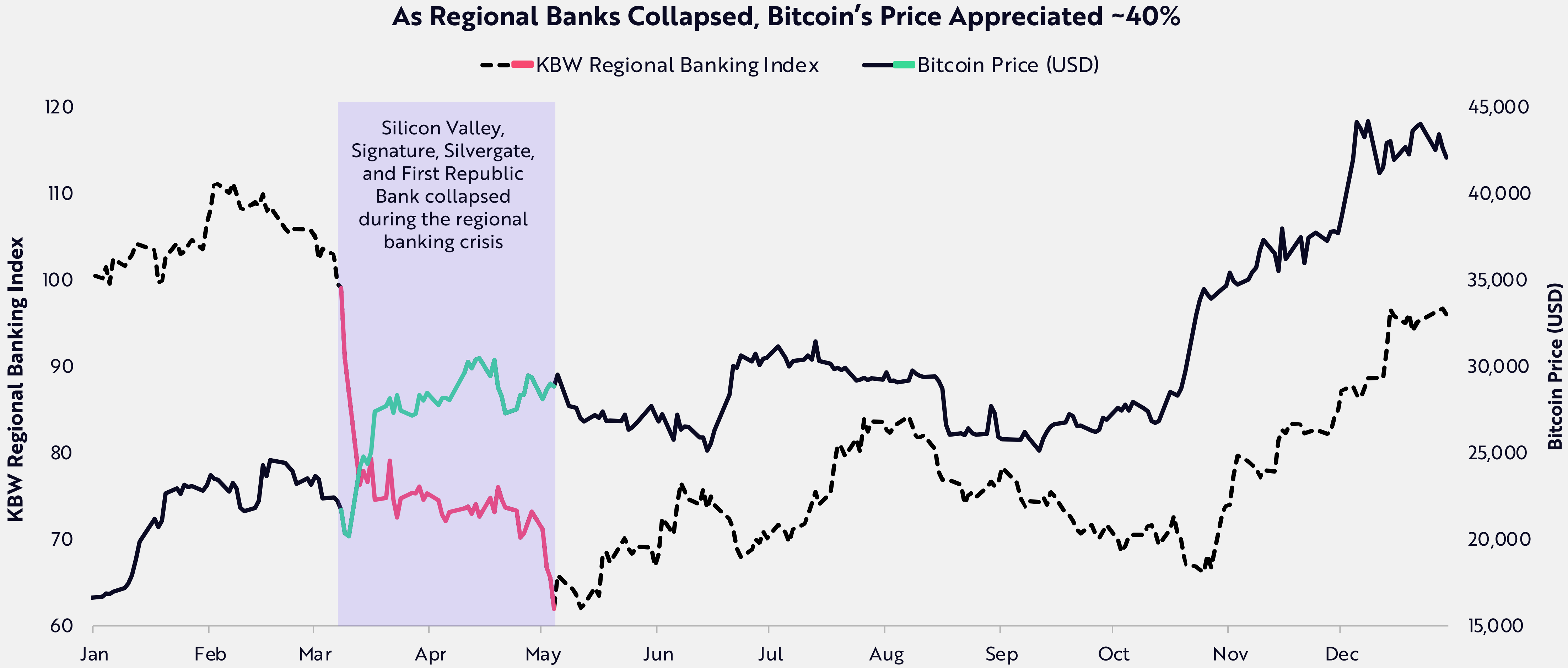
2023 Provided Important Answers To The Crises In 2022

Entity	2022 Crisis	2023 Resolution
Luna, UST	Algorithmic stablecoin UST collapsed, causing a significant sell-off in its sister cryptocurrency, LUNA, erasing over 60 billion USD in market value.*	Founder Do Kwon was arrested and faces eight indictments in Manhattan's U.S. District Court, while his startup, Terraform Labs, faces SEC civil charges for orchestrating a multi-billion-dollar securities fraud.
Three Arrows Capital	LUNA's collapse led high profile hedge fund Three Arrows Capital (3AC) into a liquidity crisis, forcing it into bankruptcy.	The Monetary Authority of Singapore banned 3AC's co-founders from capital markets activity for nine years, and a court in the British Virgin Islands froze their assets.
Celsius Network	Crypto lending platform Celsius froze withdrawals and then filed for bankruptcy.	A bankruptcy court approved a restructuring plan for Celsius that will return assets to customers and establish a new company focused on mining and staking. CEO Alex Mashinsky faces criminal charges for allegedly misleading customers.
FTX	After Coindesk exposed the fraudulent financial entanglement between trading firm Alameda and FTX, FTX suffered a bank run and collapsed.	The Southern District of New York convicted Sam Bankman-Fried on seven counts of fraud related to the collapse of FTX. A bankruptcy court granted the FTX estate approval to sell its assets.
BlockFi	BlockFi's exposure to FTX forced it into bankruptcy.	BlockFi received court approval to liquidate, with partial in-kind repayment to creditors.
Genesis	With significant loans to 3AC, crypto lender Genesis declared bankruptcy.	Crypto lender Genesis reached a settlement with parent company DCG, involving $620 million in repayments. The SEC is suing Genesis for selling unregistered securities.

*This data point is sourced from Corva 2022. Sources: ARK Investment Management LLC, 2024. Information as of December 31, 2023. 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 Appreciated During The Regional Banking Collapse

In early 2023, during the historic collapse of US regional banks, bitcoin's price appreciated more than 40%, highlighting its role as a hedge against counterparty risk.



Is Bitcoin Evolving Into A Risk-Off Asset?

With increasing macroeconomic uncertainty and less trust in traditional "flights to safety," bitcoin has become a potential viable alternative.

Evaluating Bitcoin As A Risk-Off Asset

Potential Capital Preservation

Bitcoin operates on a decentralized network, independent of any single entity, government, or central bank. Its distributed, open-source nature protects it against arbitrary asset seizure and counterparty risk.

Diversification

Bitcoin's historically low correlation with traditional asset classes is increasing its role as a source of diversification. Adding a non-correlated asset to portfolios potentially increases returns per unit of risk and provides a buffer against market downturns.

Long-Term Investment Horizon

Despite its short-term volatility, bitcoin has delivered significant long-term price appreciation. By design, scarcity increases the probability of capital preservation.

Liquidity & Accessibility

Global investors can access and trade bitcoin 24/7, which is increasingly important in times of risk-off uncertainty.

Inflation Hedge

Bitcoin's supply will be capped at 21 million coins. As with gold, scarcity characterizes bitcoin's role as a safe-haven asset.

Major Catalysts Await Bitcoin In 2024

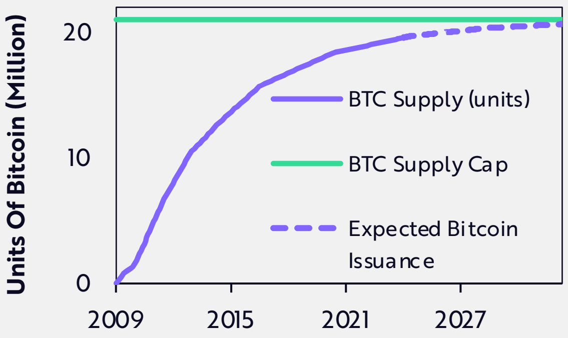
Bitcoin Spot ETF Launch

On January 11, 2024, the launch of spot bitcoin ETFs set the stage for Bitcoin's growth, by offering investors a more direct, regulated, and liquid way to gain exposure. Bitcoin spot ETFs are traded on major stock exchanges, allowing investors to buy and sell shares through their existing brokerage accounts, and should reduce the learning curve and operational complexities associated with direct investments in bitcoin.

Bitcoin Halving

The Bitcoin halving occurs approximately every 4 years, cutting the reward for mining new bitcoin blocks in half. Historically, each halving event has coincided with the beginnings of a bull market. Expected in April 2024, this halving will reduce bitcoin's inflation rate from ~1.8% to ~0.9%.

Bitcoin's Circulating Supply



Institutional Acceptance

Thanks to its continued resilience and performance, the shift in perception of bitcoin—to more of a strategic investment in a diversified portfolio—should characterize its evolution in 2024. Exemplifying this evolution, Larry Fink, CEO of BlackRock, has shifted his stance from bitcoin skepticism to its potential as a "flight to quality."

Regulatory Developments

The bankruptcies of FTX and Celsius have advanced the push for more transparent and open global crypto regulation, including the potential passage of a US bill establishing a regulatory framework for cryptocurrencies, and the implementation of Europe's Markets in Crypto-Assets (MiCA) regulation, which mandates licensing for crypto wallet providers and exchanges in the EU.

Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 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.

Research By:
Nicholas Grous
Associate Portfolio Manager
Andrew Kim
Analyst

Digital Consumers

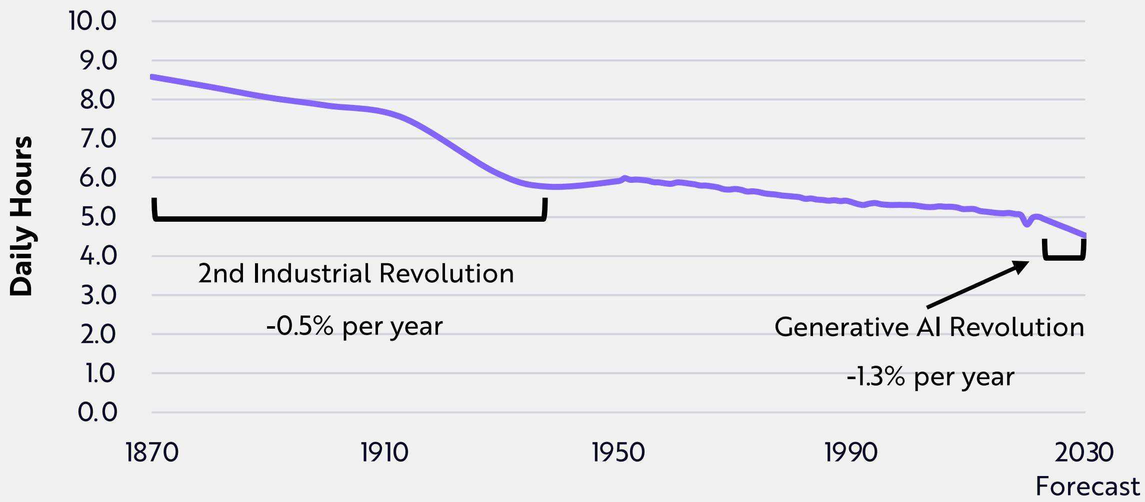
Transitioning Toward Digital Leisure

Artificial Intelligence Could Lower The Average Workweek And Stimulate Digital Consumption

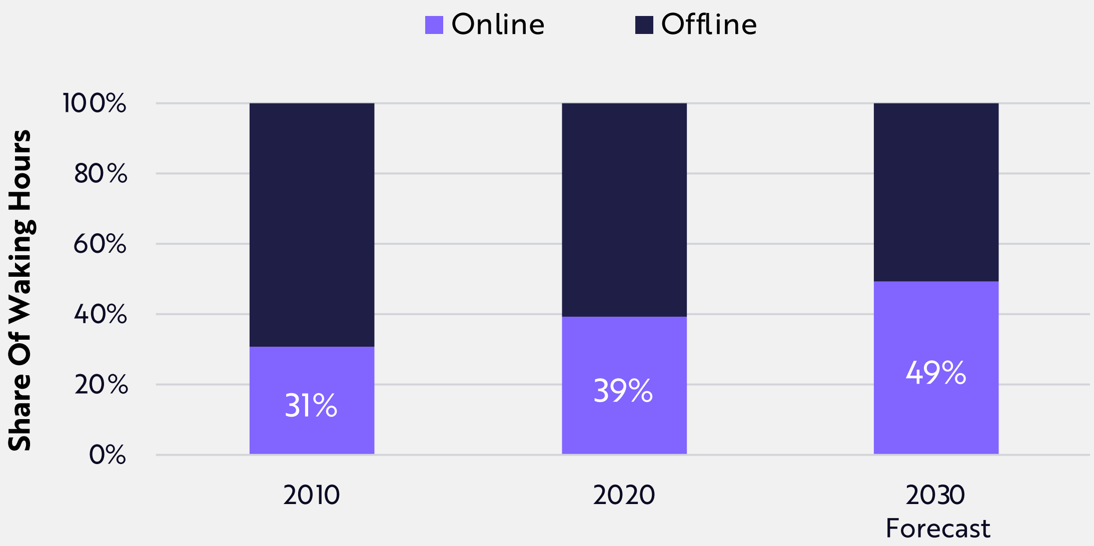
During the 80 years between the Second Industrial Revolution through the end of World War II, labor hours per worker decreased 0.5% at an annual rate globally. Generative AI could lower labor hours per worker by 1.3% on average, from 5.0 hours per day in 2022 to 4.5 hours in 2030.*

As a result, consumers might devote more time to online entertainment, potentially increasing the share of total waking hours spent online from 40% in 2023 to 49% in 2030.

Global Labor Hours Per Worker Per Day*



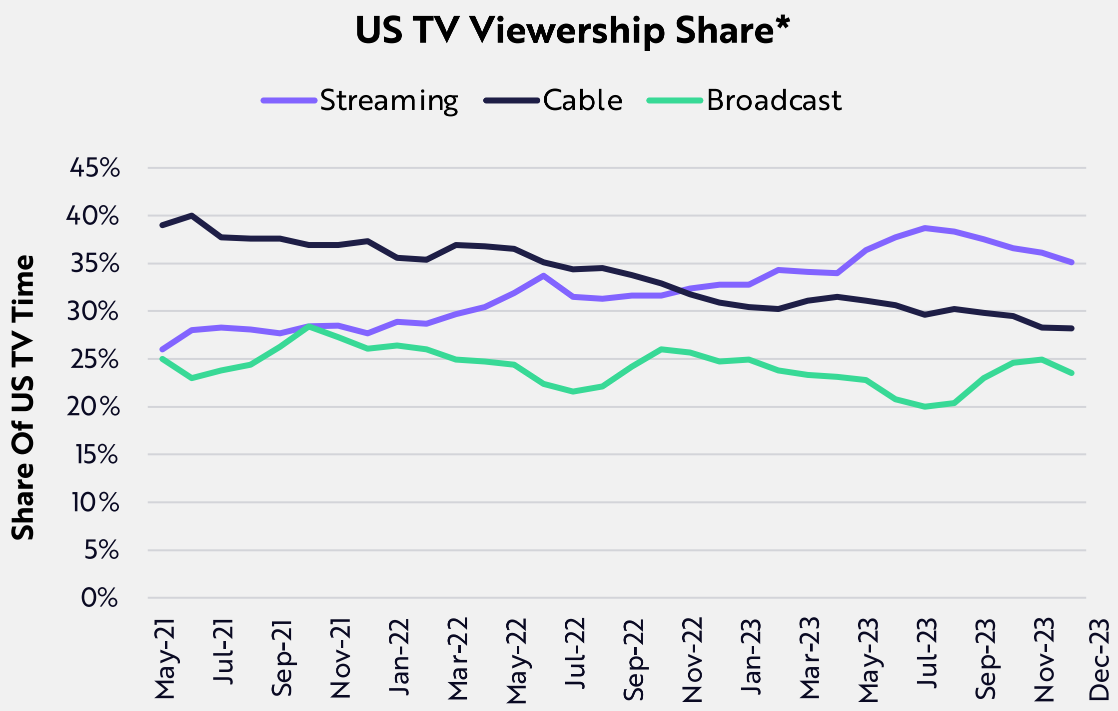
Global Online And Offline Time**

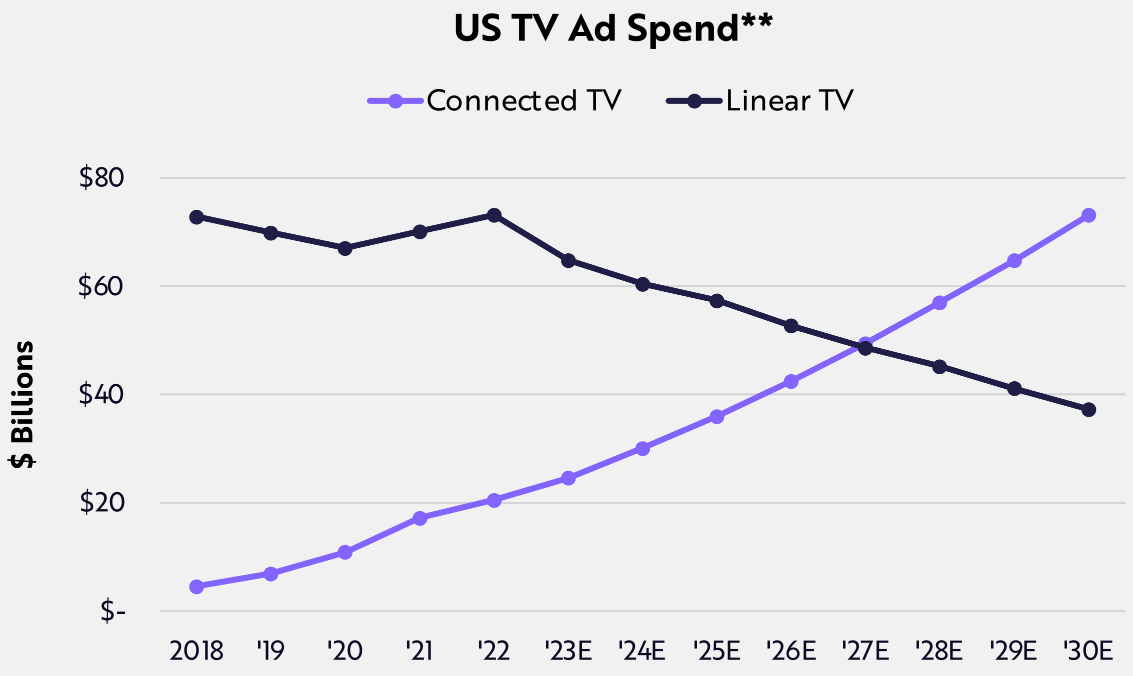


*To calculate global daily working hours, we divide total annual hours of labor per worker by the total days of the year. **The chart illustrating daily allocation of online vs. offline time captures total daily waking hours, including those allocated to labor or education. The chart captures hours generated by internet users only. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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.

Streaming TV Is Displacing Linear TV

In just two years, streaming's share of overall TV consumption increased more than 10 percentage points to 39% as of July 2023, surpassing the shares of cable and broadcast, respectively. Ad spend on connected TV (CTV) is following eyeballs and is likely to continue to grow at the pace of streaming consumption.

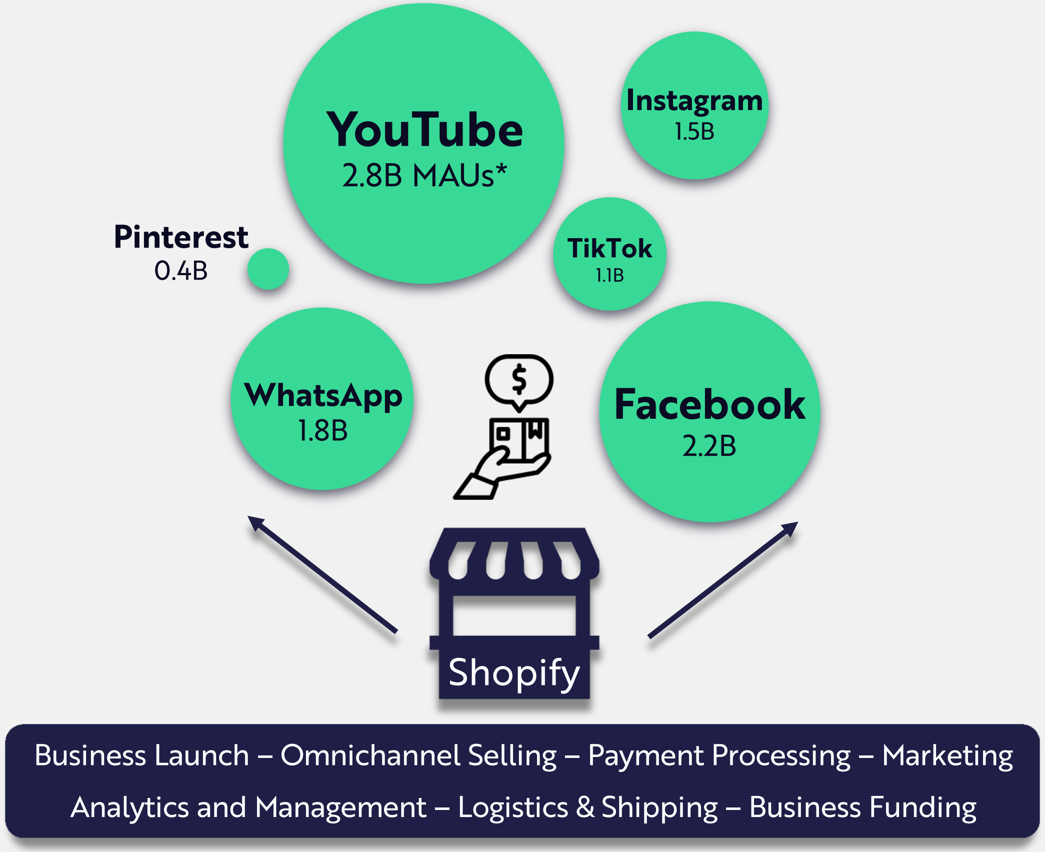




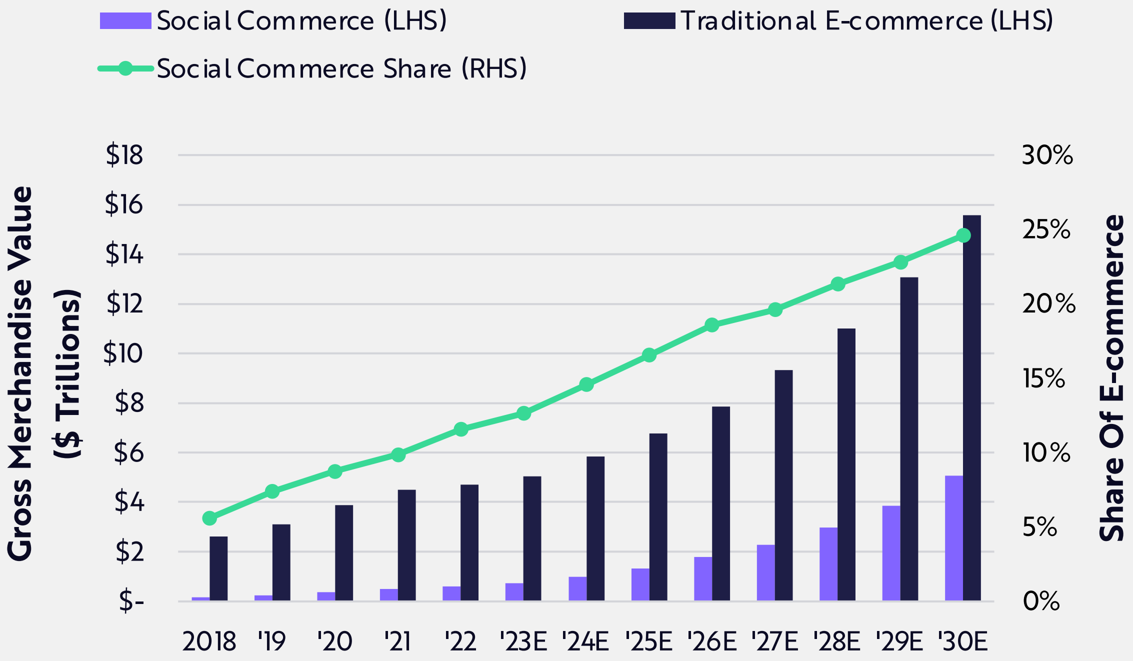
*The share of streaming, cable, and broadcast do not add up to 100%, as we exclude the portion of consumption that Nielsen categorizes as "Other," which includes time spent on unmeasured sources like video-on-demand (VOD), audio streaming, gaming, and other device use. **We define linear TV as traditional TV delivered via cable, satellite, or over-the-air. We define connected TV as streamed TV delivered over-the-top through smart TVs, streaming media devices, video game consoles, and other modern hardware. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources,, including Nielsen, Insider Intelligence, and MAGNA Global, which may be provided upon request. 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.

Social Commerce Merchants Can Sell to Anyone—Anytime, Anywhere

Social media platforms are increasing their monetization of global audiences with e-commerce. Thanks to omnichannel solutions—both physical and digital—social commerce could grow 32% at an annual rate, from $730 billion today to over $5 trillion in 2030.



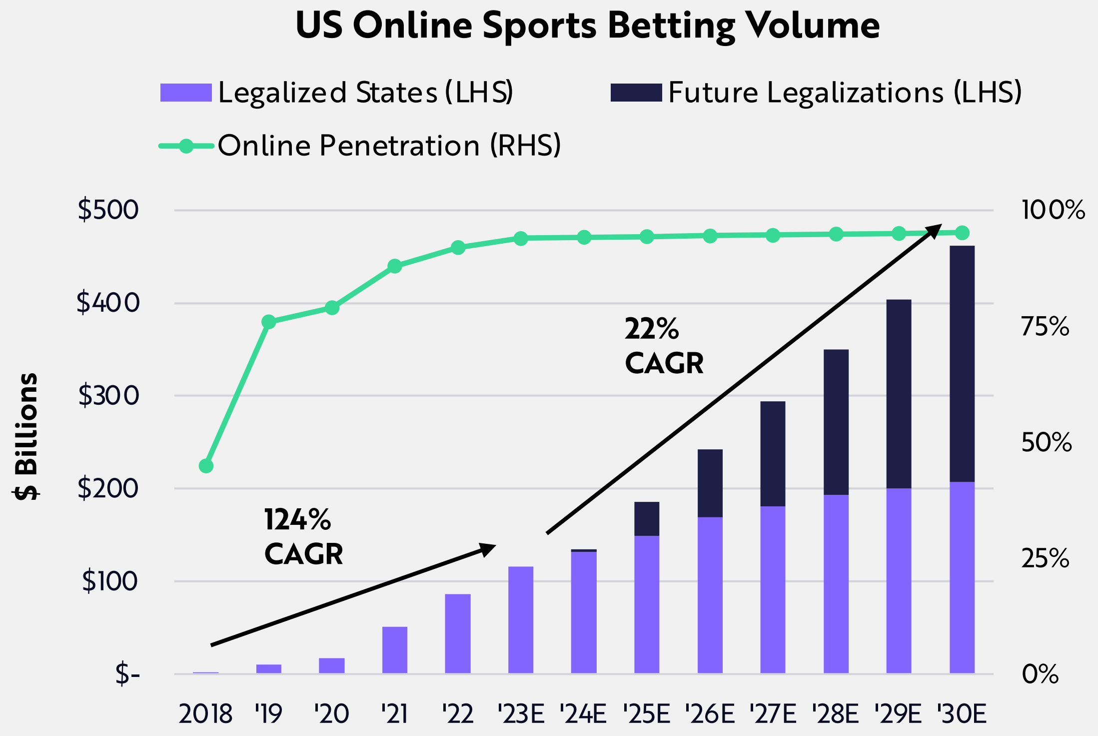
Global Social Commerce Sales
ARK Forecast

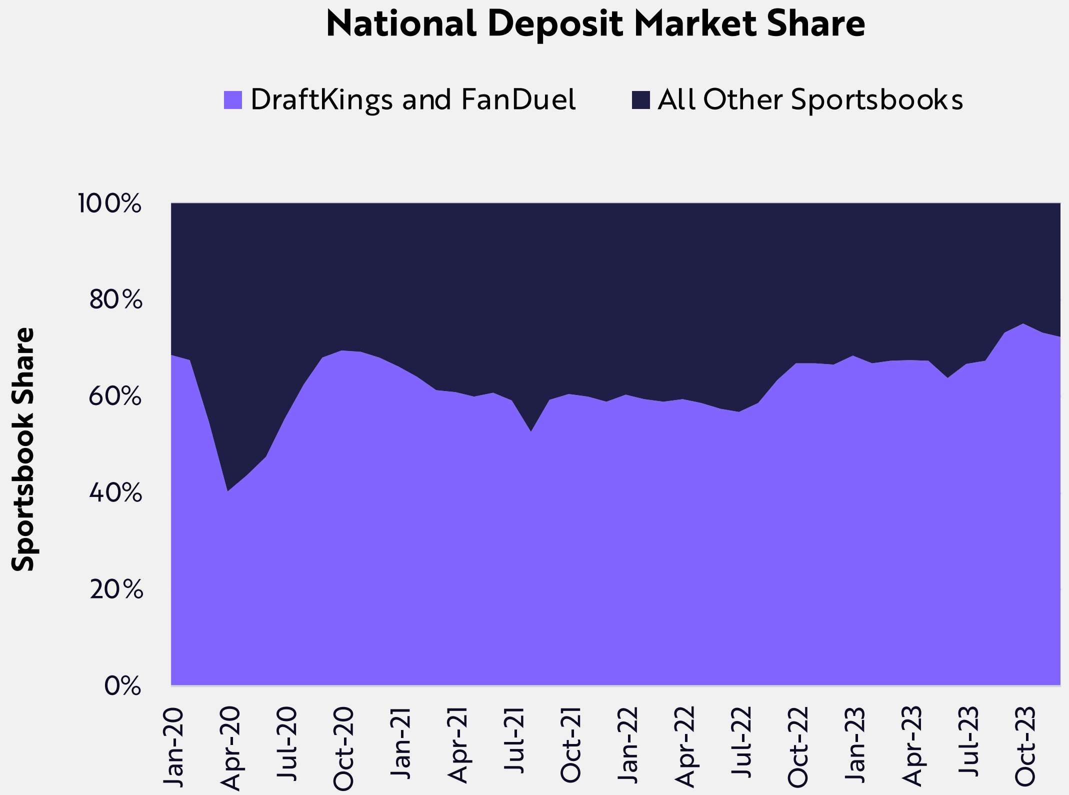


*We estimate each platform's monthly active users (MAUs) across its iOS and Android mobile apps. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Sensor Tower, which may be provided upon request. Forecasts are inherently 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.

Mobile Sports Betting Continues To Grow And Consolidate In The US

Thanks to legalization and consumer adoption, the winners in online sports betting are pulling away from the pack. As online sports betting surged 35% during 2023, DraftKings and FanDuel offered superior user experiences that helped take share from other sportsbooks. DraftKings and FanDuel grew their share of national deposits to 75% in 2023, while the long tail of sportsbooks lost 8 percentage points of share.



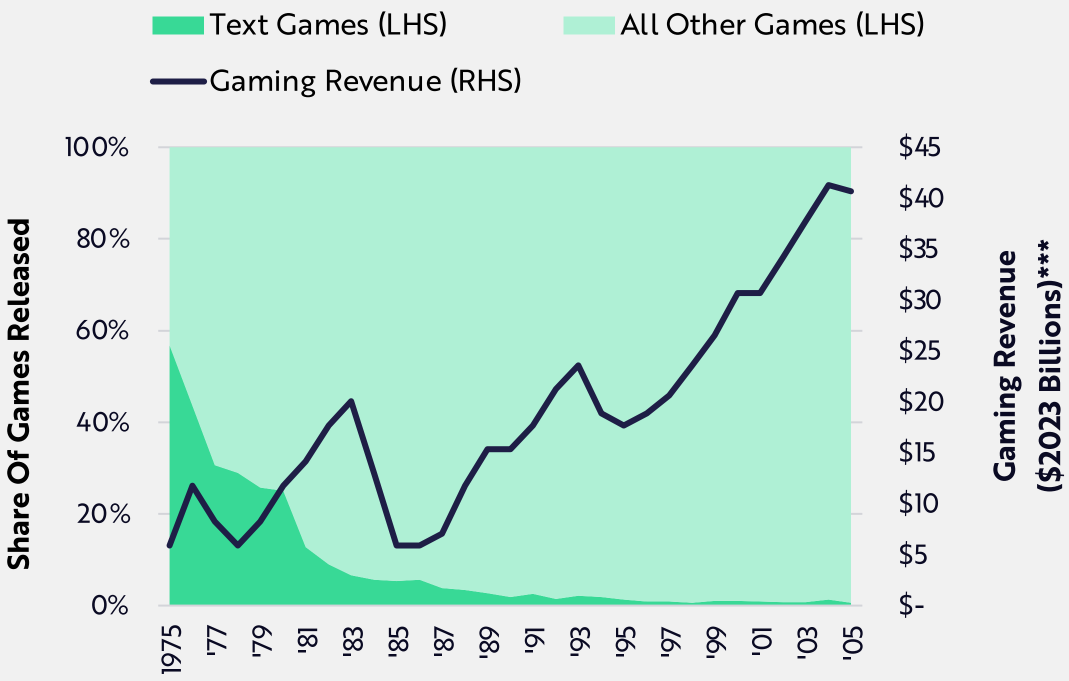


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Yipit Data, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

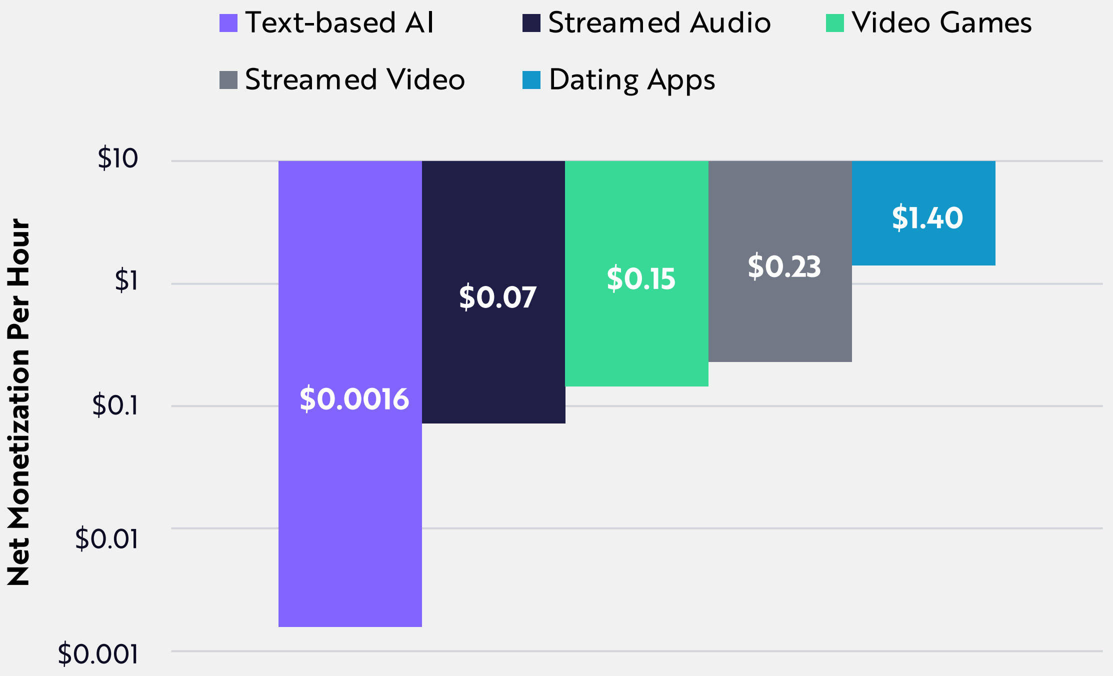
Online Experiences Are Becoming More Immersive And Monetizable

History suggests that deeper immersion leads to higher monetization. After computer graphics expanded the market beyond text-based adventure games in the 1980s, gaming revenue soared 19% at an annual rate, from $6 billion in 1985 to $24 billion in 1993. Now, multimodal AI—text, images, audio, and video—are creating more immersive and interactive experiences that should expand the market.

Video Games Evolution*



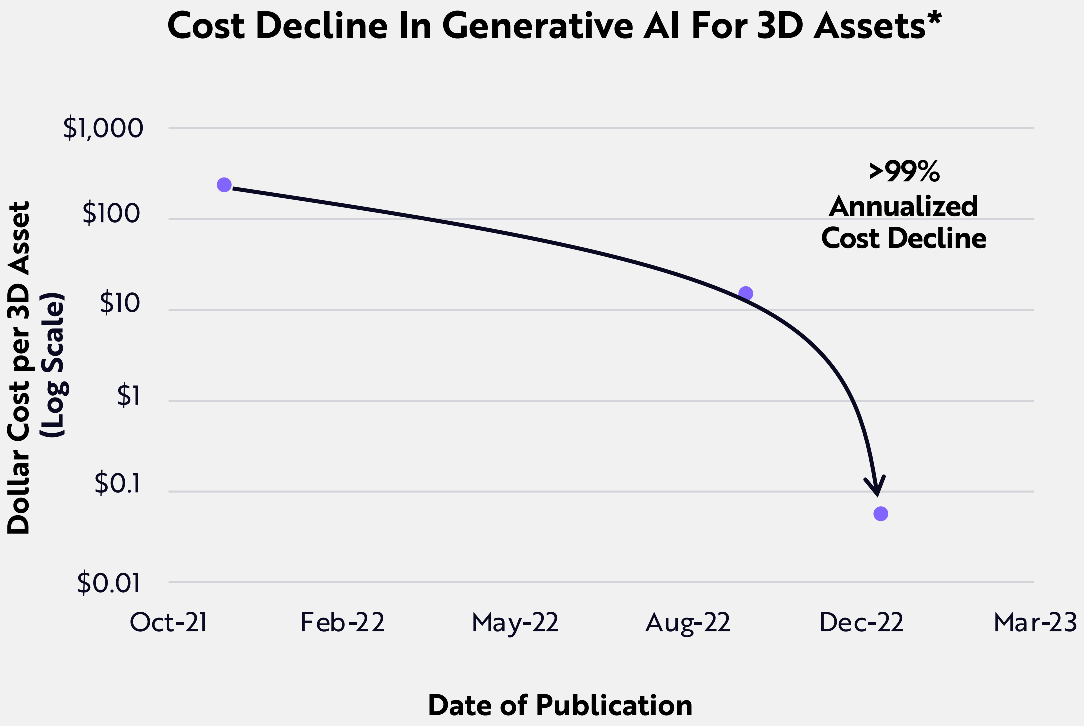
Gross Platform Monetization Rates**

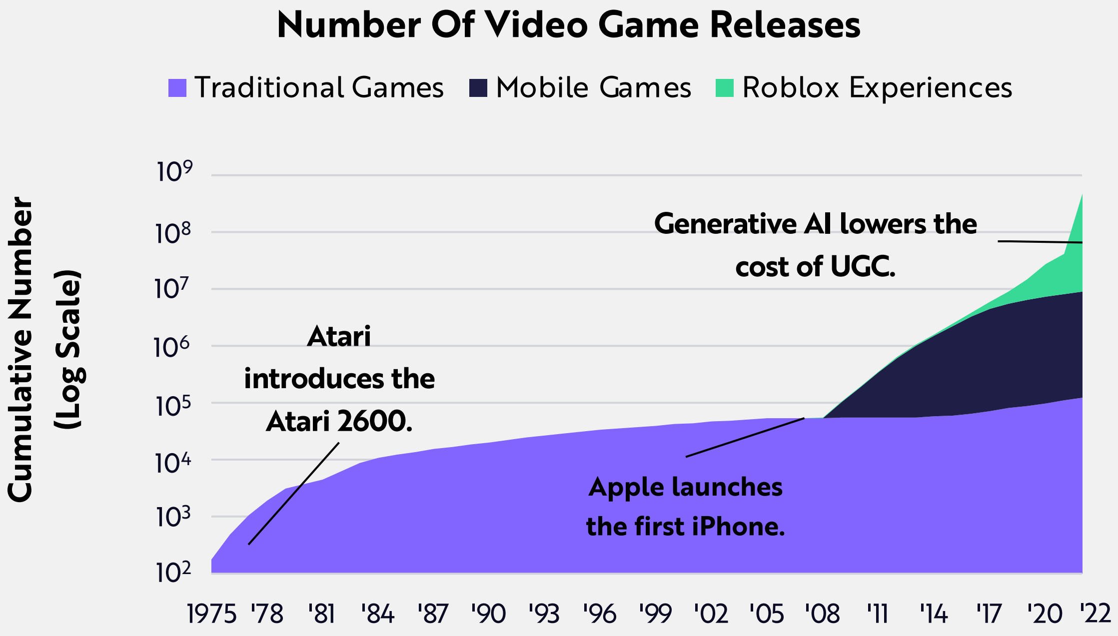


*"Text games" refer to both text-based and spreadsheet-based games. "All other games" exclude arcade game releases. Gaming revenue captures PC and console gaming revenue only **We estimate various platforms' ability to monetize on direct consumer spend only.. ***Revenue figures have been inflation-adjusted to 2023 US Dollars. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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.

Thanks To AI-Assisted Creation, Gamers Could Become Developers

AI-assisted game creation on user-generated content (UGC) platforms could cause an explosion in gaming content. According to our research, after normalizing for output quality, the cost of generating a single 3D asset has dropped ~99% at an annual rate to less than $0.06 since 2021. AI should democratize content creation and accelerate the growth in UGC. Roblox already has delivered more than ~470 million experiences globally, 52x the combined number of PC, console, and mobile app games.





*We normalize the cost of 3D asset generation by each model's CLIP R-Precision scores. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Nichol et al. 2022, which may be provided upon request. 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.

Research By: **Andrew Kim**
Analyst

Digital Wallets

Closing The Loop With Two-Sided Networks

Important Information

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.

Vertical software refers to a suite of solutions tailored to the needs of specific industries. Leading vertical software platforms are expanding rapidly into financial services for consumers and merchants. With two-sided networks, such software could facilitate closed loop transactions from consumer to merchant, merchant to employee, and employee to merchant. ARK believes that digital wallets on these platforms will enable fully closed payment ecosystems.

Block, Shopify, and Toast are compelling platforms likely to use digital wallets as the nucleus of their consumer, merchant, and employee ecosystems.

*In this exercise, we forecast the core revenues of Block, Shopify, and Toast to grow 22% at an annual rate over the next seven years. Summing the mentioned revenue opportunities on top of our core revenues forecast increases the annual growth rate from 22% to 33% over the next seven years. We primarily model Block's historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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.

Vertical Software Platforms Are Consolidating Financial Services

In addition to enabling core business operations, vertical software providers like Block, Shopify, and Toast are consolidating financial services for merchants. With digital wallets at their core, and partnering with sponsor banks and fintech companies or activating their own banking charters, vertical platforms should eliminate myriad merchant interactions with less efficient legacy financial institutions.

	Consumer*	Merchant						
	Digital Wallet	Payroll	Checking	Savings**	Debit Card	Credit Card	Working Capital Financing	Bill Pay***
Block	✓	✓	✓	✓	✓	✓	✓	✓
Shopify	✓		✓	✓	✓	✓	✓	✓
Toast	✓	✓			✓		✓	✓

*We consider Block's Cash App and Toast's MyToast mobile app as consumer digital wallets, and we consider Shopify's Shop mobile app and Toast's Toast Takeout mobile app as digital wallets in their early stages. **We consider Shopify Balance as both a checking and savings vehicle for merchants. ***Given xtraCHEF's invoice automation features, we believe Toast will soon offer direct bill pay on its platform. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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.

Vertical Software Platforms Are Consolidating Consumer Services

Vertical software platforms are not only enabling vast merchant networks but also building consumer networks using digital wallets. By scaling merchant and consumer networks simultaneously, vertical software platforms are becoming operating systems for these two-sided networks.

	Consumer*								Merchant
	Payments	Checking	Savings	Debit Card**	Buy Now Pay Later	Personal Lending	E-commerce	Loyalty	Digital Wallet
Block	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shopify	✓				✓		✓	✓	✓
Toast	✓			✓			✓	✓	✓

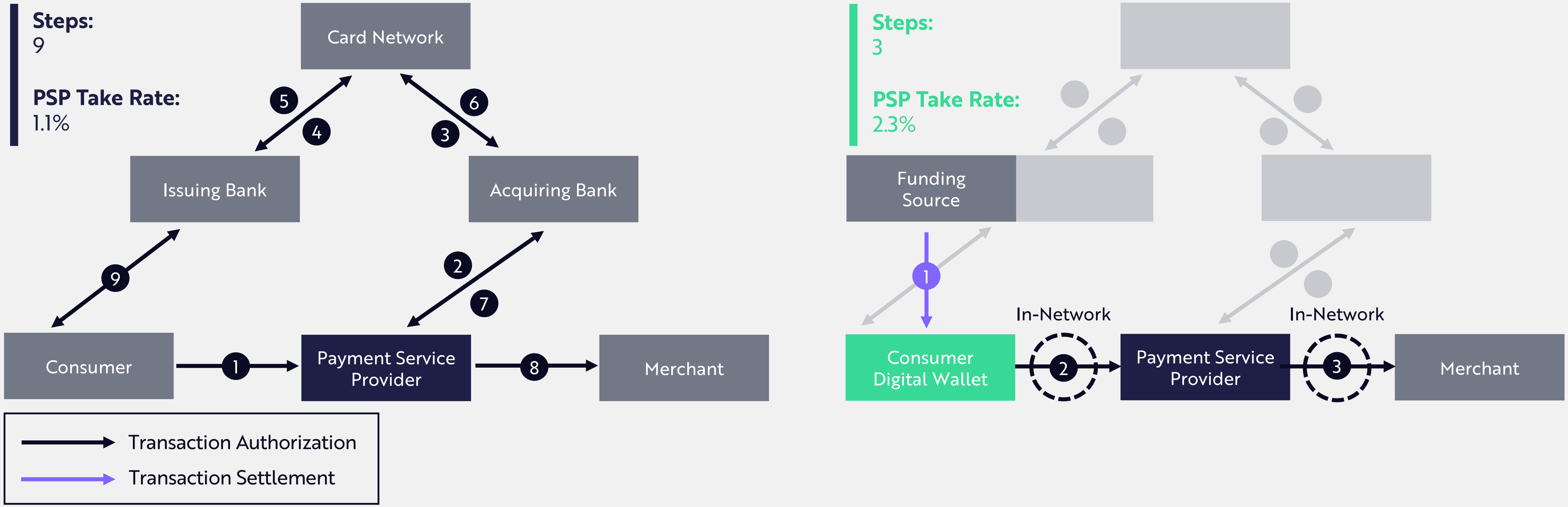
*We consider Block's Cash App and Toast's MyToast mobile app as consumer digital wallets, and we consider Shopify's Shop mobile app and Toast's Toast Takeout mobile app as digital wallets in their early stages. **We consider the Toast Pay Card a form of consumer debit cards. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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 Are Likely To Disintermediate Consumer-To-Business (C2B) Payment Ecosystems

Transactions funded with digital wallet balances bypass banks and card networks, saving interchange fees for payment facilitators, merchants, and consumers. In ARK's view, vertical software platforms with scaled consumer and merchant ecosystems will leverage digital wallets to facilitate closed-loop transactions.*

BEFORE: C2B Card Payment Authorization

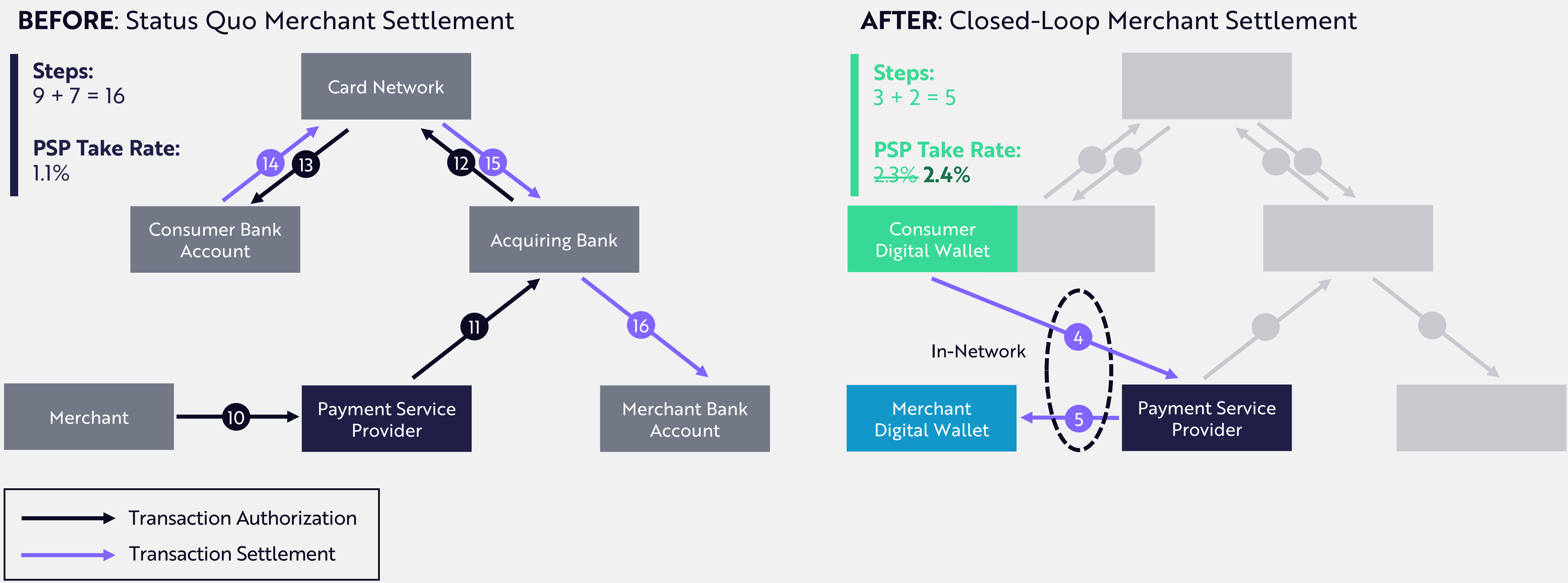
AFTER: C2B Closed-Loop Payment Authorization



*Payment processes and associated fee estimates are rendered for illustrative purposes only. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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 Could Disintermediate Merchant Banking

Vertical software platforms can serve merchants with financial services. With digital wallets, these platforms not only enhance convenience but also monetize deposits, reducing the number of steps from payment authorization to merchant settlement from 16 to 5 and more than doubling the platform take rate.*



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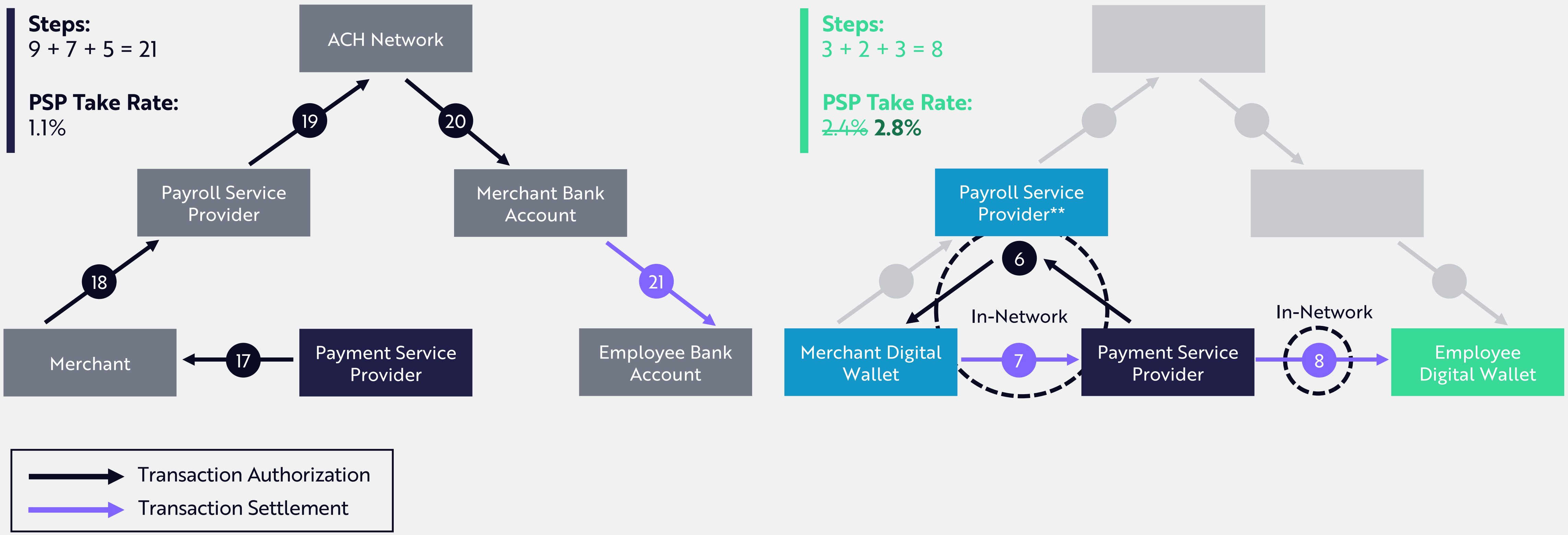
Digital Wallets Could Disintermediate The Payroll Banking Opportunity

Vertical software platforms probably will use digital wallets to link merchants directly to employees, adding monetization opportunities with little to no cost of customer acquisition.*

BEFORE: Status Quo Payroll

AFTER: Closed-Loop Payroll



*Payment processes and associated fee estimates are rendered for illustrative purposes only. **In this example, we assume the PSP offers a first-party or white-labeled third-party payroll solution. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. 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.

Research By:
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Rong Guo Research Associate

Precision Therapies

Curing Disease More Efficiently And Less Expensively

Important Information

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.

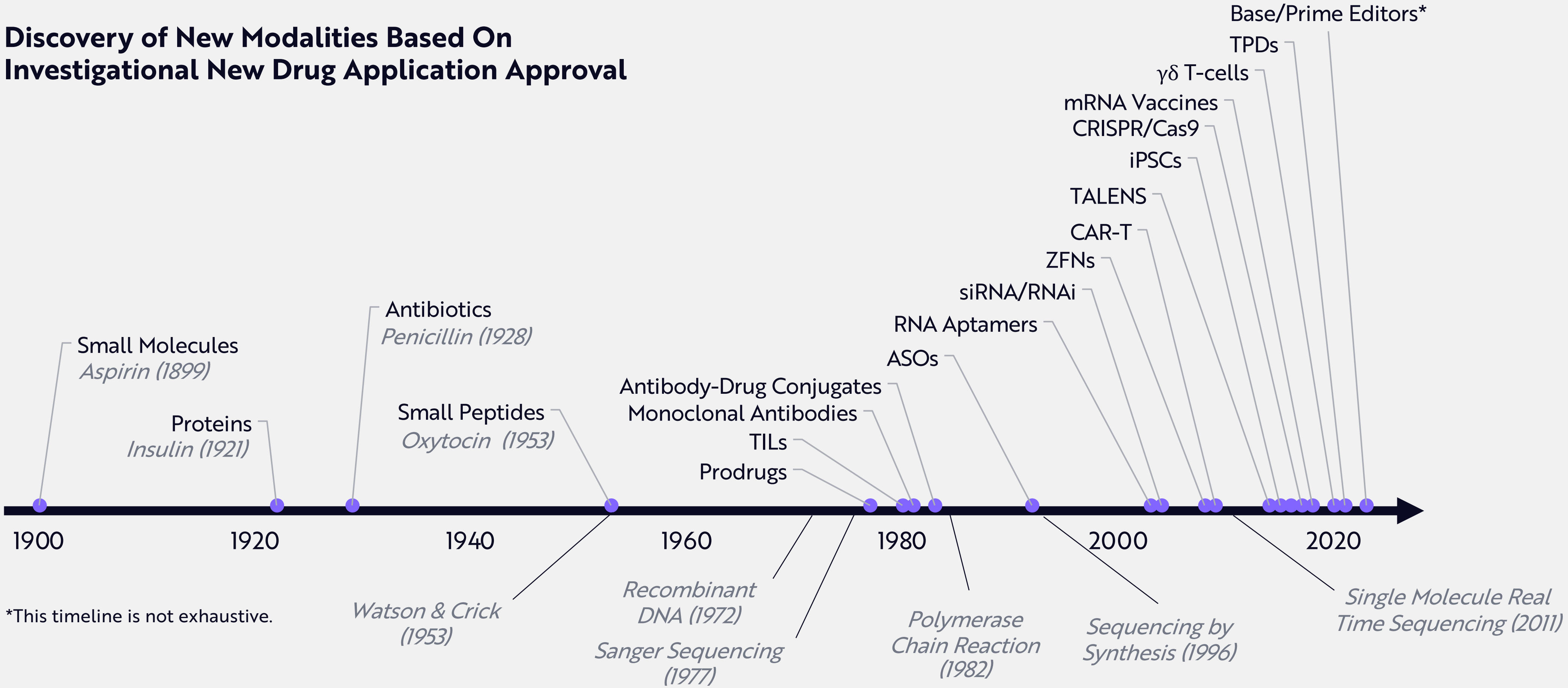
During the past twenty years, new modalities for precision therapies, CRISPR gene editing, RNA therapeutics and targeted protein degradation have proliferated. Innovative therapies powered by artificial intelligence (AI), CRISPR gene editing, and new sequencing technologies have increased returns on research and development (R&D), while enabling undruggable targets to become druggable.

Increasingly, precision therapies are becoming multiomic and curative, with mechanisms of action spanning DNA, RNA, proteins, and more.

New Therapeutic Modalities Are Proliferating

During the last thirty years, the number of therapeutic modalities with entirely new mechanisms of action has proliferated. Not only have they expanded the number of treatable diseases, but they have also improved efficacy and safety. In 2023, more than 25% of clinical trials were harnessing new therapeutic modalities.

Discovery of New Modalities Based On Investigational New Drug Application Approval



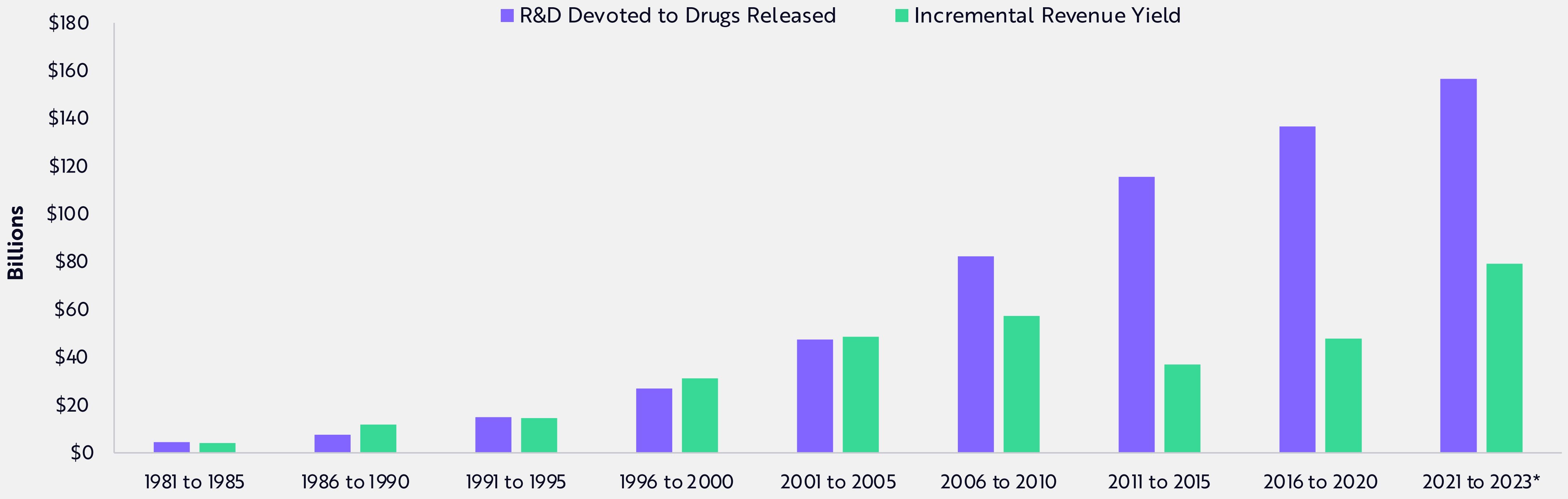
*This timeline is not exhaustive.

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Biomedtracker, which may be provided upon request. 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.

Precision Therapies Could Reverse The Downtrend In Returns On Research And Development (R&D)

Given regulatory bottlenecks and legacy drug discovery methods, the return on therapeutic R&D has been falling for nearly 25 years. According to our research, novel therapeutic modalities and R&D methods, coupled with regulatory approval of "precision" therapies, could reverse the downward trend in return on investment in the pharmaceutical industry.

Average Annual R&D And Incremental Revenue Attributable To Drugs Released

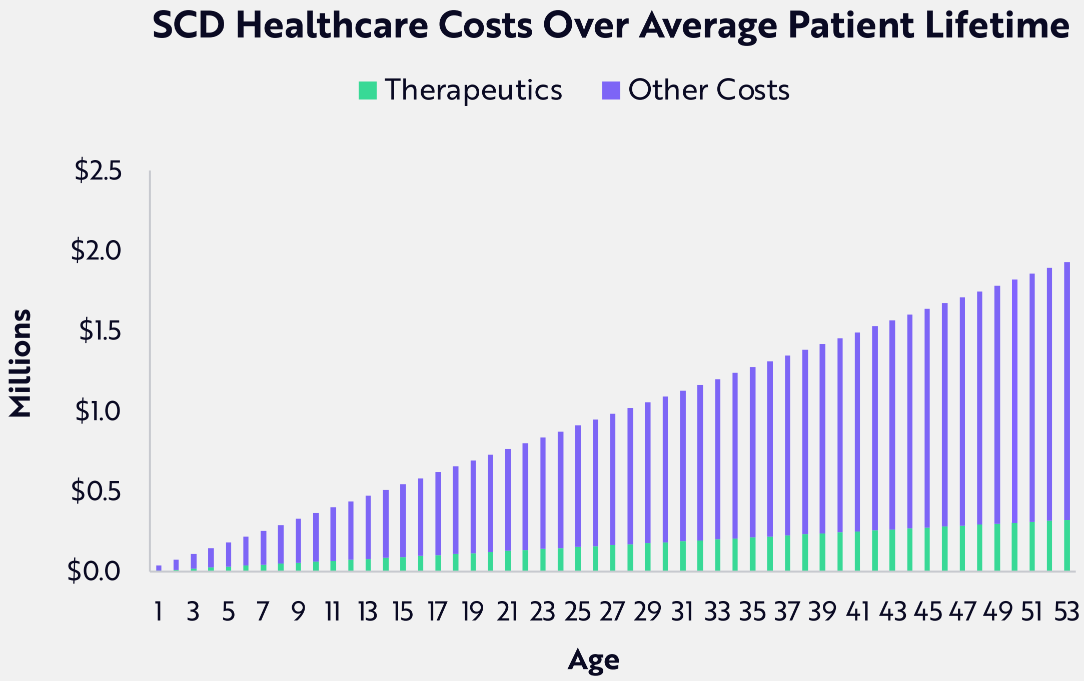


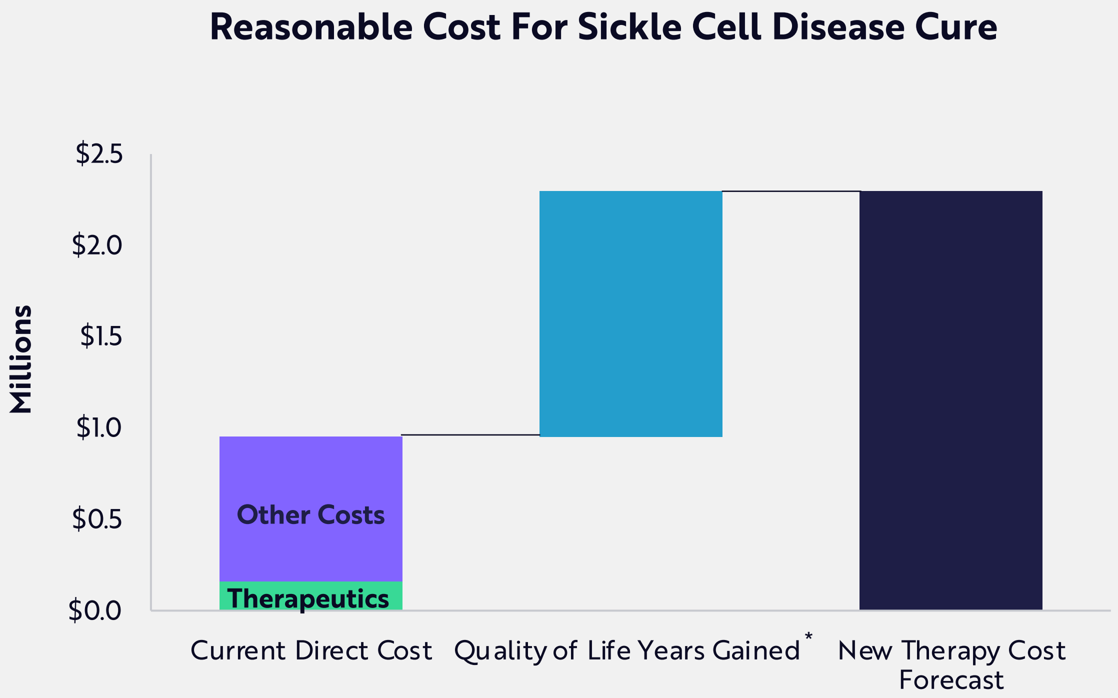
*Shorter time frame. Data impacted due to COVID.

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Biomedtracker and Ycharts, which may be provided upon request. 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 Value Of Curing Rare Diseases Like Sickle Cell Anemia Is High

Among precision therapies, gene editing medicines like CRISPR-Cas9 have the potential to cure rare genetic diseases such as Sickle Cell Disease (SCD). SCD is an inherited red blood cell disorder that affects more than 100,000 people in the US and 20 million people globally, primarily in Africa. Today, therapeutics account for ~16% of the total spent on treating SCD disease in the US, but they have done little more than manage symptoms, as the life expectancy of SCD patients is only 56% that of the general population.





*Quality of Life Years Gained = Health Utility * Duration
For Health Utility, 0 means dead and 1 means full health

Data are as of December of 2023.
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. 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.

Research By:

Pierce Jamieson
Analyst

Nemo Marjanovic
Research Associate

Multiomic Tools And Technology

Translating Biological Insights Into Better Healthcare And Economic Value

Important Information

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.

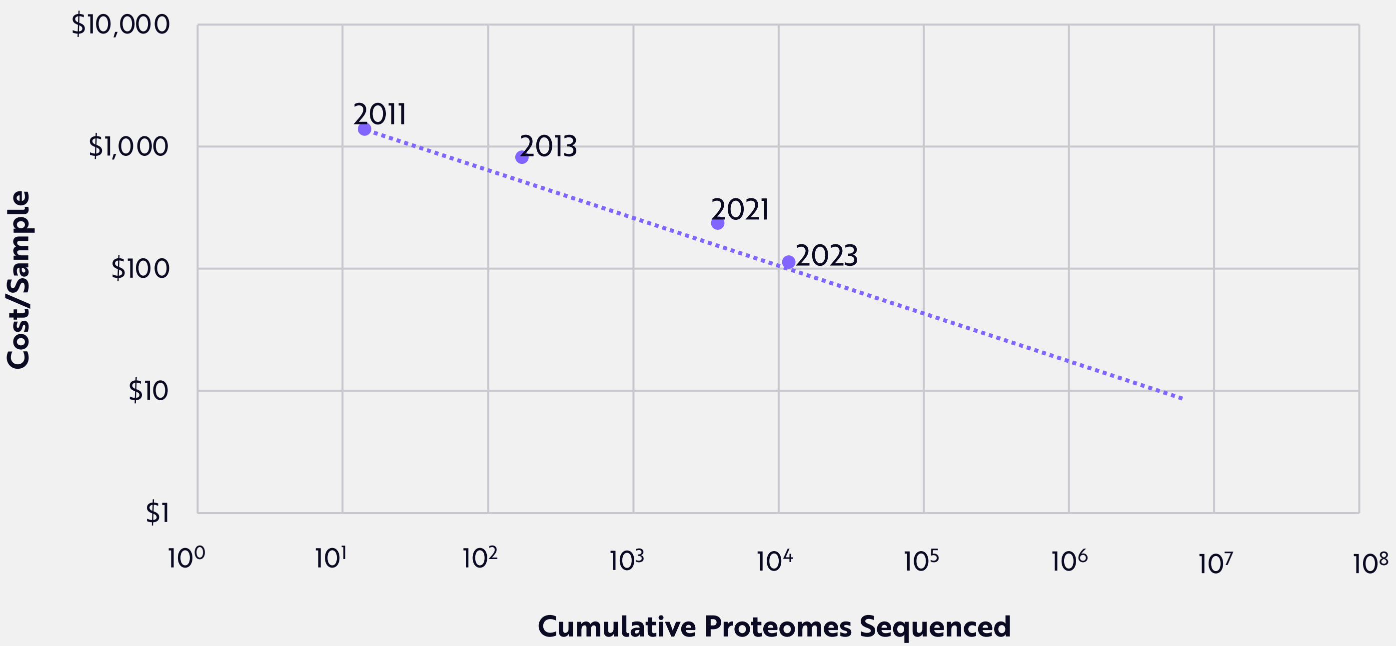
Proteoforms are the different forms of a protein produced from the genome with a variety of sequence variations, splice isoforms, and post-translational modifications. Proteoform captures the disparate sources of biological variation which alter primary sequence and composition at the whole-protein level. 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.

Over the past decade, the number of biological tools and techniques has proliferated, their capability having improved remarkably. Among others, three enabling technologies stand out: high-throughput proteomics, artificial intelligence, and single-cell sequencing. Their convergence is increasing productivity and efficiency, enhancing precision in healthcare applications, and unlocking substantial economic value.

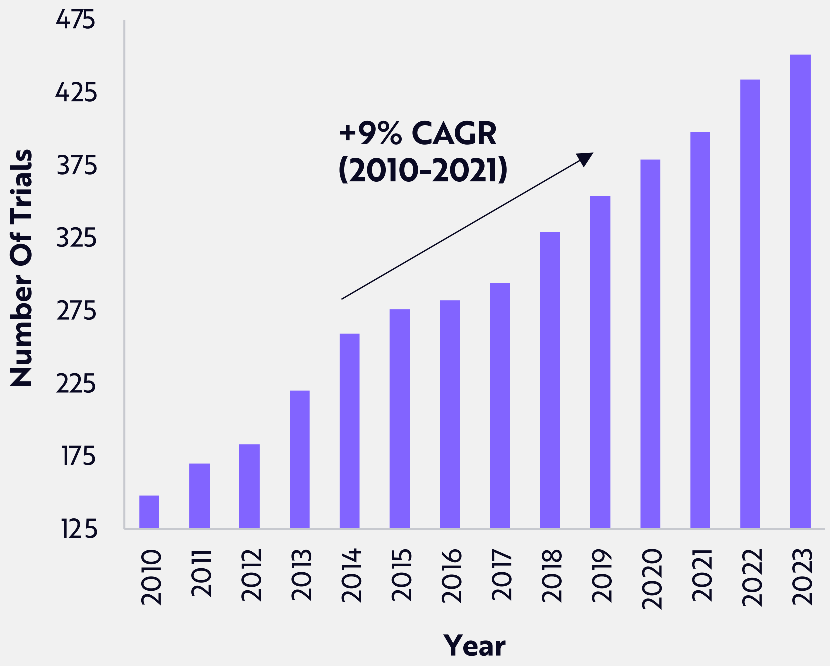
Wright's Law* Has Predicted The Cost Decline Of Proteomics

As the number of proteomes analyzed by mass spectrometry has increased, costs have dropped dramatically, unlocking new possibilities in medical research and diagnostics. Our research suggests that for untargeted proteomics using mass spectrometry, the cost per sample is declining 23% at an annual rate, or ~11% for each cumulative doubling in the number of proteomes sequenced. Proteomic discoveries are paving the way for the identification of novel biomarkers, enabling the earlier detection and treatment for unique cancer subtypes.

Wright's Law Has Predicted The Cost Decline For Untargeted Proteomics



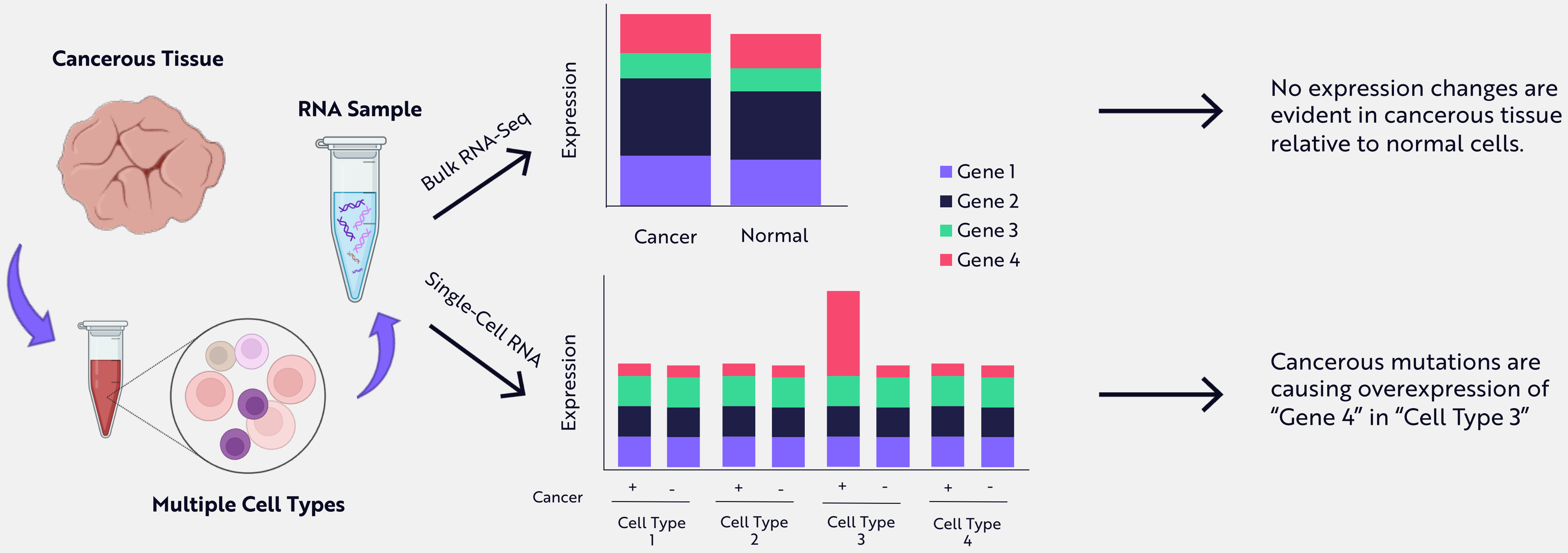
US Trials With Patient Biomarkers



*Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. Sources: ARK Investment Management LLC, 2024, https://www.ark-invest.com/wrights-law/. This ARK analysis is based on a range of external sources, which may be provided upon request. 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.

Single-Cell RNA Sequencing Is Revolutionizing Our Understanding Of Cancer

While traditional gene expression analysis using RNA-seq can measure only the expression of genes in a mixture of different cell types, single-cell RNA-seq (scRNA-Seq) can delineate the expression of different cell types in a complex tissue sample. Theoretically, linking gene expression to specific cells increases the accuracy of measuring by 10x and cuts costs per gigabyte by 76%.



Drug Development Costs Could Drop Precipitously

Advances in fundamental biology, artificial intelligence, automation, and trial design should lower preclinical drug development costs significantly. They enable methods that eliminate less-promising candidates early in the drug development process, prevent downstream misallocation of R&D capital, and create a larger chemical search space early in the discovery phase. During the next decade, companies leveraging these techniques fully could lower costs per approval by almost 50%, in part by more than doubling the odds of success for those drug candidates that do enter clinical trials.

Efficiency Innovations

Innovative Trial Design

+ Adaptive Clinical Trial Design
+ Precision Biomarkers
+ Decentralized/Virtual Trials

Fundamental Biology

+ Single-Cell Biology
+ Proteomic Techniques
+ Virtual Compound Libraries
+ Biomarker Development
+ Humanized animal models

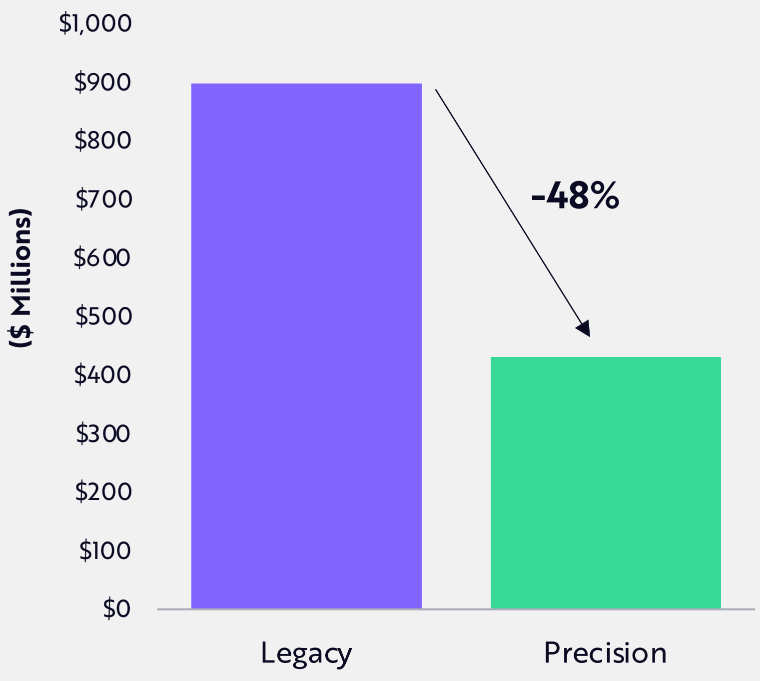
Automation

+ Automated Liquid Handling
+ Automated Invivomics
+ Automated Microsynthesis
+ CRISPR "Perturb-Seq" Screens
+ Organ-on-a-chip Technology

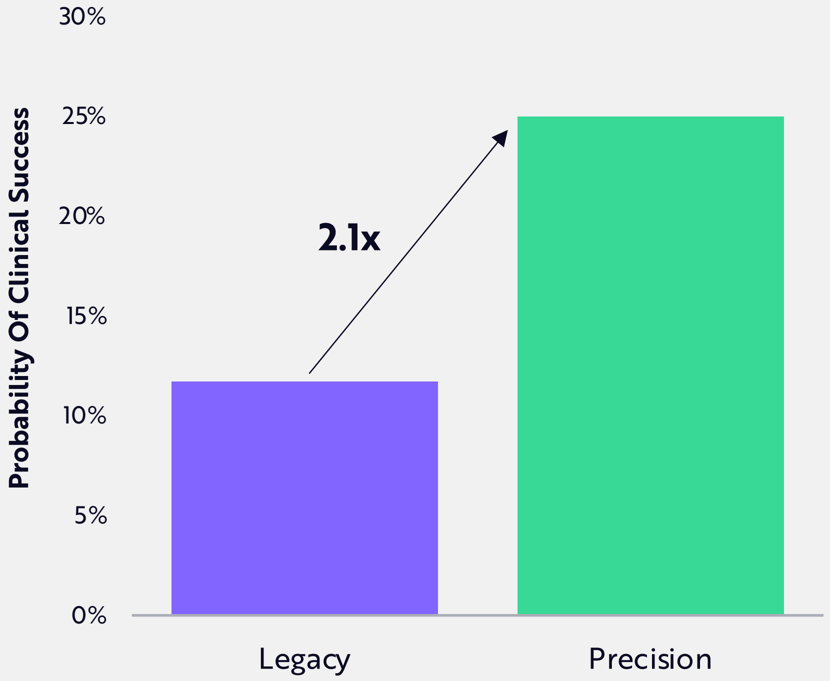
Artificial Intelligence

+ AI-Enabled Pathway Analysis
+ AI-Enabled Toxicity Prediction
+ In-Silico Molecular Modeling
+ ML-Driven Compound Screens

R&D Cost Per Drug Approval (Including Failures)



Clinical Success Probability



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. 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.

Research By:

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Director of Research,
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Daniel Maguire, ACA
Research Associate

Electric Vehicles

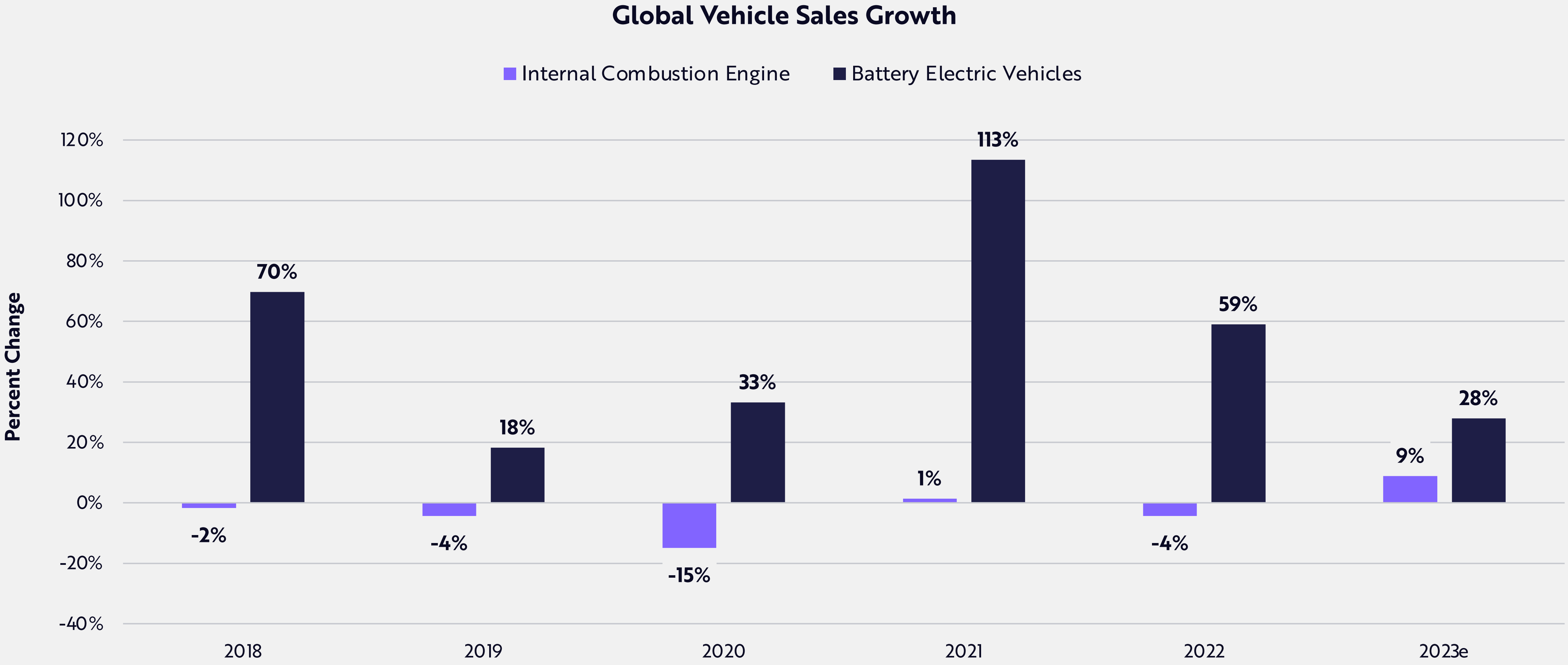
Lower Battery Costs Powering EV Adoption

After increasing in response to supply chain disruptions, battery costs now are falling in line with Wright's Law, leading to lower electric vehicle (EV) sticker prices.

If robotaxi platforms proliferate, EVs could account for 95-100% of vehicle sales in 2030.

ARK forecasts that electric vehicle sales will scale 33% at an annual rate during the next seven years, from roughly 10 million in 2023 to 74 million in 2030.

Electric Vehicles Continue To Take Share From Internal Combustion Engine Vehicles



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including EVVolumes.com, which may be provided upon request. 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 Auto Industry Is Likely To Consolidate

If EV adoption continues to gain traction, traditional automakers may be forced to restructure and consolidate.

GM Delays EV Truck Production At Michigan Plant By Year

—Reuters Oct 17, 2023

VW Group Delays EV Battery Plant In Europe Amid "Sluggish" EV Demand

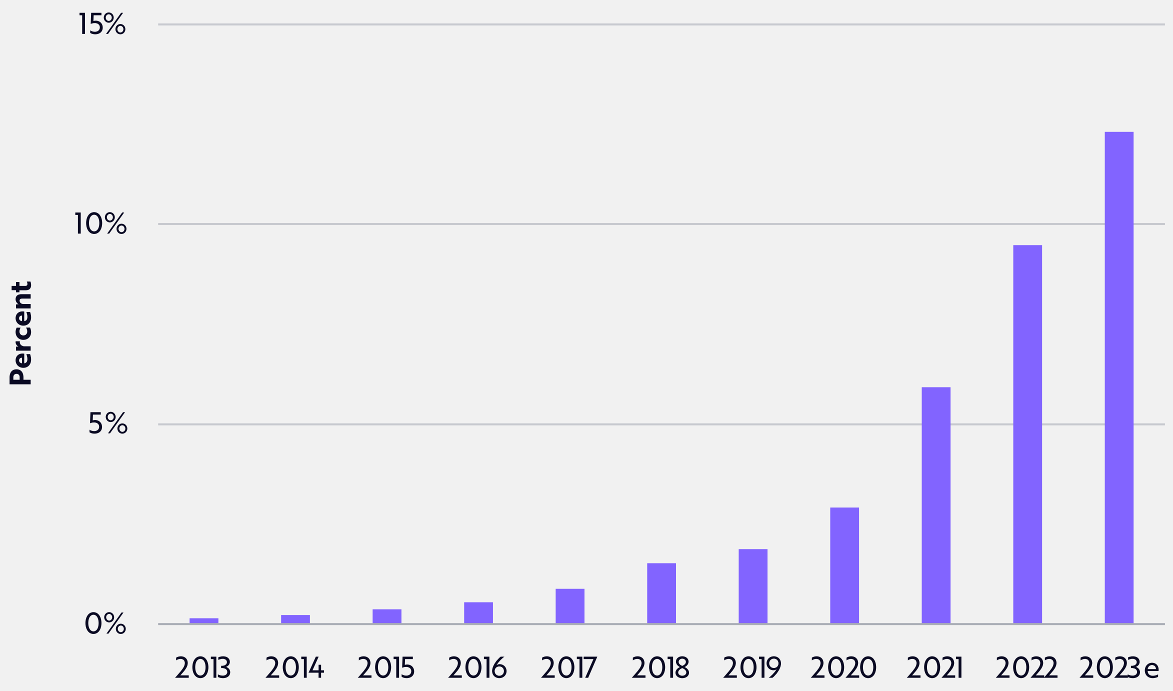
"There is for the time being no business rationale for deciding on further sites," Volkswagen Group CEO Oliver Blume said.

—InsideEVs Nov 2, 2023

Ford Will Cut Weekly Production Of F-150 Lightning In Response To Slowing Demand

—The Verge Dec 11, 2023

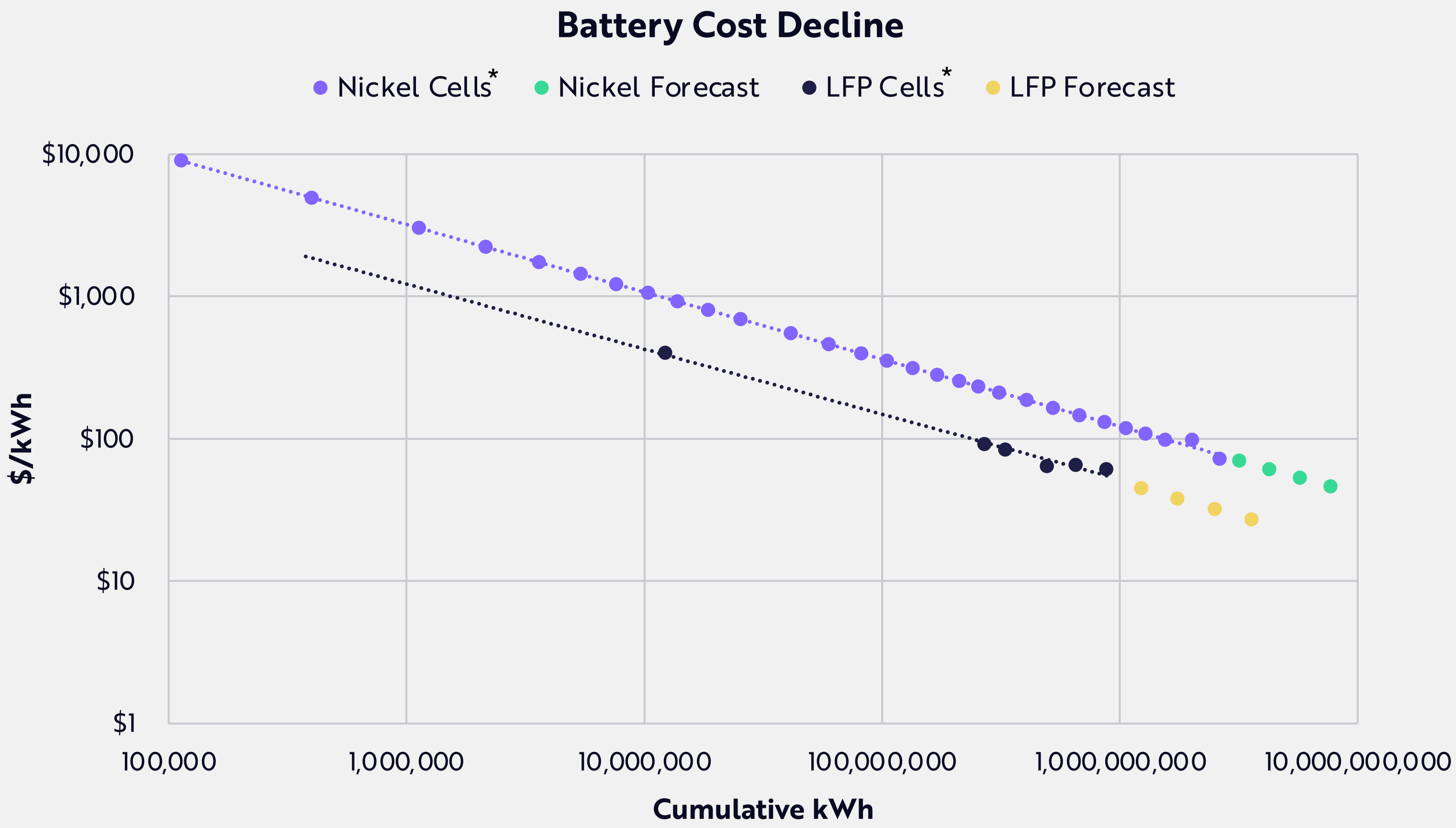
Global Battery Electric Vehicle Sales Market Share*

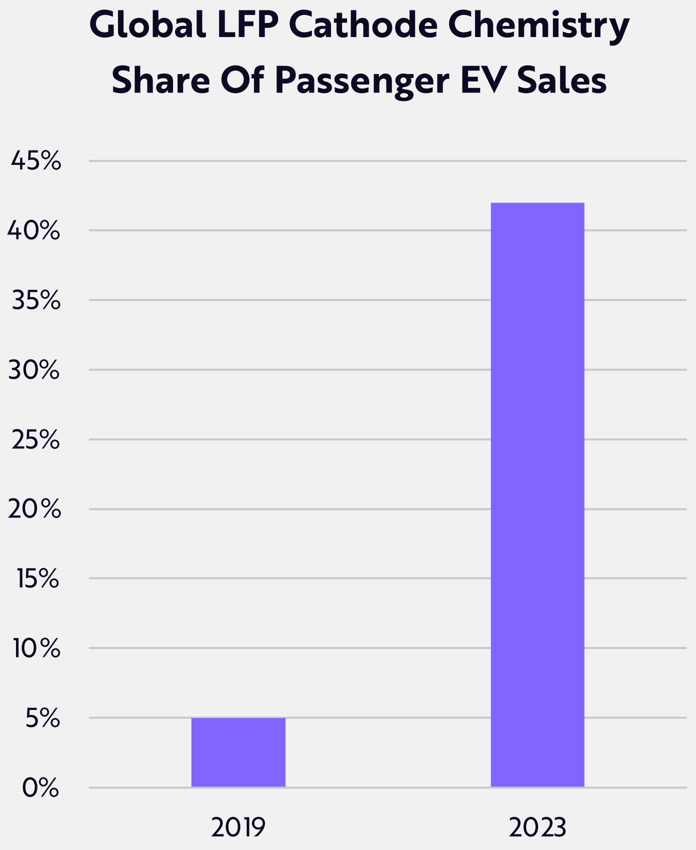


*BEV market share is calculated relative to all "light vehicles", which are vehicles with a maximum Gross Vehicle Weight Rating (GVWR) of < 8,500 lbs. Sources: ARK Investment Management LLC, 2024, based on data from EVVolumes.com 2023, Hawkins 2023, Mihalascu 2023, Shepardson & Klayman 2023, Rosevear 2023, Transport Policy 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.

Wright's Law Has Modeled The Decline In Battery Costs Accurately

According to Wright's Law, for every cumulative doubling in the number of kWh produced, battery costs will fall by 28%. Lithium iron phosphate (LFP) cells are taking share from nickel-rich cells, illustrating the difficulty of forecasting commodity prices as battery chemistries change over time.

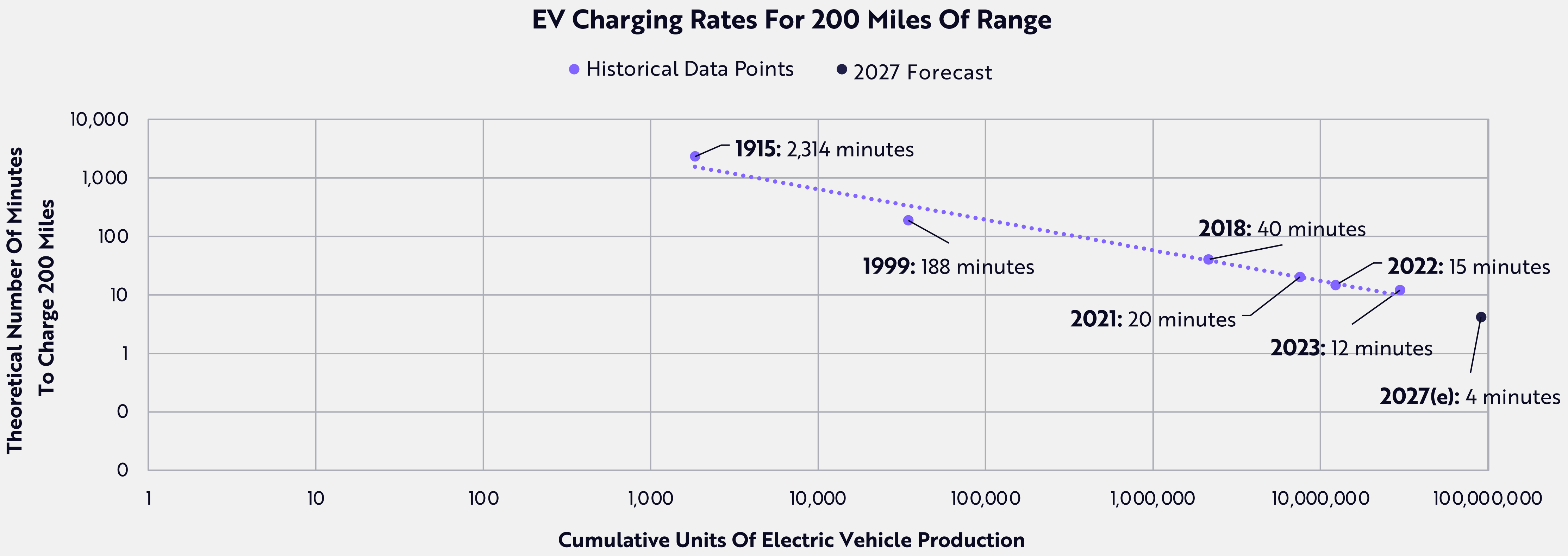




*Combination of modeled and historical data. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Bloomberg New Energy Finance 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied 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 Points To Faster EV Charging Rates

The EV charging rate seems to be a good proxy for overall performance, including efficiency, range, and power. In the past five years, charging rates for 200 miles of range have improved nearly three-fold, from 40 minutes to 12, and could drop another three-fold to 4 minutes over the next five years. As EV charging reaches acceptable rates, manufacturers are likely to optimize for other features, including autonomous driving, safety, and entertainment.



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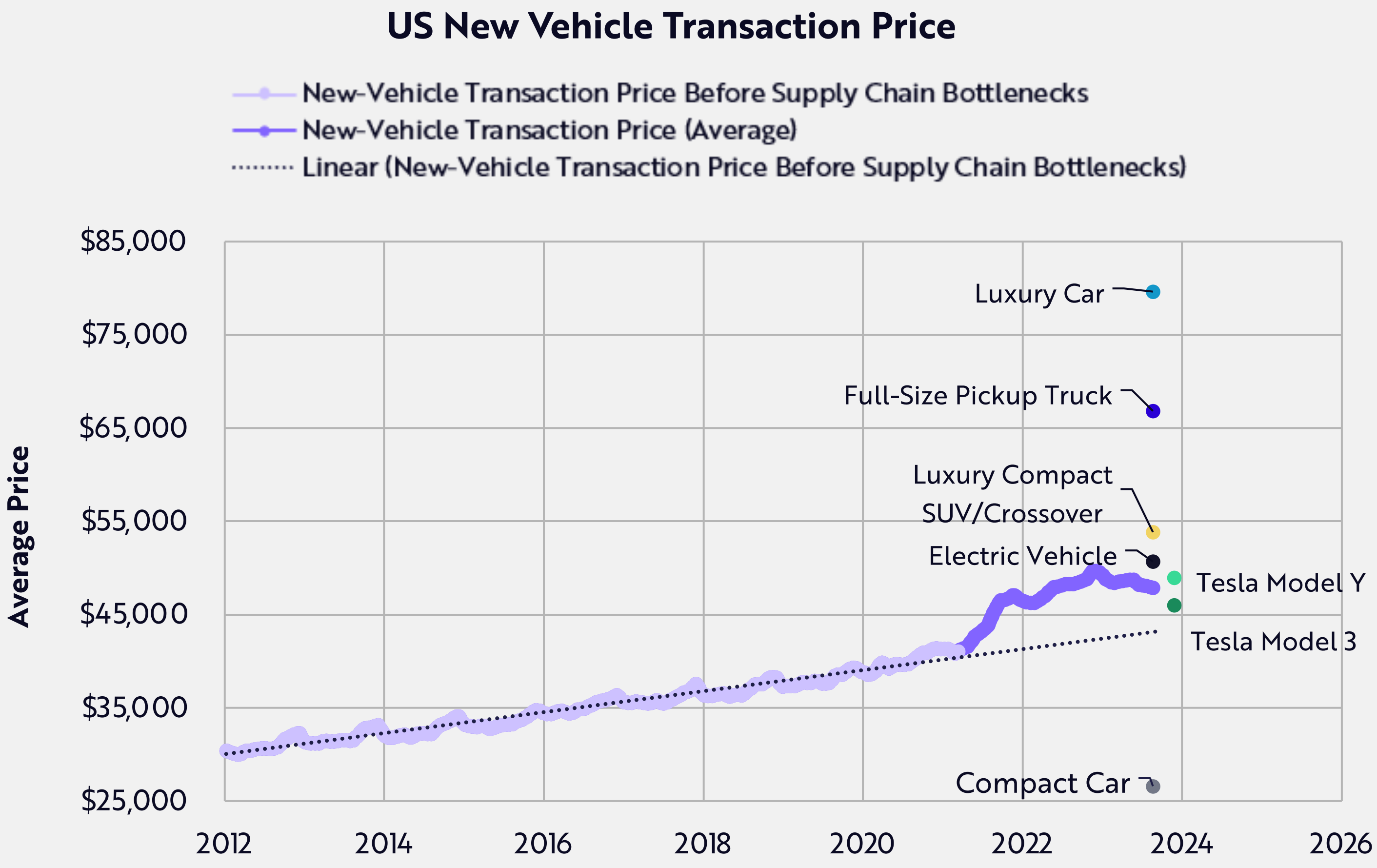
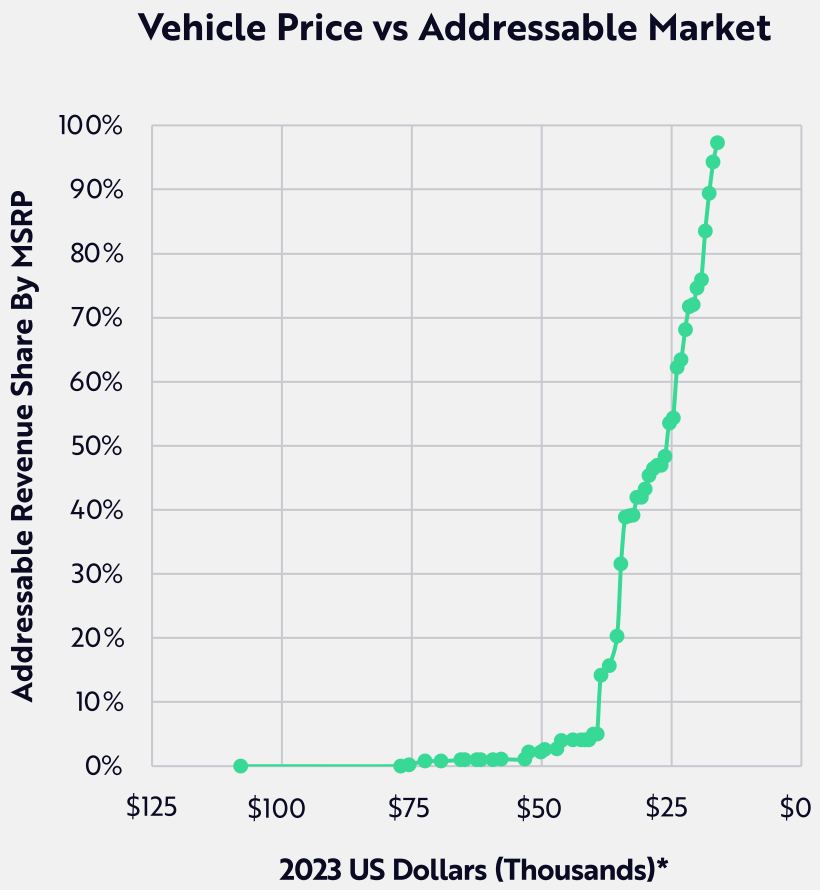
ELECTRIC VEHICLES

EVs Have Hit Price-Parity With Internal Combustion Engine Vehicles

As battery costs continue to decline, EV prices should fall, potentially driving exponential growth in unit sales.





*Older data points adjusted to 2023 dollars using CPI. Segment average transaction prices are as of September 2023 as reported by Cox Automotive. Tesla Model Y LR price taken from Tesla website as of December 2023. Sources: ARK Investment Management LLC, 2024, based on data from Cox Automotive 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.

Research By:

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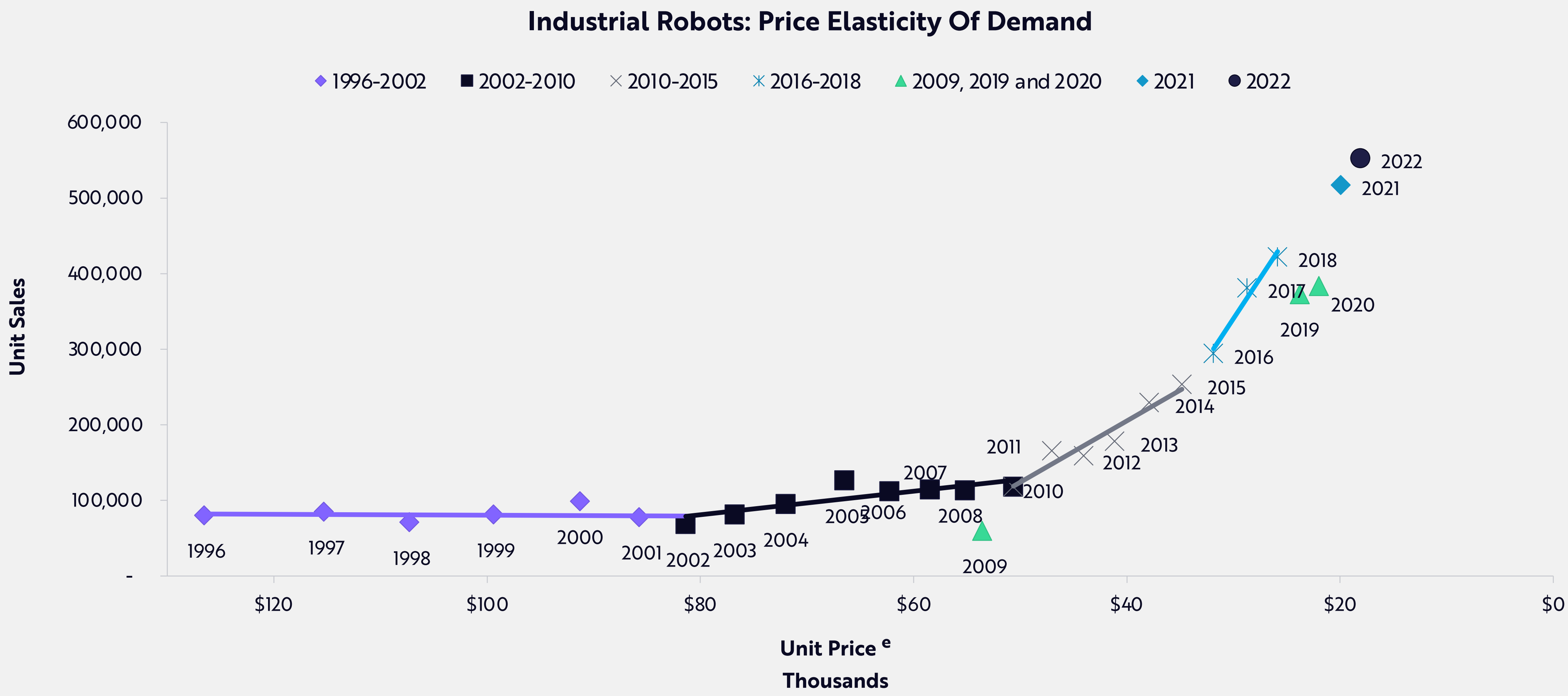
Robotics

Generalizing Automation Thanks To The Convergence Of AI Software And Hardware

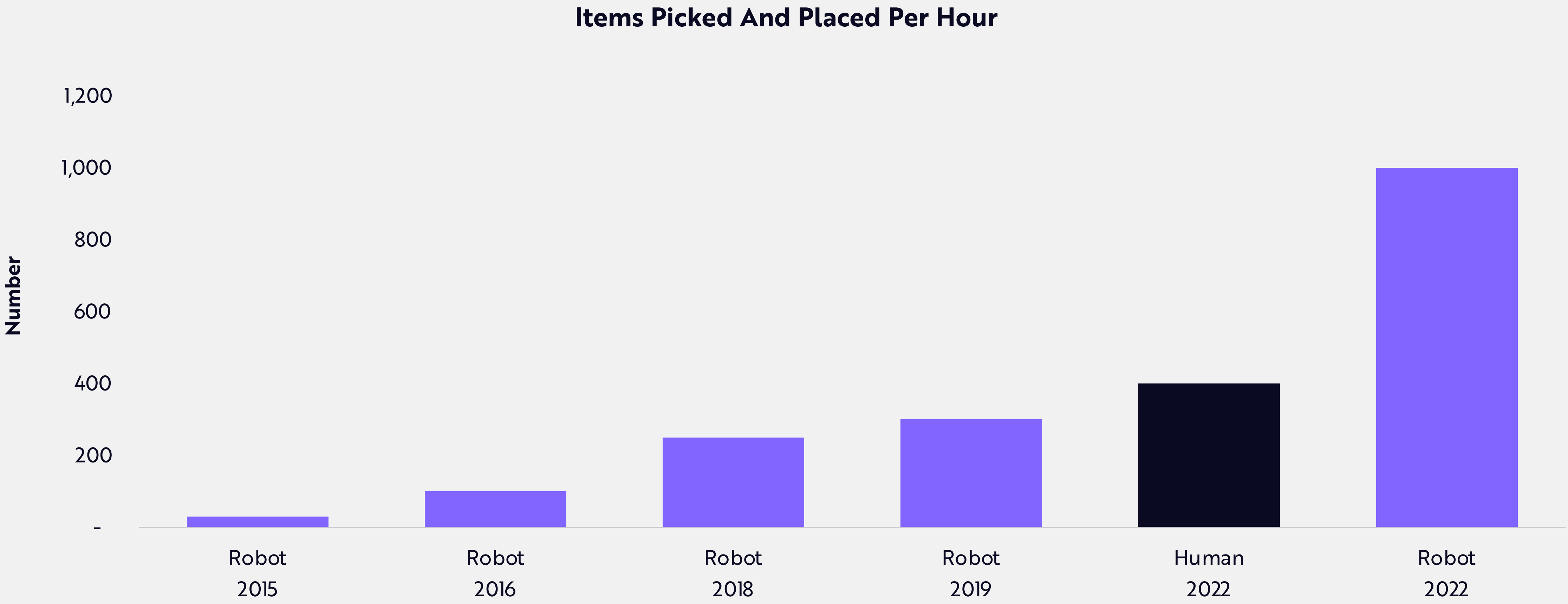
Lower Prices Are Stimulating Demand For Industrial Robots

Industrial robot costs have been dropping 50% for every cumulative doubling in production.



Increased Performance Is Stimulating Demand For Industrial Robots

Advances in computer vision and deep learning have improved robot performance 33-fold in seven years. Robots are already surpassing human performance by greater than a factor of two and it's unclear where the upper limit will be.



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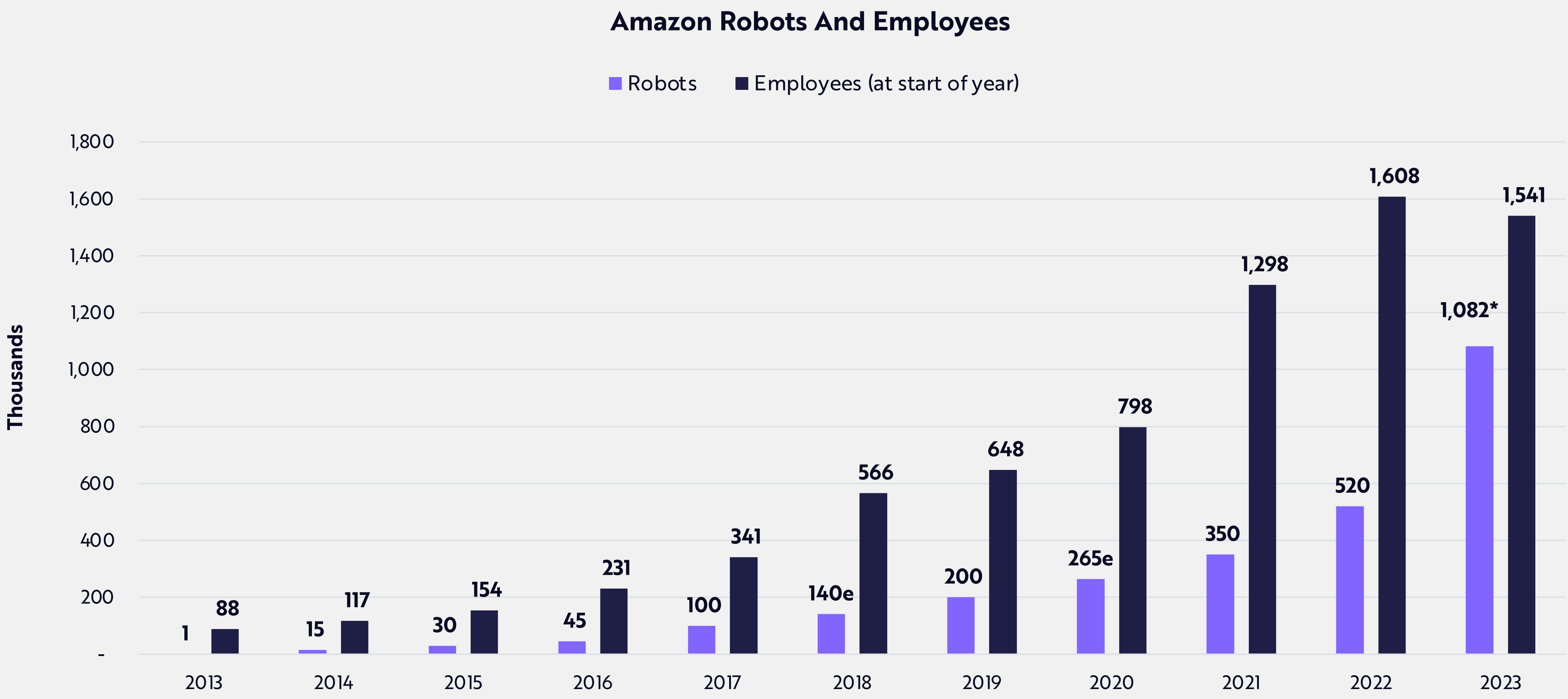
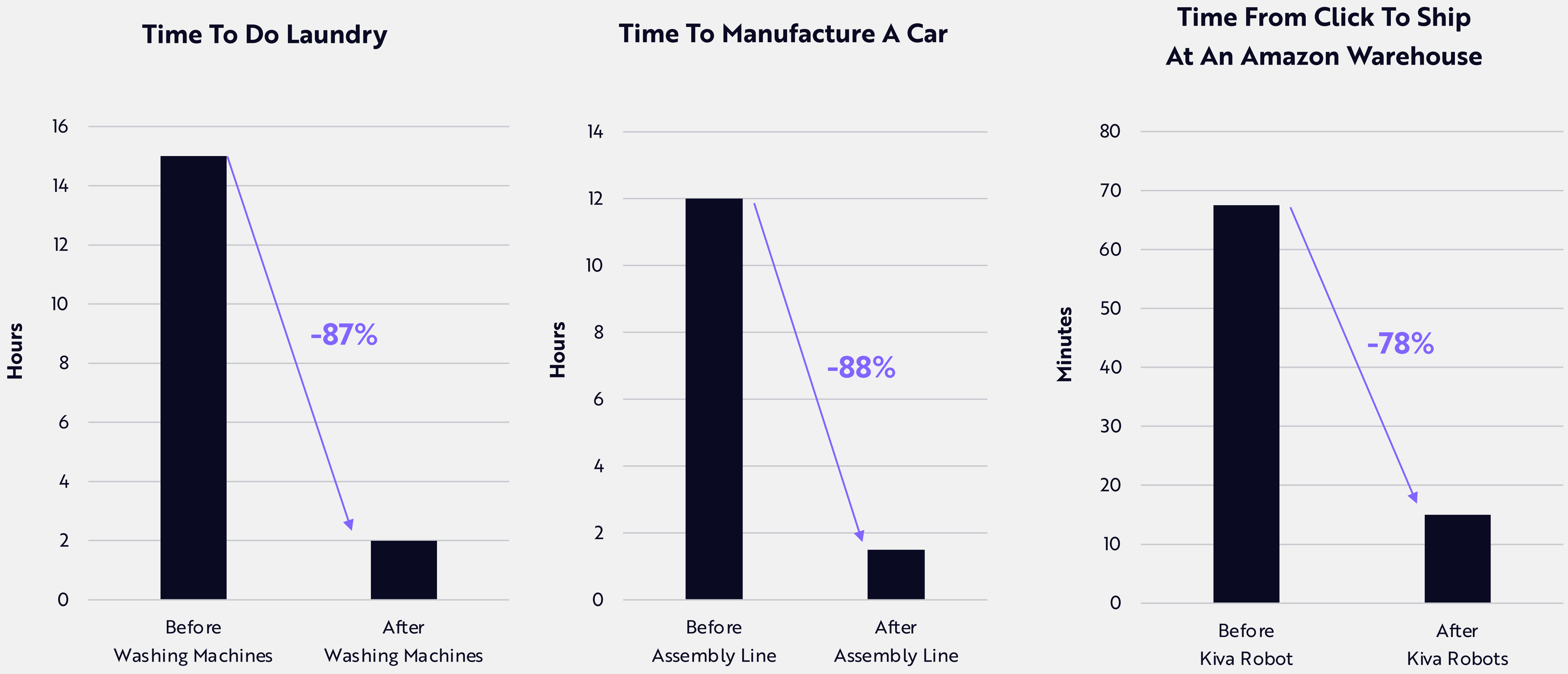
Many Companies Are Likely To Deploy More Robots Than Humans

Robots are freeing humans from tedious physical tasks.



*Modeled/annualized. Figures denoted with an "e" are ARK estimates. Sources: ARK Investment Management LLC, based on data from Amazon 2023 as of June 26, 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.

Automation's Impact On Productivity Has Transformed Industries



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Research By:

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& Institutional Strategies

Daniel Maguire, ACA
Research Associate

Robotaxis

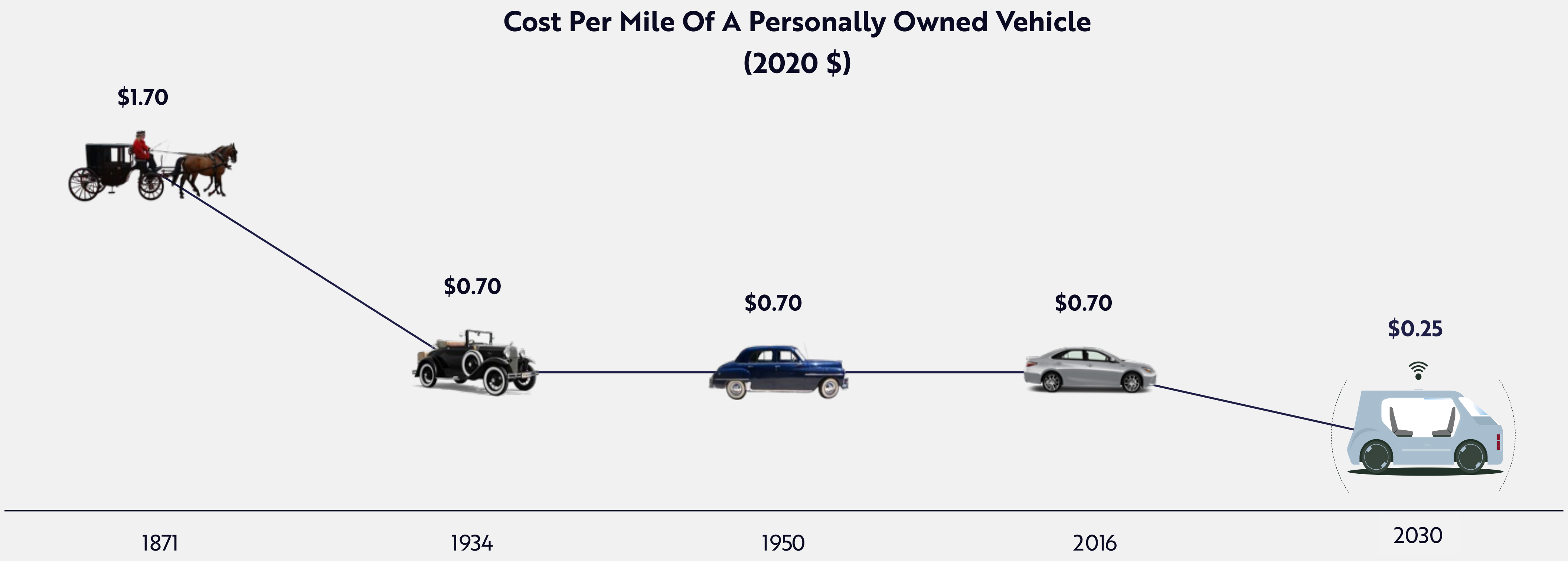
Transforming Urban Transit Safely And Affordably

Thanks to breakthroughs in AI, robotaxis are beginning to revolutionize urban travel and could accelerate the unraveling of the auto loan sector.

Safer than human drivers, robotaxis hold the promise of safer and cleaner streets. Robotaxi platform pioneers should enjoy the higher prices associated with early adoption.

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 more than 100 years ago. ARK estimates that autonomous taxis at scale could cost consumers as little as $0.25 per mile, spurring widespread adoption.



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Autonomous Vehicles Are Safer Than Human-Driven Vehicles

In 2015, ARK estimated that the rate of autonomous vehicle accidents would be ~80% lower than that associated with human drivers, reducing the ~40,000 auto-related fatalities per year in the US and the ~1.35 million globally. Current data support our original estimates.

In full self driving (FSD) mode on surface streets, a Tesla appears to be ~5x safer than a Tesla in manual mode, and ~16x safer than the national average. Waymo's autonomous cars are ~2-3x safer than the national average, while Cruise—now sidelined by regulators—seems to have underperformed the national average considerably.

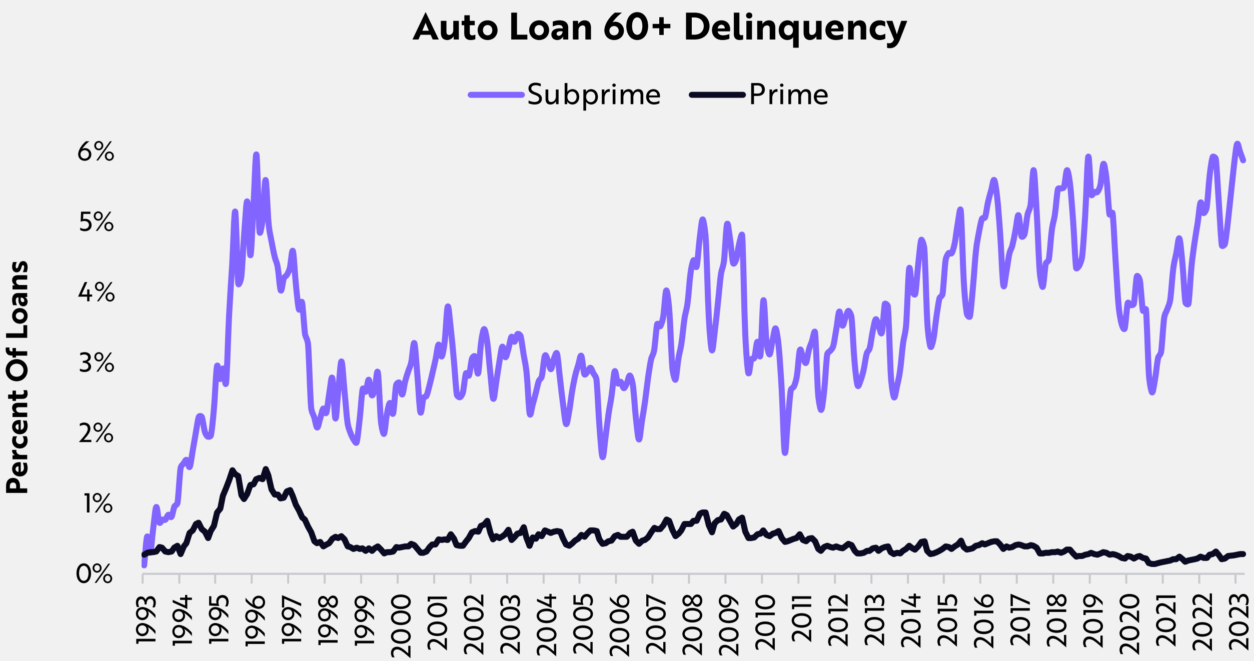
Miles Between Crashes On Surface Streets Only (Thousands)

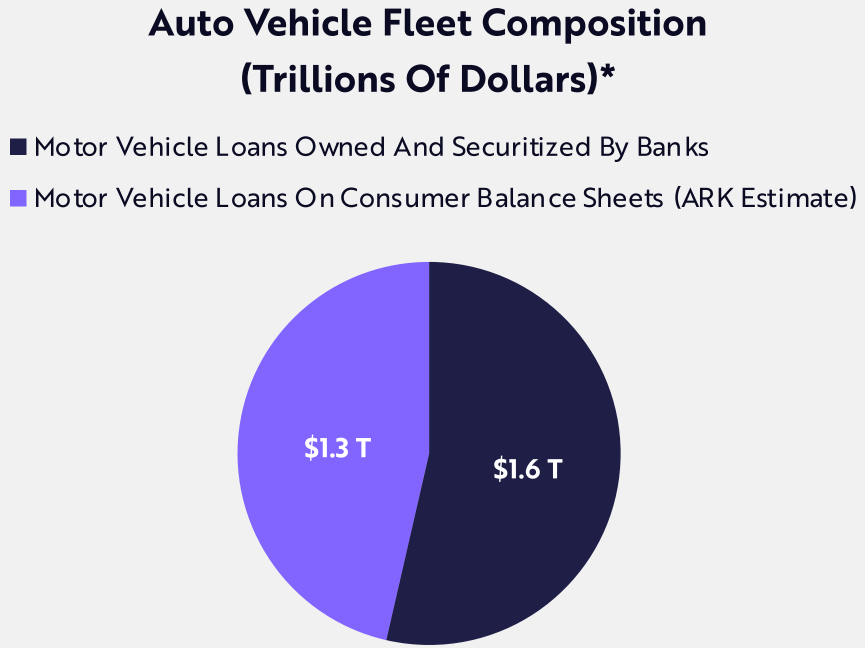
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including CDC 2024, Kusano 2023, NHTSA 2023, Tesla 2023, 2024, and Zhang, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. 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 Electric Vehicle Adoption Could Disrupt The US Auto Loan Industry

During the past three years, interest rate hikes have increased new vehicle monthly car loan payments by ~27%, from $581 to $739. As a result, the number of subprime auto loans delinquent by 60+ days recently hit an all-time high.

Thanks to Wright's Law, EV prices should continue to fall, shifting more miles onto electric platforms and decreasing the value of gas-powered vehicles. As a result, the ~$1.6 trillion in auto loans currently sitting on financial institution balance sheets, issued predominantly for gas-powered vehicles, could be at risk over the next 10 years.





Note: Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. *Motor Vehicle Loans Owned and Securitized data as of Q3 2023. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, as of January 3, 2024, which may be provided upon request. 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.

Research By:

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Daniel Maguire, ACA
Research Associate

Autonomous Logistics

Reducing Costs And Reshaping Supply Chains

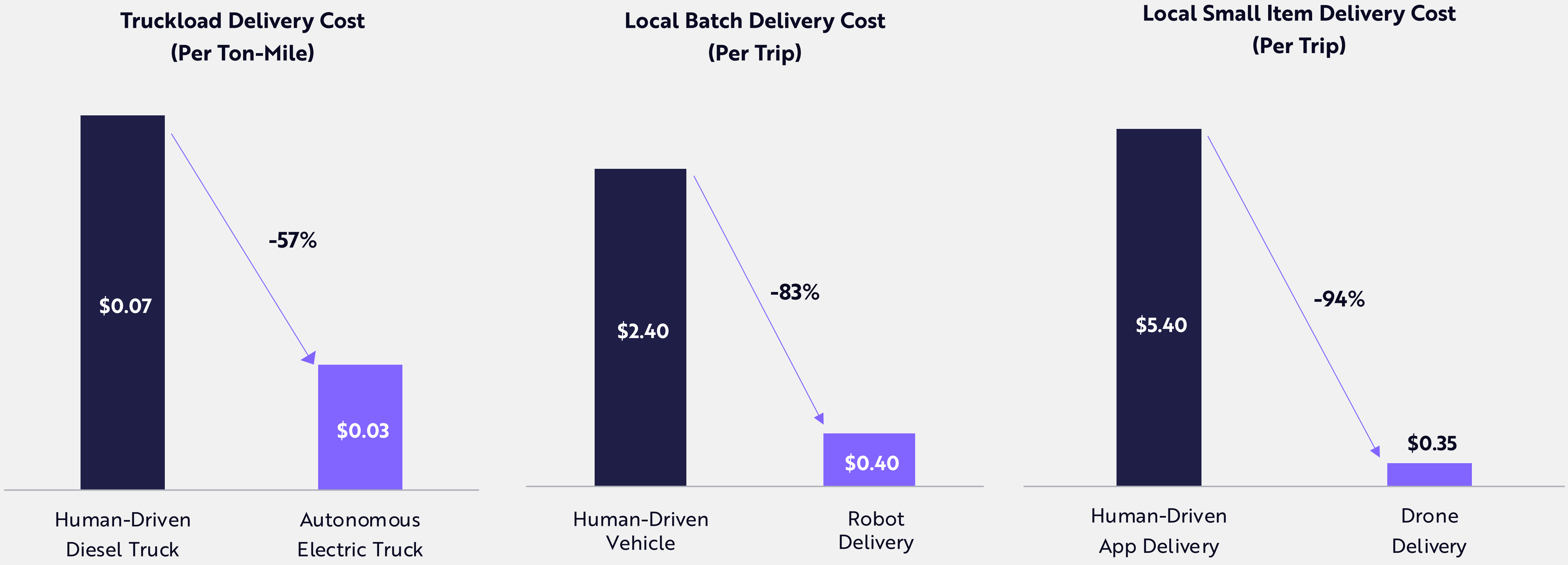
Autonomous logistics should reduce the cost of moving goods by 15-fold during the next five to ten years. Autonomous drones and robots have made millions of deliveries, while autonomous trucking companies have logged tens of millions of miles and are beginning to remove safety drivers.

AI is proving superior to human pilots and drivers, encouraging regulators to allow truly autonomous operations that will change shopping behavior.

Autonomous vehicles should impact health care by accelerating the delivery of life-saving supplies, particularly in emerging markets.

Autonomous Vehicles That Roll And Fly Could Lower Supply Chain Costs Dramatically

According to our research, autonomous vehicles should operate at higher utilization rates than human-in-the-loop systems, creating more cost-effective last-mile delivery systems.



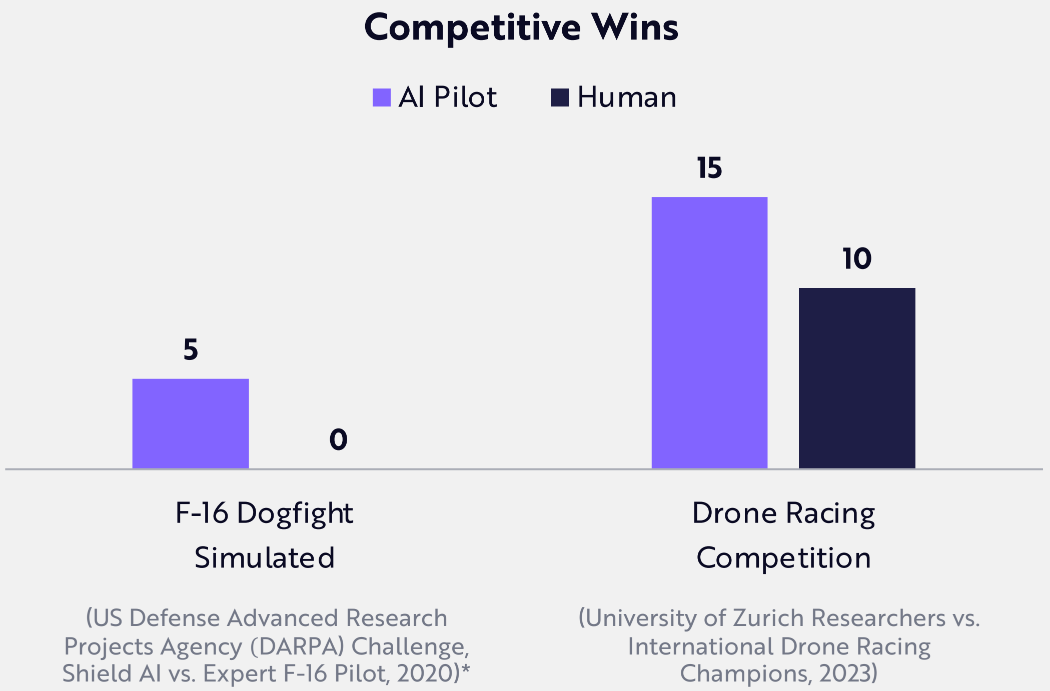
Note: Drone price per mile has been updated with our latest assumptions for replacement costs, launching and charging infrastructure, insurance, and labor costs. Fees for drone and robot delivery are shown net of infrastructure costs (outside of charging and launch/land), which we believe could either be born by the drone or robot delivery operators or shared with logistics or retail partners. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. 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.

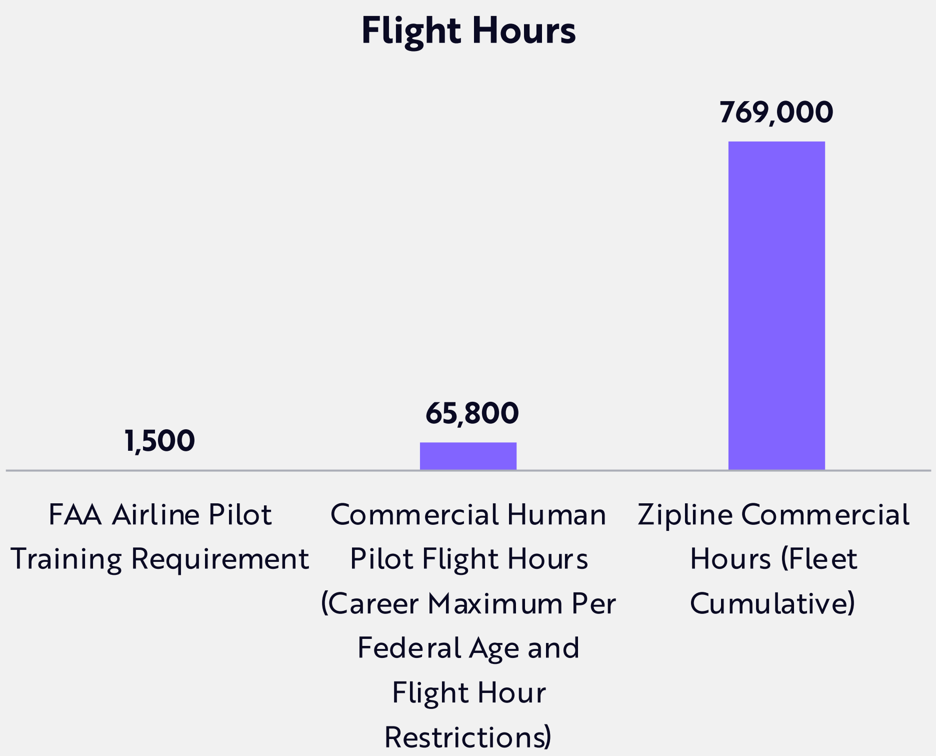
AI Pilot Performance Seems Superior To That Of Human Pilots

AI pilots have immense data advantages over humans. Zipline drones have logged more commercial flight miles than would have been possible by humans.

In head-to-head simulated F-16 dogfights with a human expert fighter pilot, Shield AI won 5-0.*

In drone races, AI trained by deep reinforcement learning outperformed professional human pilots 15 out of 25 times, with lap times ~10% faster.



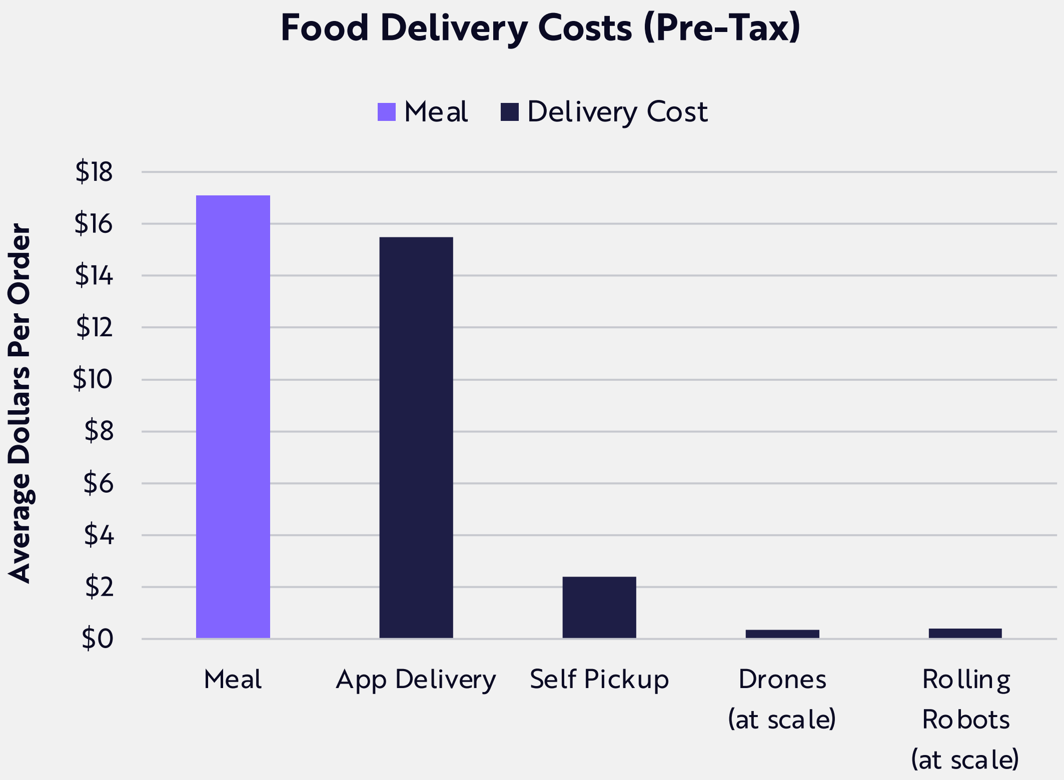


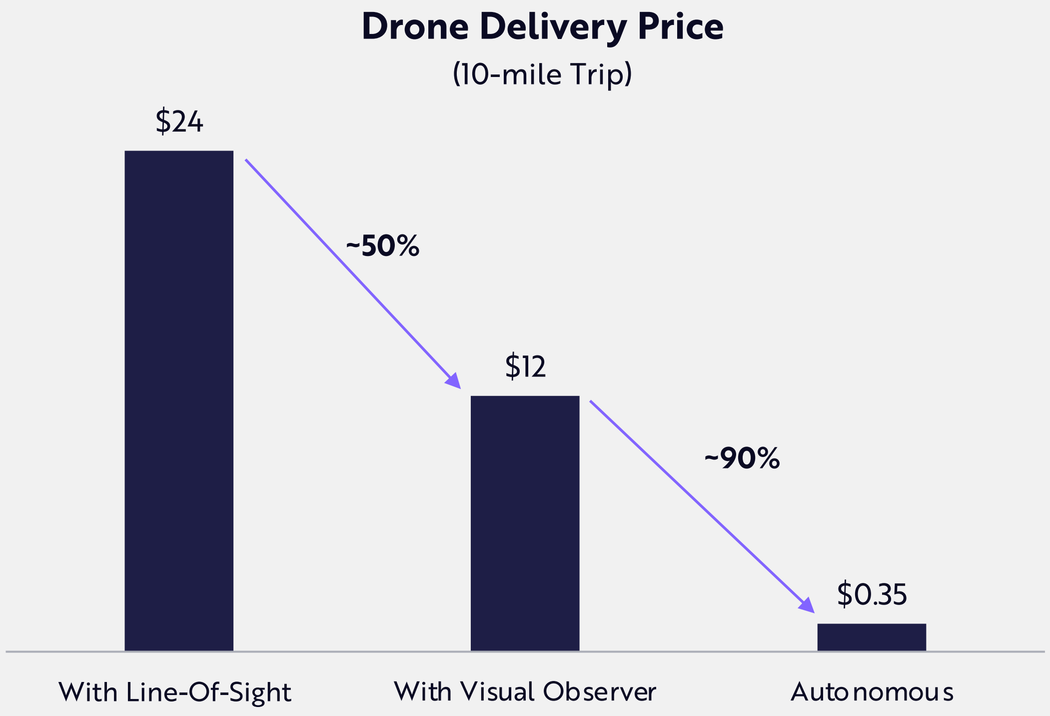
*Note: Heron Systems, now part of Shield AI, won the dogfight. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Numbers are rounded. Forecasts are inherently limited and cannot 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 Drones Should Reduce Food Delivery Costs, Thanks To Regulatory Approvals

Boosted during and after COVID, food delivery fees have doubled the average cost of baseline menu orders.

Beyond line-of-sight drones without visual observers should reduce food delivery costs dramatically, thanks to recent FAA approvals.

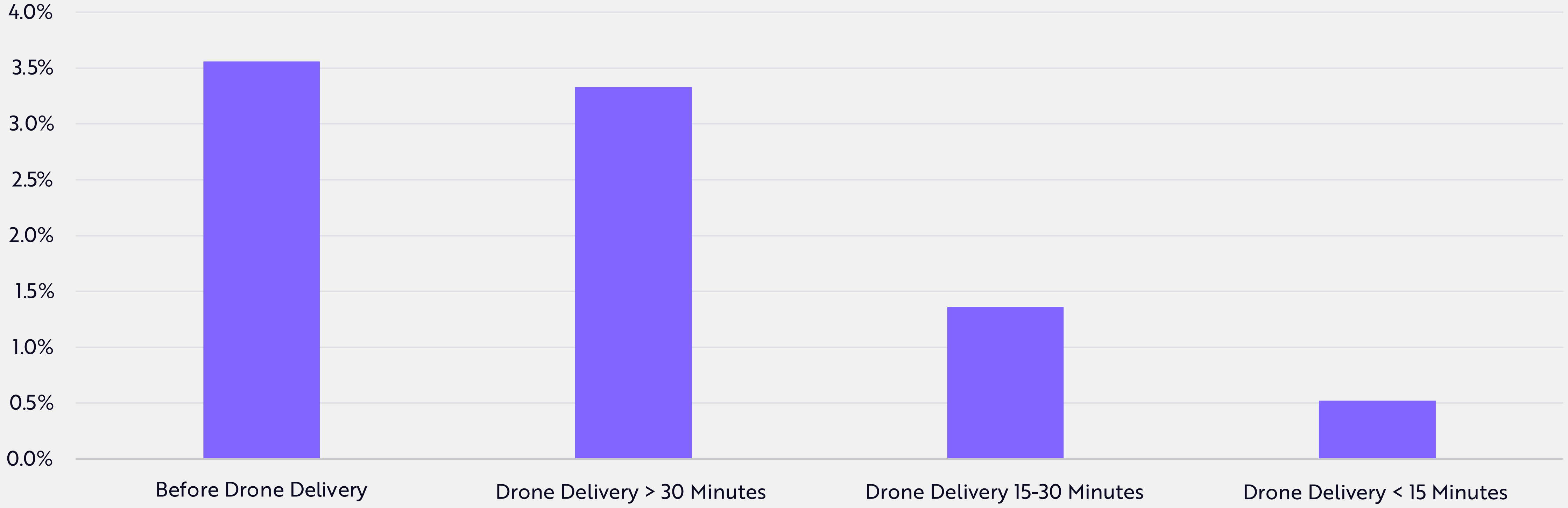




Drones Are Saving Lives

In geographies without road infrastructure, Zipline drones can deliver blood in fewer than 15 minutes, improving the mortality associated with post-partum hemorrhages by 80%.

Postpartum Hemorrhage Mortality Rate
Before And After Drone Delivery Of Blood Transfusions In Rwanda



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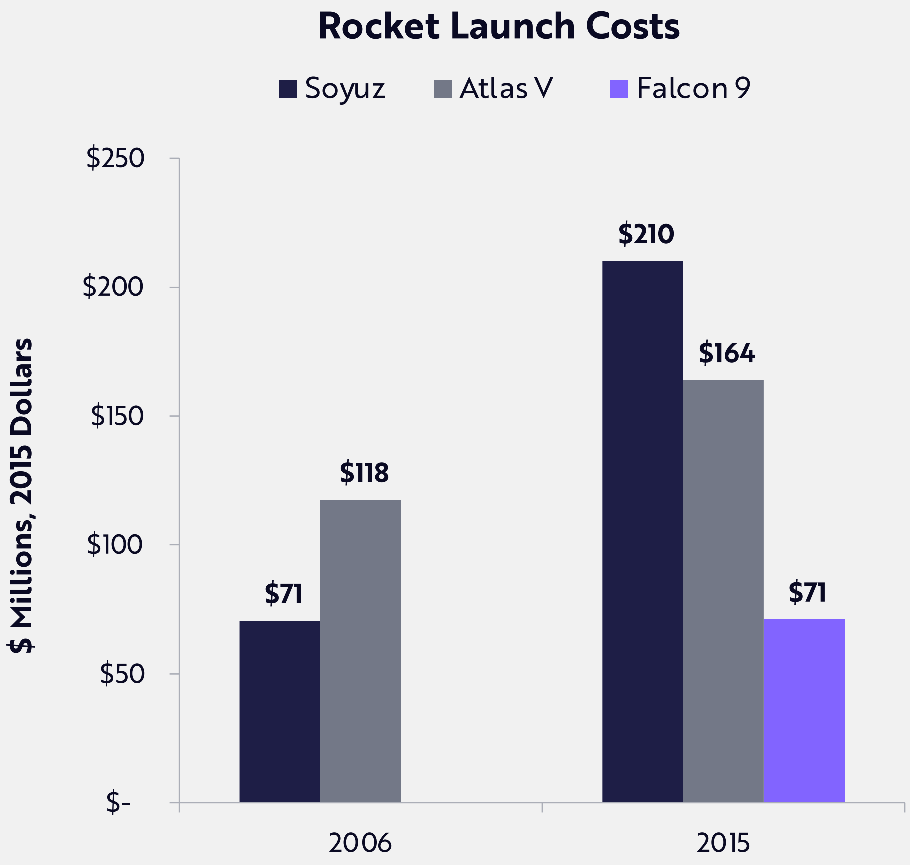
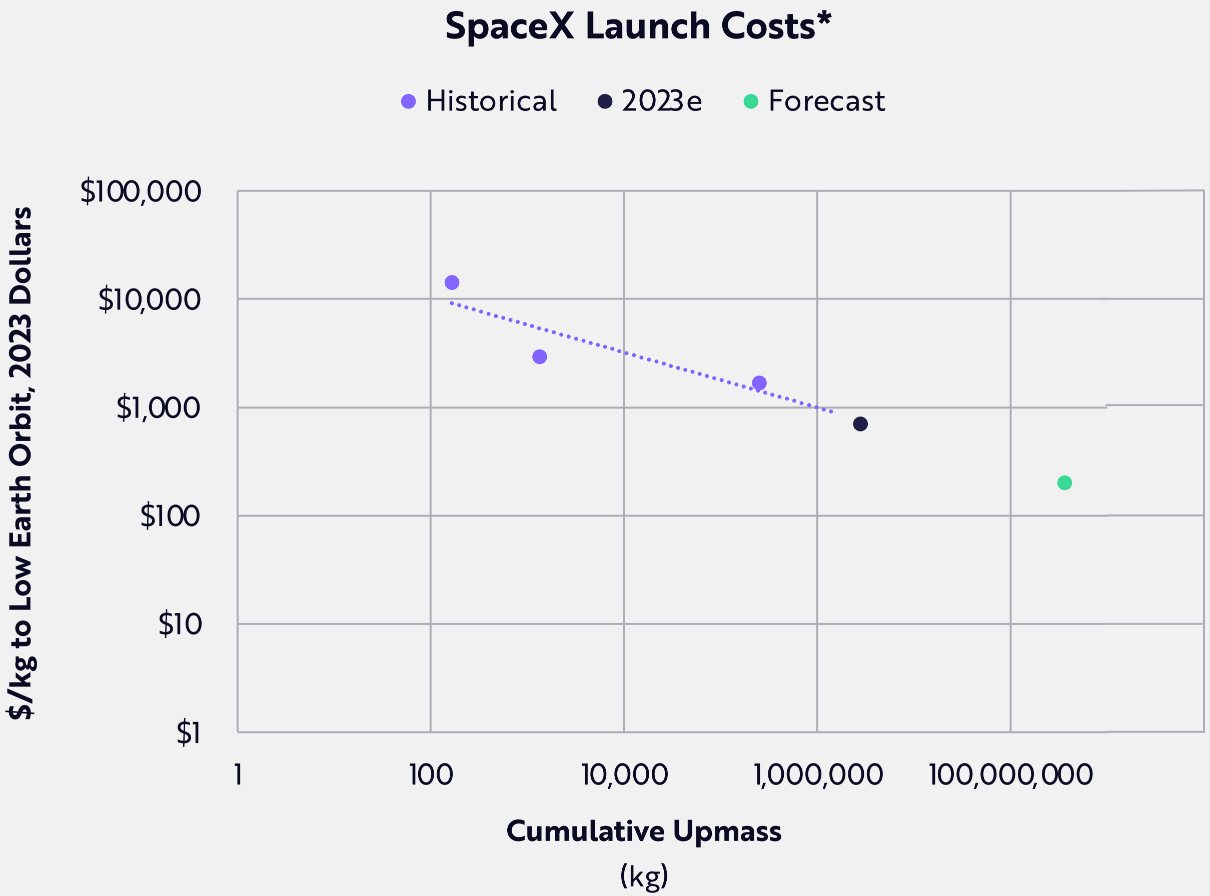
Reusable Rockets

Opening Outer Space For Business

Reusable Rockets Should Lower Launch Costs By An Order Of Magnitude...Or Two!

SpaceX's reusable rocket, Falcon 9, put an end to soaring launch costs. By reusing one Falcon 9 booster 19 times, SpaceX increased its annual launch cadence nearly 60% to 96 in 2023.



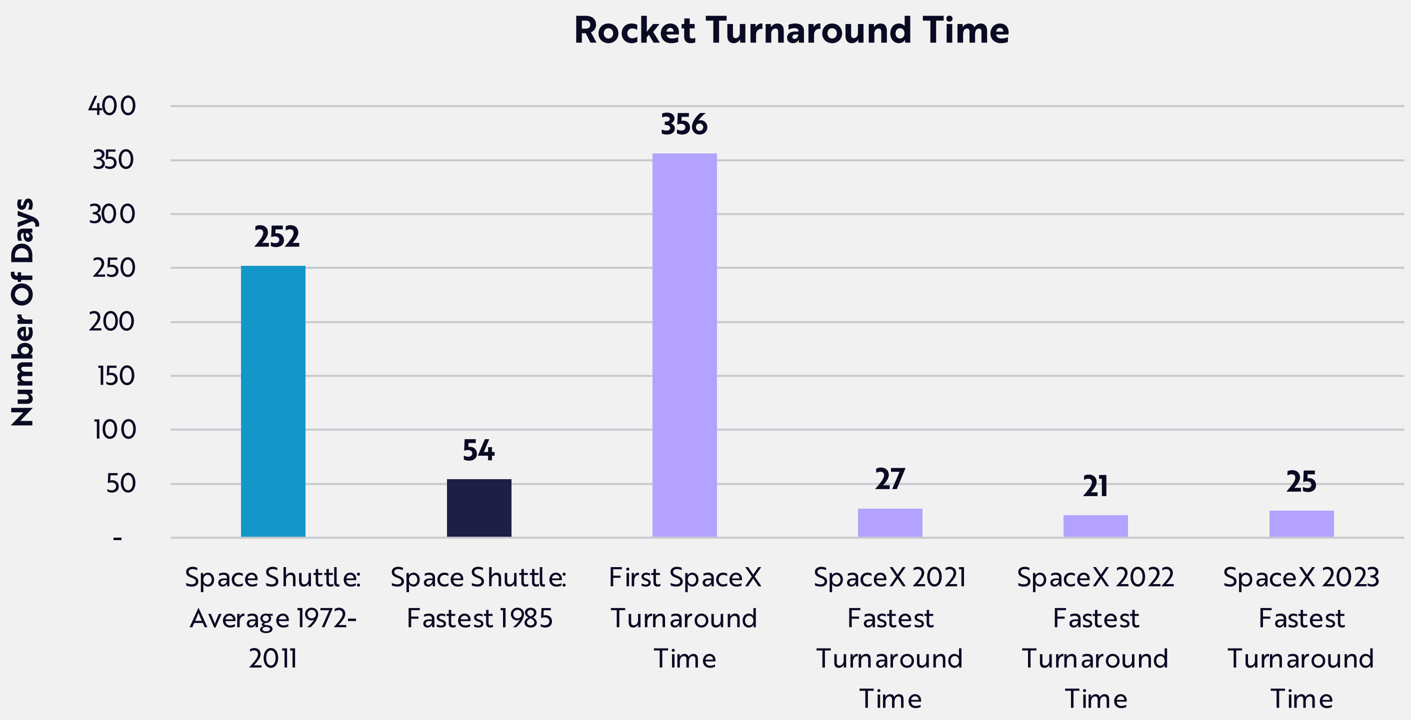


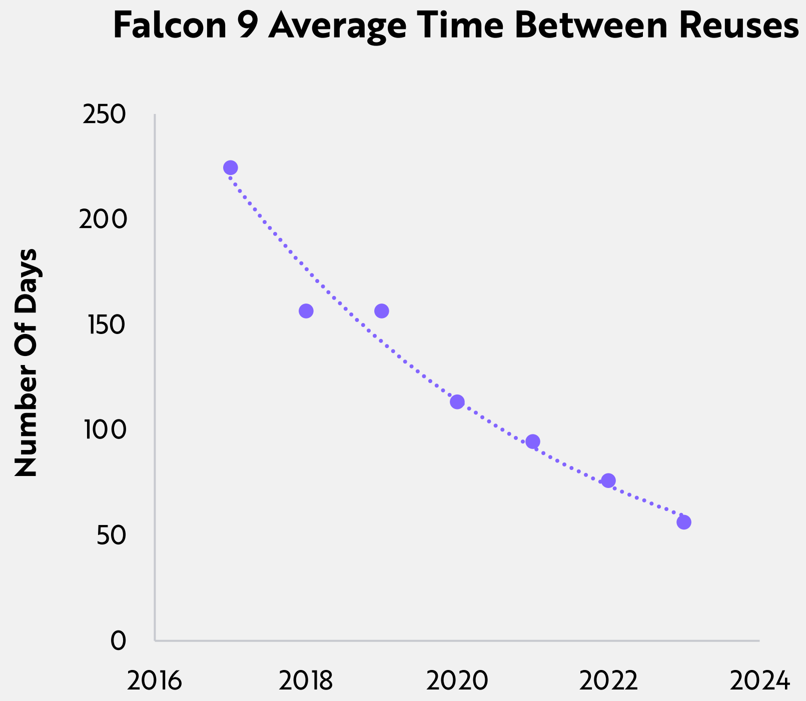
*Forecast timeline dependent on the speed of development of SpaceX's Starship. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. 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

When the Space Shuttle cost ~$1.5 billion per launch, industry experts assumed that a reusable rocket would be impossible economically. SpaceX then flipped the script.

According to ARK's research, the first stage of the Falcon 9 cost <$1 million to refurbish. Now, rocket turnaround time should be proportional to the cost required to refurbish a rocket booster, the key metric in tracking launch cost declines.

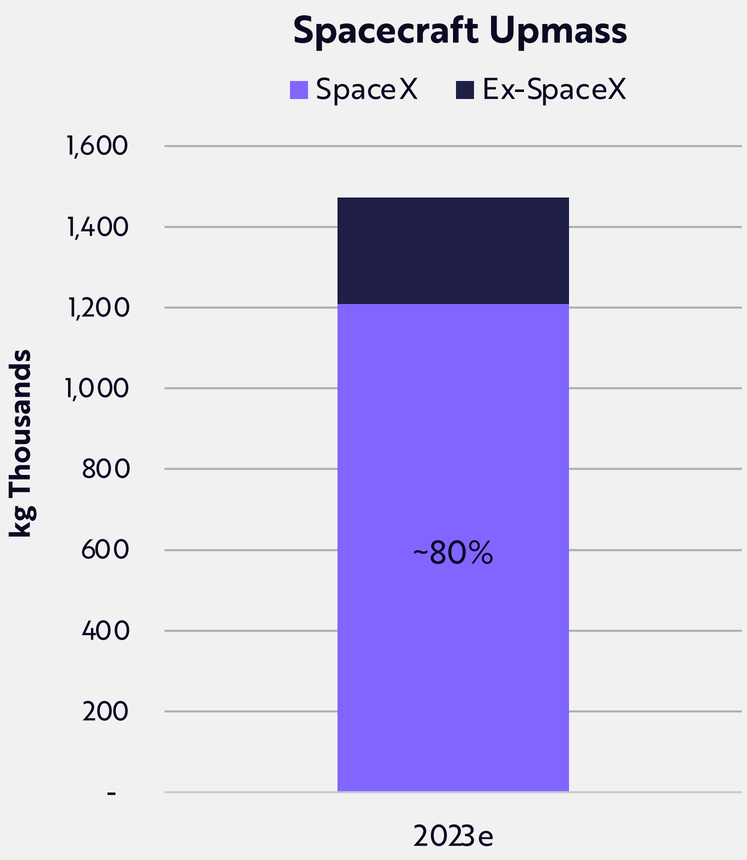


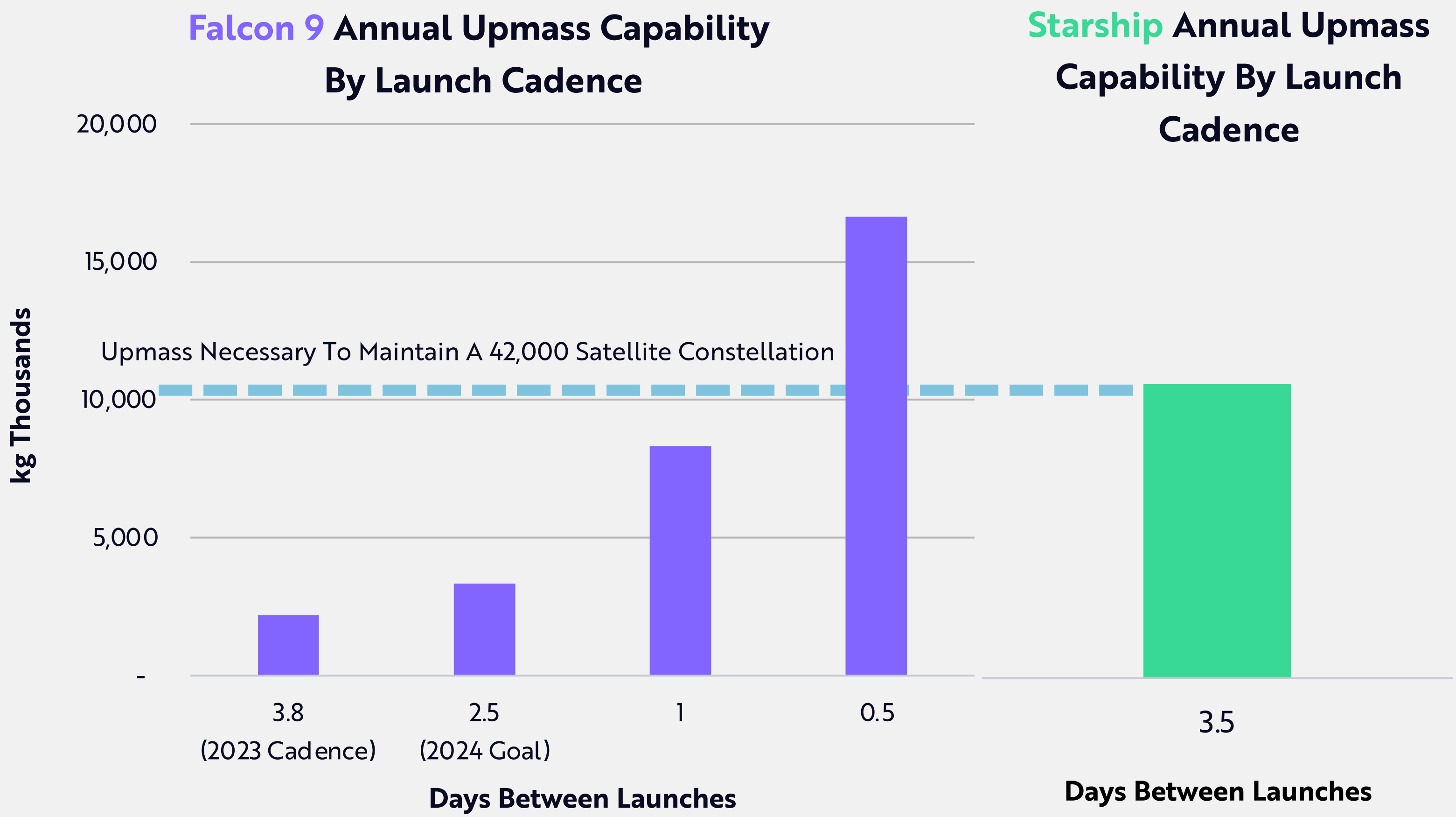


Sources: ARK Investment Management LLC, 2024, based on data from NASA 2023 and SpaceX 2023a, 2023b as of December 11, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Starship Will Help The Starlink Constellation Achieve Its Potential

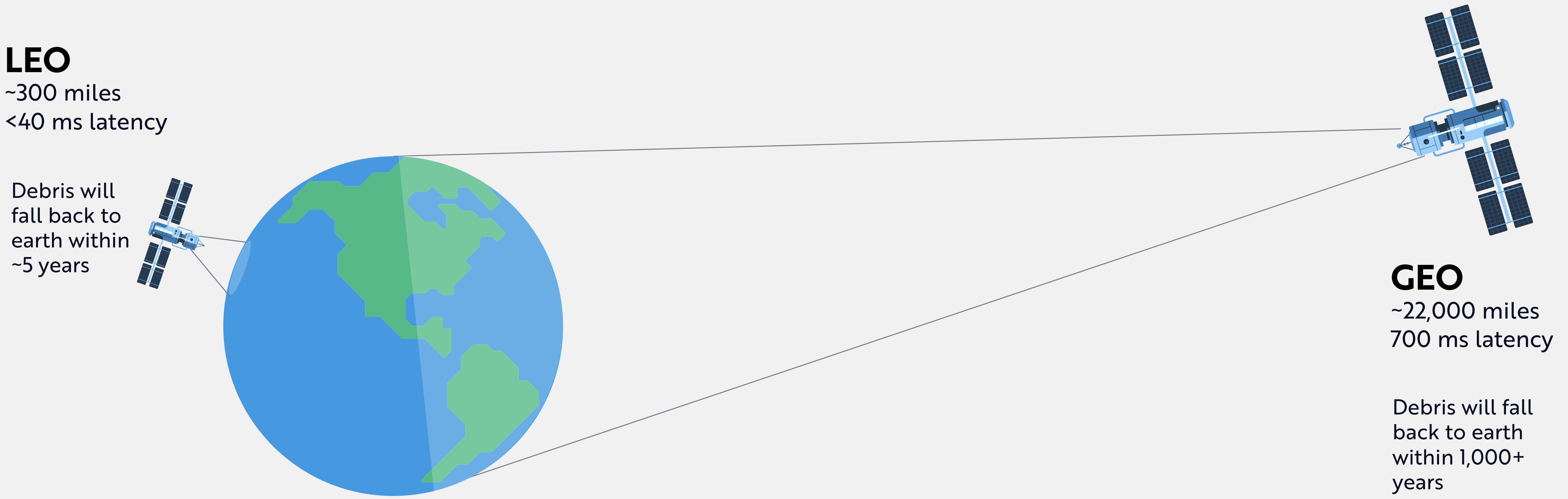
Starship's payload capacity to LEO is ~5x that of the Falcon 9. While impressive, given the five-year life of its satellites, Starship still will have to fly every 3.5 days to maintain its target constellation of 42,000 Starlink satellites. As of January 2024, SpaceX has a constellation of ~5,400 satellites.





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

While latency precluded geostationary orbit (GEO) satellites from offering a compelling broadband internet solution, now thousands of low-cost, low earth orbit (LEO) satellites can provide service with low latency, continuous global coverage, and direct-to-mobile device connectivity.



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3D Printing

Reshaping Manufacturing

In automotive manufacturing, 3D printing has lowered both the part count and the product development timeline dramatically. As a result, automakers can carry less inventory and save on tooling costs.

In healthcare, 3D printing is making novel surgeries possible with customized guides, tools, and implants.

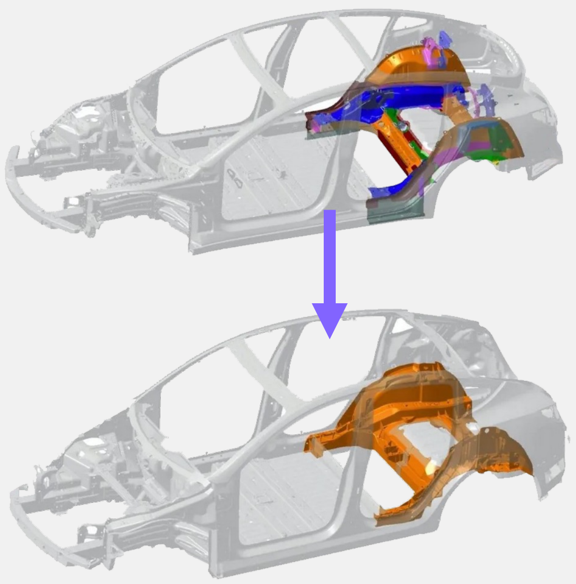
3D printing also should provide positive environmental benefits relative to traditional manufacturing.

Thus far, companies using 3D printing have benefited more than the 3D printing equipment manufacturers. In the future, data feedback loops could change that dynamic.

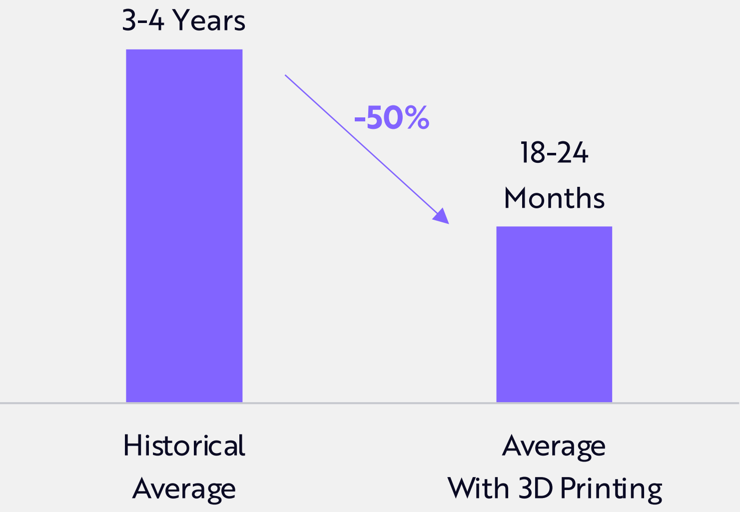
Thanks To 3D Printing, Automotive Production Has Entered Unchartered Territory

Reportedly, Tesla is experimenting with 3D printed sand molds to cast auto underbodies that could substitute one part for 400 parts, lowering automotive development timelines and mold design validation costs by 50% and 97%, respectively. 3D printing could play a role in the production of every car.

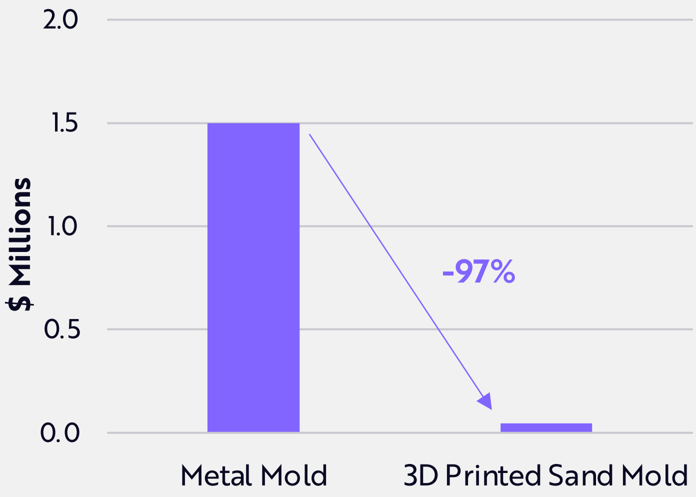
400 parts → 1 casting



Vehicle Development Time

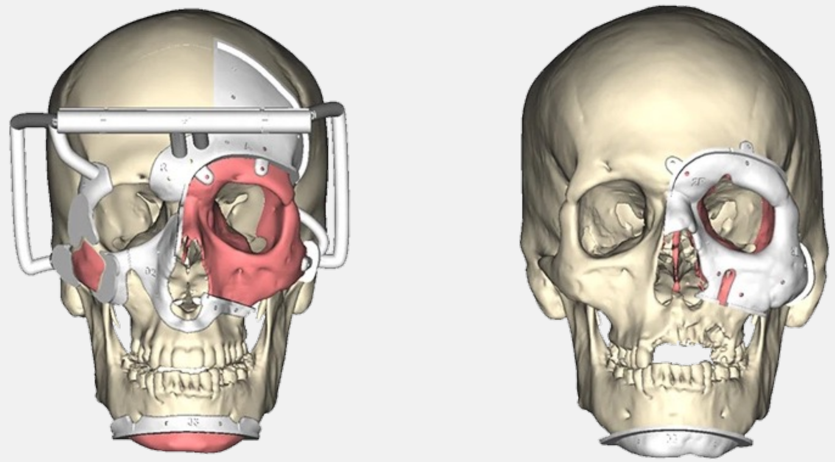


Design Validation Cost



3D Printing Has Played A Role In Medical Breakthroughs

In fewer than 24 hours after identifying the donor, Materialise 3D printed pivotal surgical tools and guides used in the world's first eye transplant. Speed to operation is critical to preserving donor tissue deprived of blood supply.

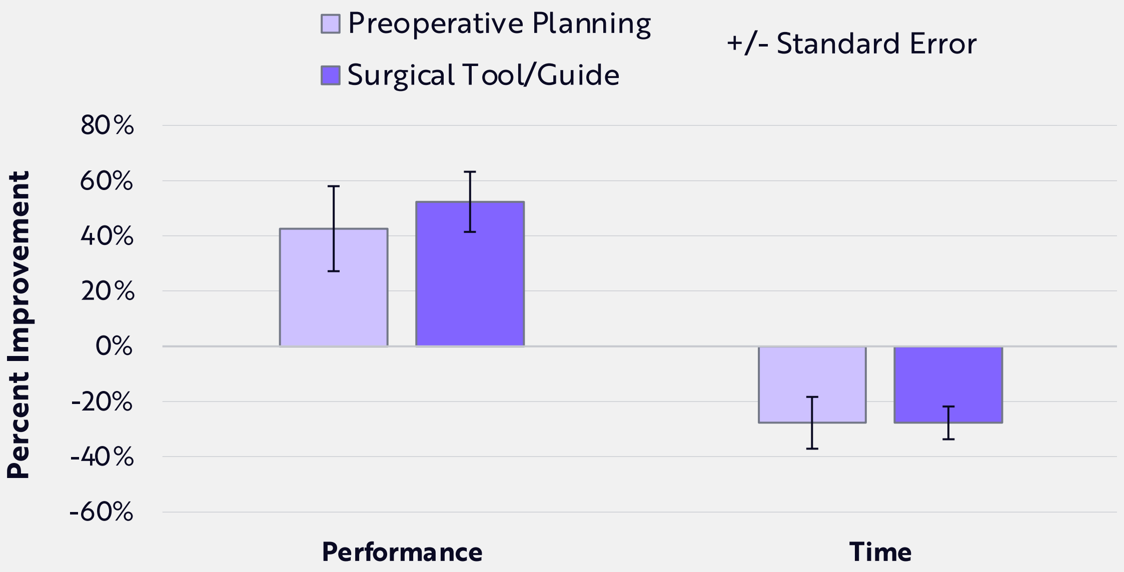


Donor

Patient

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

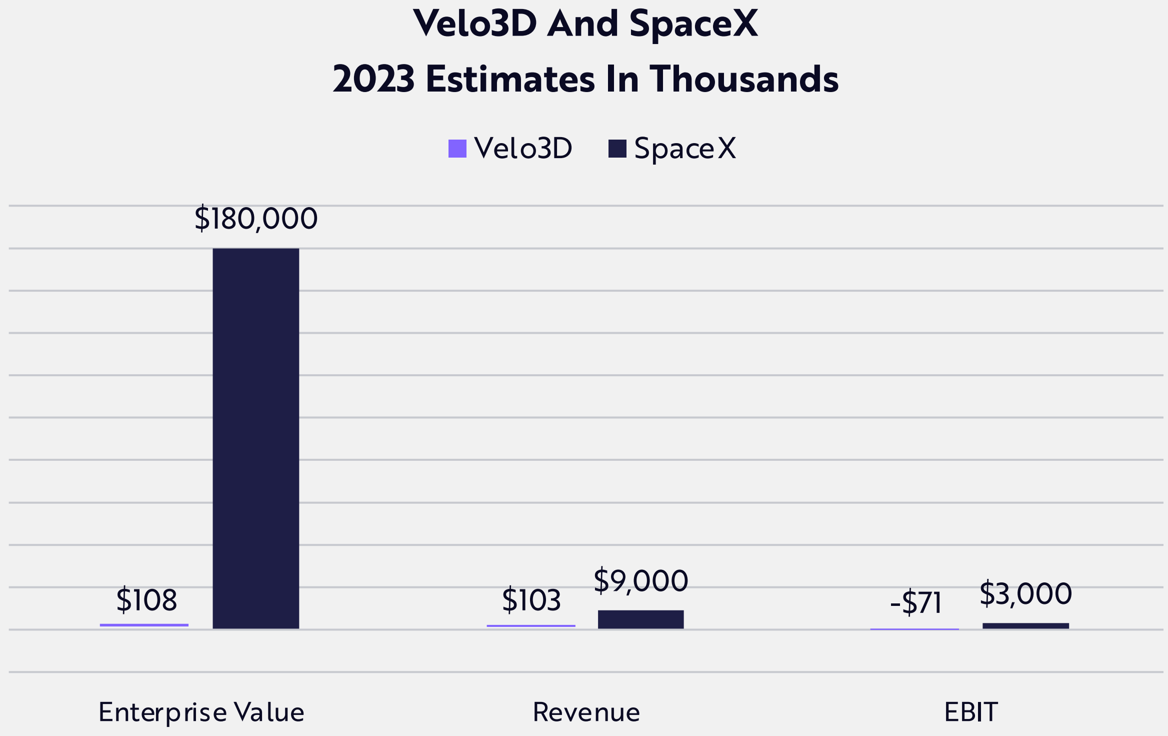
During Surgeries, 3D Printed Tools, Guides, and Models Shorten Time And Improve Accuracy



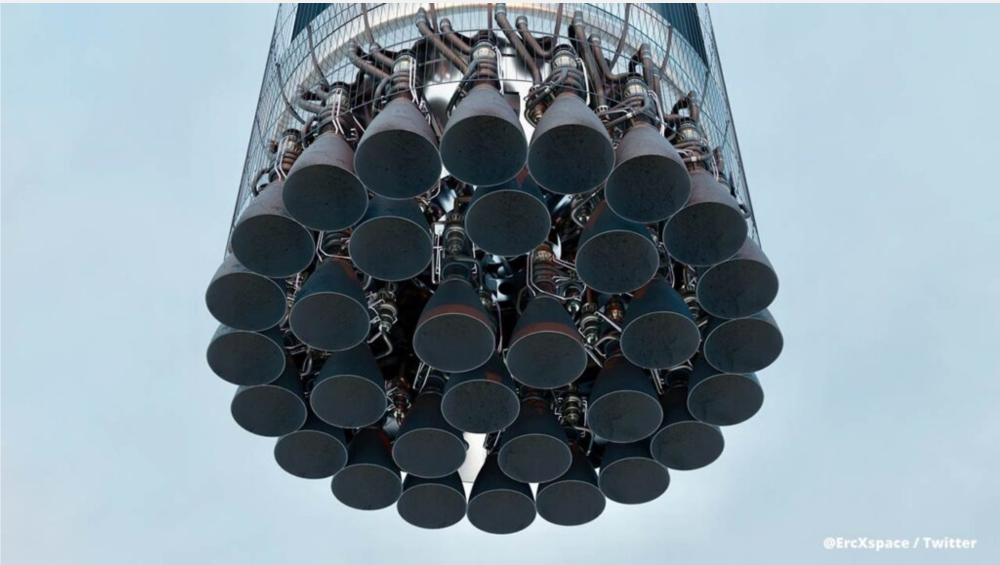
Note: Time Savings and Accuracy Improvements Provided by 3D Printed Surgical Guides and Preoperative Planning Aides: bars represent the average percent improvement in time or performance as described in Bergmann et al. 2017 and Woodard et al. 2019, N=6-9 for each sample group. Error bars represent +/-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

Thus Far, 3D Printing Has Benefited Users More Than Suppliers

SpaceX uses 3D printing every day to make parts for Starship's Raptor engines. Today, the operating margins of SpaceX's launch and satellite business are superior to those of any 3D printing supplier. Industrial companies benefiting from 3D printing could vertically integrate to sustain their competitive advantages.



A SpaceX Super Heavy Booster With 33 Raptor Engines:

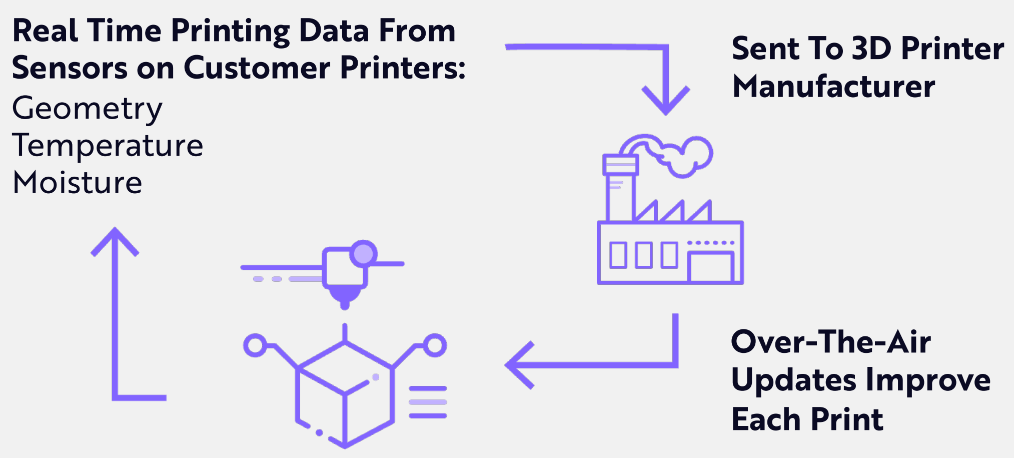


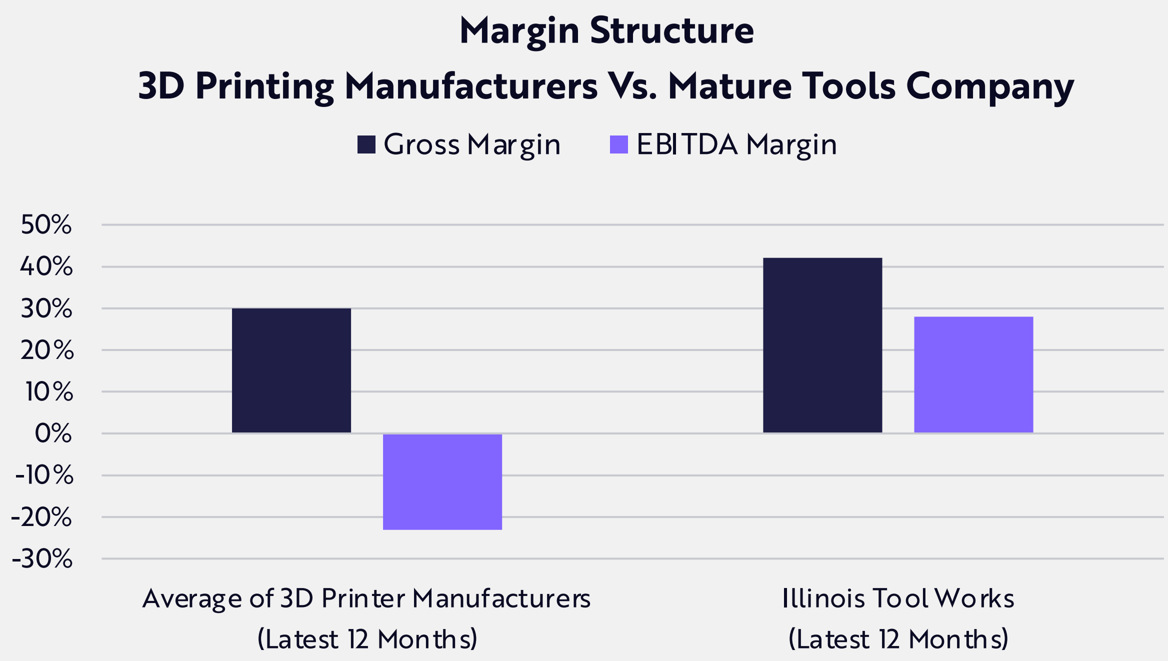
Velo3D is a 3D-printer manufacturer specializing in support-free powder bed fusion. Sources: ARK Investment Management LLC, 2024, based on data from S&P Capital IQ, 2024. SpaceX Heavy Booster Illustration sourced from Ali 2021. Forecasts are inherently limited and cannot be relied upon. For informational 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.

Software-Defined 3D Printers Could Shift Some Economics Back To Printer Manufacturers

With sensor-equipped 3D printers, 3D printing equipment manufacturers can collect data from customer print jobs and improve their fleets of printers in the field with over-the-air software updates. This data feedback loop could help 3D printing companies capture more economics than they do today.

While companies may be reluctant to share data, AI-enabled manufacturing solutions should create better outcomes for 3D printing equipment companies and their customers





EBITDA: Earnings before interest, taxes, depreciation, and amortization. Sources: ARK Investment Management LLC, 2024, based on data from S&P Capital IQ, 2024. 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.

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DISCLOSURE

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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.

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