

GLOBAL X MODEL PORTFOLIOS

INVESTING IN THEMATICS FROM A PM PERSPECTIVE

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INTRODUCTION

Expectations for technology are constantly changing. Just a decade ago, accessing the internet via a mobile device was clunky at best. Today, the slightest amount of buffering of HD video draws intense annoyance from smartphone users. As innovation begets innovation, the COVID-19 pandemic accelerated the adoption and use of important technologies spurring even more advancement. While the pandemic encouraged a step up in use, we think of this overarching trend as the continued shift from [Innovation to Utility](#), where new technologies build on ideas that came before, turning the revolutionary into the day-to-day. As workplaces regain normalcy, the technological tools utilized during the pandemic look to have staying power, launching Americans into a “New Normal” of technology.

In this white paper, we seek to detail key themes shaping our world. This iteration of the report is focused exclusively on the Disruptive Themes category, but later this year we will be releasing our analysis into the People & Demographics and Physical Environment categories. This research and analyses support some of the thematic investing decisions made in the Global X ETF Model Portfolios. Used standalone or as satellite strategies, our thematic approach strives to position portfolios for the future. Global X’s suite of Model Portfolios contains three strategies that are exclusively focused on thematic equity, and an additional seven model portfolios that include thematic equity in the context of a broader asset allocation. Our portfolios are actively managed (not static) and will enter and exit themes over time. As such, not all themes available will be directly represented at a given time. For more information on Global X Model Portfolios, including allocations, please consult our [Advisor Login](#).

THEMATIC EQUITY ADOPTION

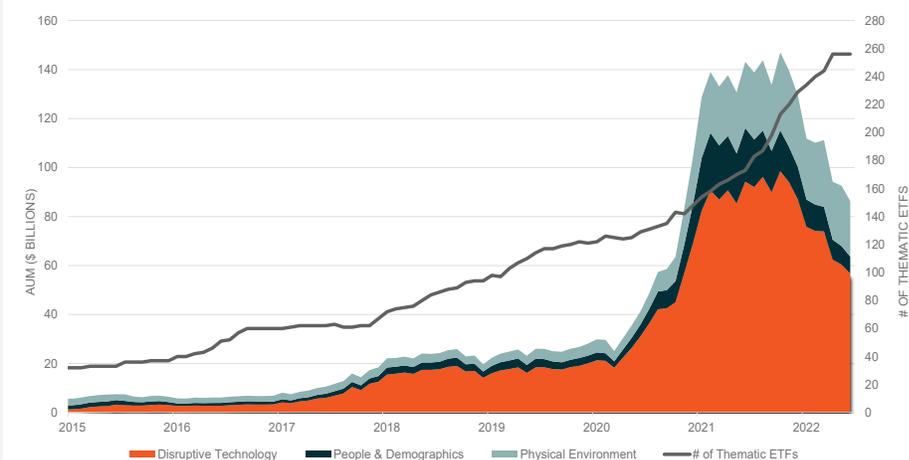
Interest in accessing thematic equity through ETF products increased significantly over the last few years. COVID-19 related lockdown restrictions and shifts in how society engages with technology drove a sharp increase in thematic adoption during 2020. While society is learning how to live with this virus as life is starting to return to normal, the technologies that enabled us to engage during the pandemic could be used as building blocks to the future.

“At the end of 2021, there were 229 thematic ETFs totaling **\$129.4B** in assets under management (AUM), down 3% from Q3 2021 but still **up 24%** from Q4 2020.¹”

¹ Global X Research as of 1/10/22

AUM OVER TIME

Source: Global X ETFs, Bloomberg Data as of June 30, 2022.



Note: AUM includes assets of funds closed until the last month of trading activity.



THEMATIC ADOPTION

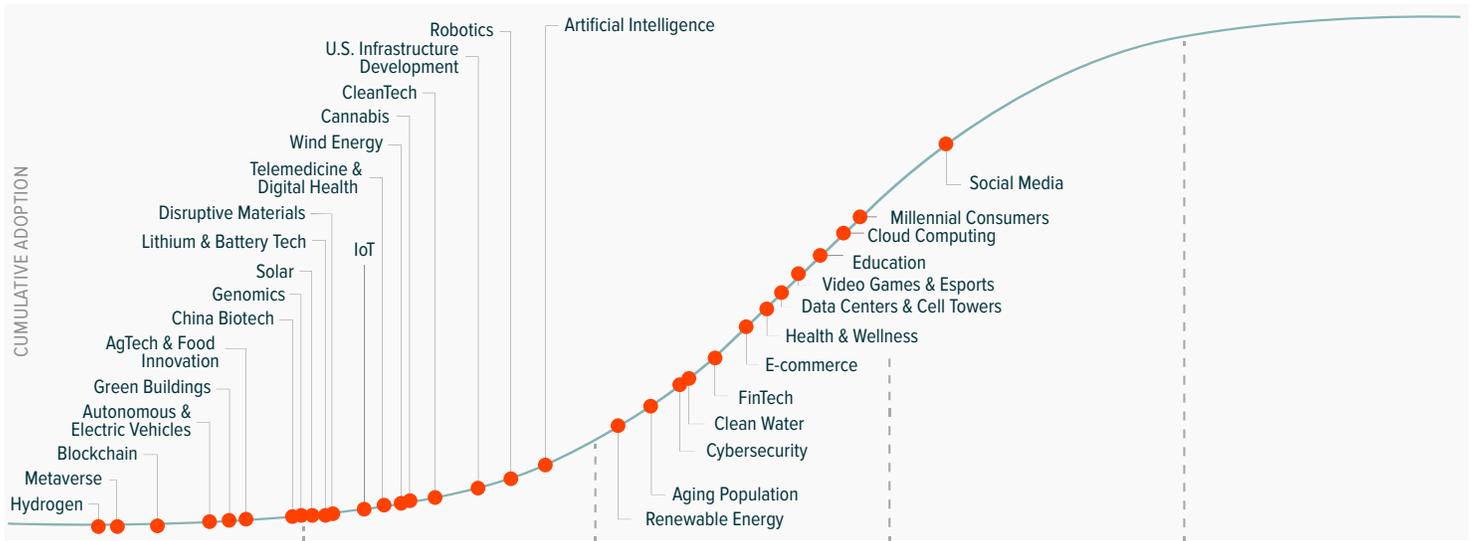
The adoption of new technologies typically follows an S-shaped pattern, with the rate of growth accelerating as the product gains mass acceptance, until eventual deceleration as the technology becomes pervasive (see chart). Our thematic strategies target themes in the Early Adopters and Early Majority phases, and reduce exposure to themes as they advance into Late Majority territory.

The scalability of key technologies typically rises at higher levels of adoption, boosting revenue and potentially also profitability. While most themes experience gradual improvements in scale along the adoption curve, for themes that rely on interconnectivity, such as Social Media and to a lesser extent Video Games & Esports, monetization opportunities accelerate once the technology has high adoption levels and network effects make it is more difficult to switch to a different service.

In the disruptive technology category, we can currently trace majority of the structural changes to data and connectivity. As we transition to a digital future, this established new frontiers for interconnectivity.

THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2022.



Displayed for illustrative purposes. Curve shape not indicative of mathematical transformation.

PHASES OF ADOPTION

INNOVATORS	EARLY ADOPTERS	EARLY MAJORITY	LATE MAJORITY	LAGGARDS
Adoption starts slowly, as only a small group of Innovators take a chance on a new technology before it is proven or widely accepted.	Early Adopters accelerate and evangelize via word-of-mouth. This is often the tipping point, as Early Adopters convince others that a particular technology is worthwhile.	Early Majority, we reach the part of the Adoption S-curve where the slope is the steepest, and hence the rate of adoption is at its fastest. In this phase, sales tends to explode.	Adoption continues growing at a solid pace as the Late Majority are convinced to participate, and the technology appears seemingly everywhere.	Finally, holdouts, begrudgingly acquiesce and accept/adapt a technology.

This is an indication of thematic adoption within society. This analysis is as of April 2022 and is subject to change. The curve does not in any way reflect past or future performance of the ETFs.

THEMATIC CLASSIFICATIONS

Global X Research has developed a holistic Thematic Classification System, designed to help investors better understand, track, and analyze the evolving thematic landscape. Focused on identifying powerful themes and organizing them by common traits and drivers, the system consists of four layers of classifications: Categories, Mega-Themes, Themes and Sub-Themes, with each layer becoming increasingly granular in its focus.

As of publication, the classification system is comprised of 3 categories, 11 mega-themes, and 42 themes. The number of each is expected to change over time as the thematic landscape evolves. The table provides an overview of the Global X Thematic Classification System and our takeaways from each mega theme.



Category	Mega Theme & Key Takeaway		Theme	
DISRUPTIVE TECHNOLOGY	The Infrastructure of the Digital World	Big Data Big Data's cloud computing and cybersecurity technologies integrate exceptionally well from a portfolio perspective, as the data-dense cloud necessitates ongoing cybersecurity spending and investment.	Machine / Deep Learning	
			Cybersecurity	
			Quantum Computing	
		Connectivity If AI is a system's brains, the Internet of Things (IoT) acts as the digital nervous system. Connectivity enables real-time and remote monitoring of autonomous systems.	Cloud / Edge Computing	
			Digital Infrastructure	
			5G / Next Gen Networking	
	Emerging Market Internet			
	How it Relates to the Physical World	Robotics The adoption of robotic and AI tools combined with internet of things (IoT)-based sensors and massive scale cloud computing could be sparking the Fourth Industrial Revolution, increasing the efficiency and effectiveness of factory-based production.	Internet of Things	
			Space / Satellite Communication	
		Mobility We expect the Mobility theme to be boosted by the integration of robotics & AI and internet of things (IoT) technologies that may result in the proliferation of connected, autonomous EVs.	AI / Automation	
	How it Relates to the Digital World	Digital Experiences Improved connectivity opens a world of possibilities for enhanced online engagement. The future is likely to be more interactive with improved cloud computing increasing the potential for video game streaming and increased blurring of physical and digital worlds.	3D Printing	
			Drones	
			Autonomous Vehicles	
FinTech We expect continued innovations in mobile payments, online banking, and alternative lending platforms to bring financial services to previously unbanked and underserved populations.		Electric Vehicles		
		AR / VR		
		Video Games		
		Social Media		
UPCOMING	PEOPLE & DEMOGRAPHICS	New Consumer	Streaming	
			Mobile Payments	
			Peer-to-Peer Lending	
			Crowd Funding	
			Blockchain	
			Health	Millennials & Gen Z
				Emerging Market Consumers
				Urbanization
				E-commerce
				Education
	PHYSICAL ENVIRONMENT	Climate Change	Sharing / Gig Economy	
			Safety & Security	
			Cannabis	
Disruptive Materials	Sports Betting			
	Professional Sports			
	Healthcare Innovation			
Infrastructure Development	Aging Population			
	Health & Wellness			
	Emerging Market Healthcare			
Infrastructure Development	Alternative Medicine			
	CleanTech			
	Clean & Renewable Energy			
Infrastructure Development	Resource Scarcity			
	Disruptive Materials			
Infrastructure Development	Disruptive Materials			
	Infrastructure Development			



Infrastructure of the Digital World

We can currently trace majority of the structural changes to data and connectivity. A handful of key themes are foundational, providing the technological backbone for the digital future. Given interconnectivity between technologies and themes, these foundational themes link to both the physical and digital world.

KEY MEGA THEMES:

- Big Data
- Connectivity



BIG DATA (CLOUD COMPUTING & CYBERSECURITY)

Perhaps no investment theme has been more important to the business world since the COVID-19 outbreak than Big Data. As workplaces went remote, access to key documents, applications, and computing resources made cloud computing essential. We expect the global economy to shift further into the cloud over time, though connectivity can be both a blessing and a curse, as readily accessible files can become an easy target for malicious actors. Fortifying cybersecurity measures are therefore necessary investments to protect remote treasure troves of sensitive data.

KEY TAKEAWAYS

- COVID-19 related pressure boosted the Big Data theme as it increased cloud utilization faster than previous estimates. Now an estimated 92% of enterprises use multiple cloud services, employing 2.6 public and 2.7 private clouds on average.¹
- Cybersecurity spending is expected to increase significantly with the global economy going digital. Ninety-six percent of organizations increased their cybersecurity spending in 2020, according to a recent survey. And 91% increased their cybersecurity budgets in 2021.²
- Big Data's cloud computing and cybersecurity technologies integrate exceptionally well from a portfolio perspective, as the data-dense cloud necessitates ongoing cybersecurity spending and investment.

WHY CLOUD COMPUTING AND CYBERSECURITY ARE SUCH POWERFUL FORCES

Cloud computing offers proven efficiencies that modernize business practices

Of all the investment themes that we track, the Cloud Computing theme likely accelerated the most due to COVID-19 because it became essential to business continuity. In a survey by computer software company Flexera, 29% of respondents said that they increased their cloud usage significantly more than expected during the pandemic, while 61% made slight increases due to pandemic-related operational changes.³ Today, an estimated 92% of enterprises use multiple cloud services, employing 2.6 public and 2.7 private clouds on average.⁴

With growing demand attributed to lower operating costs, better collaboration, increased flexibility, and improved turnaround times for server expansion, the largest enterprises by revenue accounted for 51% of the cloud market in 2020.⁵ These firms were not new to the cloud, having used it to build applications or host corporate infrastructure. The next push looks to modernize core business applications and processes. Technology conglomerate Cisco expects 94% of all corporate workflows to run through some form of cloud infrastructure by 2021, as servers dedicated to individual tasks quickly become relics.⁶

The next stage of the cloud's evolution looks to be omni-cloud solutions that stitch together multiple platforms and services to create more integrated data sharing and access. Managed multi-cloud environments should help assuage security, cost, and governance issues, the top concerns of enterprise cloud decision-makers.⁷

Currently, supply chain constraints, including the ongoing semiconductor shortage, are a challenge. But we believe the shortage can enhance the Cloud Computing theme. Under more normal conditions, corporations have a choice. They can build out their own personalized data centers, spending the time, resources, and expertise to customize servers. Or they can contract a cloud provider that offers a more general but rapid turnkey solution. Currently, high costs and long lead times due to supply constraints

disincentivize personalized server builds, forcing organizations into the cloud to avoid the risk of delays.⁸

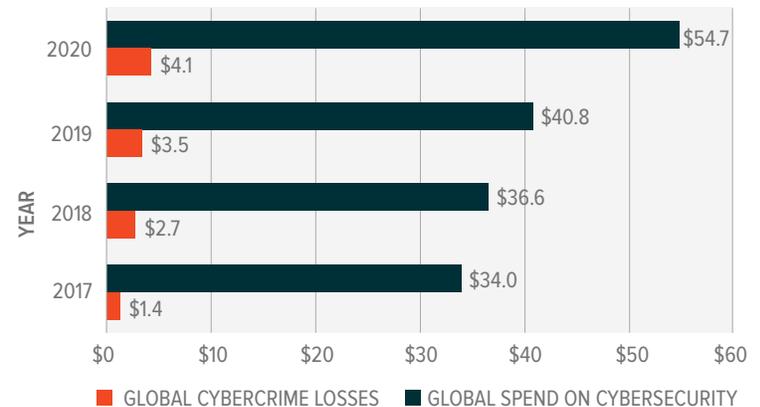
As the value of data increases, it requires more protections

Cloud computing data centers aggregate and concentrate valuable data and processing power, increasing the speed and effectiveness of computing tasks. But that digitization makes protecting this valuable and sensitive data essential. The World Economic Forum marked cyberattacks as the 7th global risk by likelihood and 8th by impact in 2020.⁹ It's estimated that global cybercrime costs will grow by 15% per year to \$10.5 trillion annually by 2025.¹⁰

In 2020, ransomware attacks increased by 62% globally and 158% in North America compared to 2019.¹¹ These malicious attacks have real consequences for business, infrastructure, and end users beyond lost data and operational disruptions. According to FBI data, U.S. economic losses from more than 791,790 reported cybercrime incidents in 2020 exceeded \$4.1 billion.¹² The effects of a successful breach, financial and otherwise, can be felt for years after the actual threat ends. As much as 22% of negative effects occur in the second year after the event, and another 11% surface in the third year.¹³

CYBER ATTACKS CONTINUE TO CAUSE DAMAGE EVEN AS SPENDING INCREASES DRAMATICALLY

Source: IC3, March 2021, Canalys, January 2021.



According to solutions provider Insight CDCT (Cloud + Data Center Transformation), 96% of surveyed organizations increased their cybersecurity spending in 2020, and 91% expanded their cybersecurity budgets in 2021. However, current solutions largely focus on closing immediate security gaps and addressing the easiest-to-deploy options first, not the most concerning threats, including state-sponsored corporate espionage, attacks on critical infrastructure, and disinformation campaigns.¹⁴ For example, the Solar Winds hack discovered in December 2020 is believed to be the work of the Russian Foreign Intelligence Service. About 100 companies and a dozen government agencies were compromised, including the U.S. Treasury, Justice, and Energy departments, and the Pentagon.¹⁵

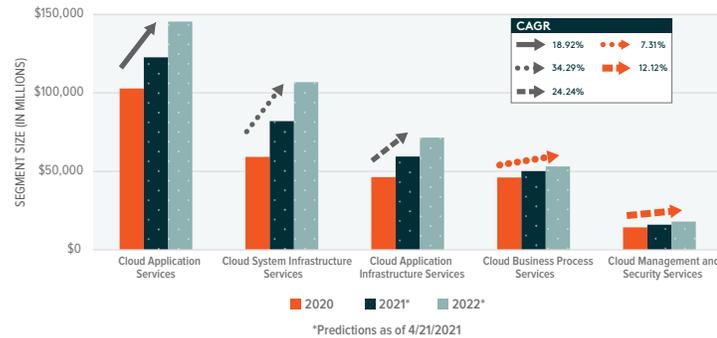
The increased sophistication of state-sponsored cyber threats requires equally sophisticated state responses. The Biden administration recently issued a new mandate for federal agencies to patch cybersecurity vulnerabilities in government software. This mandate covers about 200 known security flaws, making it one of the most widespread initiatives of its kind.¹⁶ Additionally, the House passed the Small Business Administration (SBA) Cyber Awareness Act, requiring small businesses to notify Congress of cybersecurity breaches. A second component includes the Small Business Development Center Cyber Training Act for cybersecurity counseling certification programs.



VISUALIZING THE MARKET OPPORTUNITY

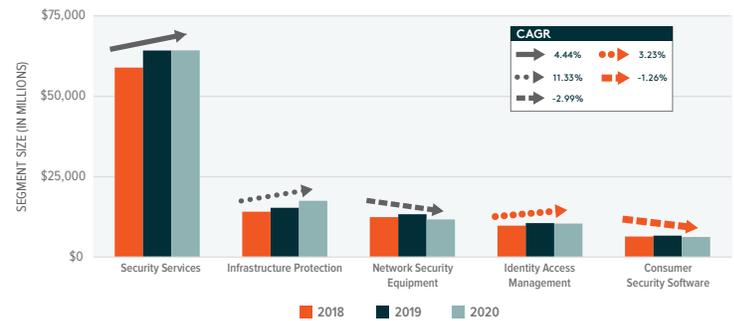
GLOBAL CLOUD COMPUTING SPENDING BY LARGEST SEGMENT

Source: Gartner data as of 4/21/2021.



GLOBAL CYBERSECURITY SPENDING BY LARGEST SEGMENT

Source: Embroker data as of 11/2/2021.



RISKS TO THE BIG DATA THEME

Supply chain disruptions could affect development of critical cloud infrastructure

A concern for Big Data and the broader technology space is the supply chain constraints limiting the availability of certain types of semiconductors. This shortage has nuanced effects on the Cloud Computing theme as increased demand from end users is offset by capacity growth restrictions. Data center development is necessary for the continued expansion of service offerings and staying competitive in an industry with regular hardware advancements and data demand increases.

Shortages aren't affecting every type of semiconductor. High-margin microchips, such as the server-level central processing units (CPUs) and graphics processing units (GPUs) that make up the backbone of data centers, are generally available. But other necessary components like power supplies and network switches face lead times in the 40–60 week range, more than double the pre-pandemic norm.^{17,18} Semiconductor foundry capacity is growing at 1–3% per year, but that growth is outpaced by the demand for computing power, so constraints are expected to persist. Industry leaders expect tightness through Q2 2022.^{19,20}

Cybersecurity is an inherent risk in the digital age

Data is gold today, which means data centers must become virtual fortresses. Concentrating such a valuable resource only increases the interest of malicious actors, and when they see an opening, they take it. For example, attacks on cloud infrastructure providers increased 630% between January and April 2020 compared to the previous four-month period as cyber criminals looked to exploit COVID-related confusion.²¹

Unauthorized access can occur even without malicious activity due to incorrect settings or user and employee errors. In 2019, more than 540 million user records from a large social media company were exposed by a leading cloud provider due to improper data protections.²² Absolute protection of data is likely impossible because there is a direct trade-off between data security and accessibility, but many risks can be mitigated by adequate cybersecurity spending and security awareness training.

From a risk perspective, the Cybersecurity theme looks well-insulated. Cybersecurity technologies work to proactively shield against possible attacks while mitigating and repairing the damage from attacks that already occurred. As a result, there is little risk at the broad theme level because the factors spurring adoption are unlikely to ever wane. Risk remains acute at the individual company level, where malicious actors constantly stress-test specific cybersecurity approaches and tools.

Should a breach occur under a cybersecurity provider's nose, markets are likely to devalue that company compared to its peers. However, in such instances, interest actually increases for the space overall. Cybersecurity stocks and ETFs have a history of positive price performance following the announcement of large-scale hacks, including the Solar Winds incident. In a situation where a data center or application developer falls victim to a large breach, negative share performance could be offset by broader cybersecurity gains.

THEMATIC INTERSECTION: INTERNET OF THINGS AND ARTIFICIAL INTELLIGENCE

Internet of Things (IoT)

The proliferation and advancement of connected devices driven by IoT technology looks to enhance the opportunities for Big Data themes. The integration of microchips and networking into more products creates more opportunities for data collection, as well as unauthorized access. Distributed sensors require a central data processing location to receive and aggregate collected information. And as the number of connected devices expands alongside increasingly sophisticated data analysis, so does the need for processing power and cloud computing resources.

But sensors are next to useless if they aren't secure, so IoT also positively impacts the Cybersecurity theme. For a malicious actor, the IoT is a cornucopia of opportunities to attack. Ninety-eight percent of all IoT device traffic is unencrypted, which translates to 57% of IoT devices being highly vulnerable to cyberattacks that can expose personal and confidential data.²³ Successful IoT deployments require multi-layered, end-to-end security that ranges from upfront, baked-in security requirements to the ongoing management and protection of sensitive machine-generated data.²⁴

Artificial Intelligence (AI)

The cloud and AI are also a fitting match. The cloud can democratize access to AI, providing turnkey solutions without significant upfront investment or specialized experience. AI can enhance cloud infrastructure through computing resource management, streamlining workloads, and automating repetitive tasks without human interaction. Additionally, growth in AI capability and complexity requires expanded computing resources. In 2018, AI research lab OpenAI reported that the amount of computational power used to train the largest AI models doubled every 3.4 months, an appetite that cloud providers can quickly satisfy.²⁵

AI technology is a boon for the Cybersecurity theme, given its use of pattern recognition and predictive intelligence to detect unusual network activity or penetration attempts. As cyberattacks grow in complexity, regularity, and intensity, AI can bolster human-based cyber defenses. Spending on AI



cybersecurity tools is expected to grow faster in the coming five years than hardware or services, indicating wholesale adoption of the technology.²⁶

BIG DATA IN A PORTFOLIO CONTEXT

Big Data is foundational to our digital future, and is comprised of core themes that we believe have a place in most thematic portfolios. Both Cloud Computing and Cybersecurity fall squarely into the Early majority phase, indicating that adoption levels are high and rising, and that the market has begun to accept these themes at scale.

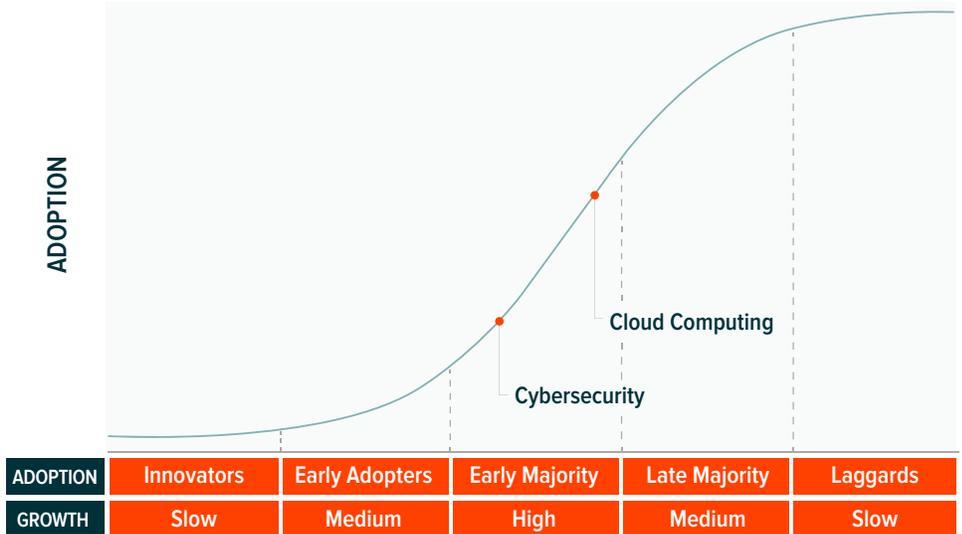
The companies that implementing Big Data technologies are global and stand to benefit as thematic adoption rises across the world. The pie charts below breaks down the geographic exposure of the largest Big Data ETF products. We believe there is ample innovation occurring outside of the states, and that limiting exposure to the U.S. will exclude key players to the detriment of investors over the long term.

In our view, thematic equity should be targeted, using screens to ensure the underlying companies provide the desired thematic exposure. This pure play exposure minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products. An overlap analysis between Big Data thematic ETFs and XLK, the Technology Select Sector SPDR Fund, shows that average overlap by weight is 6.4% and 2.5% for cloud computing and cybersecurity funds, respectively.²⁷ As shown above, cloud computing scores higher on adoption than cybersecurity, and this is reflected in the theme's larger level of inclusion in broad tech sector ETFs. The names that overlap tend to be large, well known and active in many business segments, such as Microsoft and Cisco, while those that don't overlap are smaller and relate specifically to the theme. This highlights a key advantage of thematic investing - gaining exposure to key players early in their business lifecycles before they are included at any significant weight in broader indexes.

We believe both Cloud Computing and Cybersecurity could grow in importance over the next decade. Migrating to cloud-based infrastructure and software affords enterprises greater flexibility, predictability, and scale. While the market nears mass adoption, opportunities remain for firms to expand Software-as-a-Service and Infrastructure-as-a-Service offerings. The cloud's effectiveness has been proven; the next leg will maximize its potential. Helping the cloud reach its potential will be the cybersecurity industry, which seems well-positioned to capitalize as people and economies move further online. Cyber threats continue to increase in occurrence and severity, demonstrating the permanent need for cybersecurity spending. Both these Big Data themes benefit from subscription revenue models, helping establish more stable and predictable income streams.

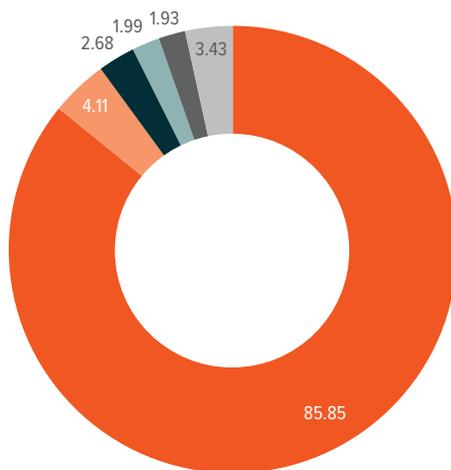
THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021



CLOUD COMPUTING: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

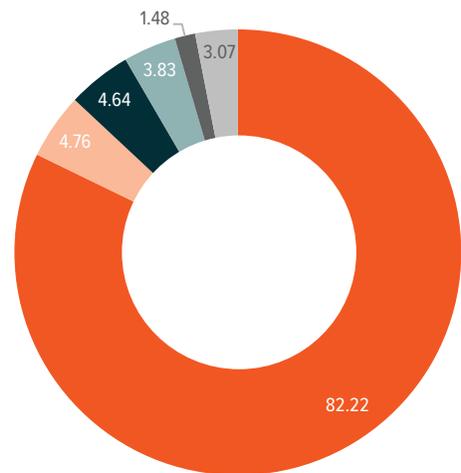
Source: Morningstar data as of 12/31/21.



United States, China, Canada, Israel, Japan, Other Countries

CYBERSECURITY: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



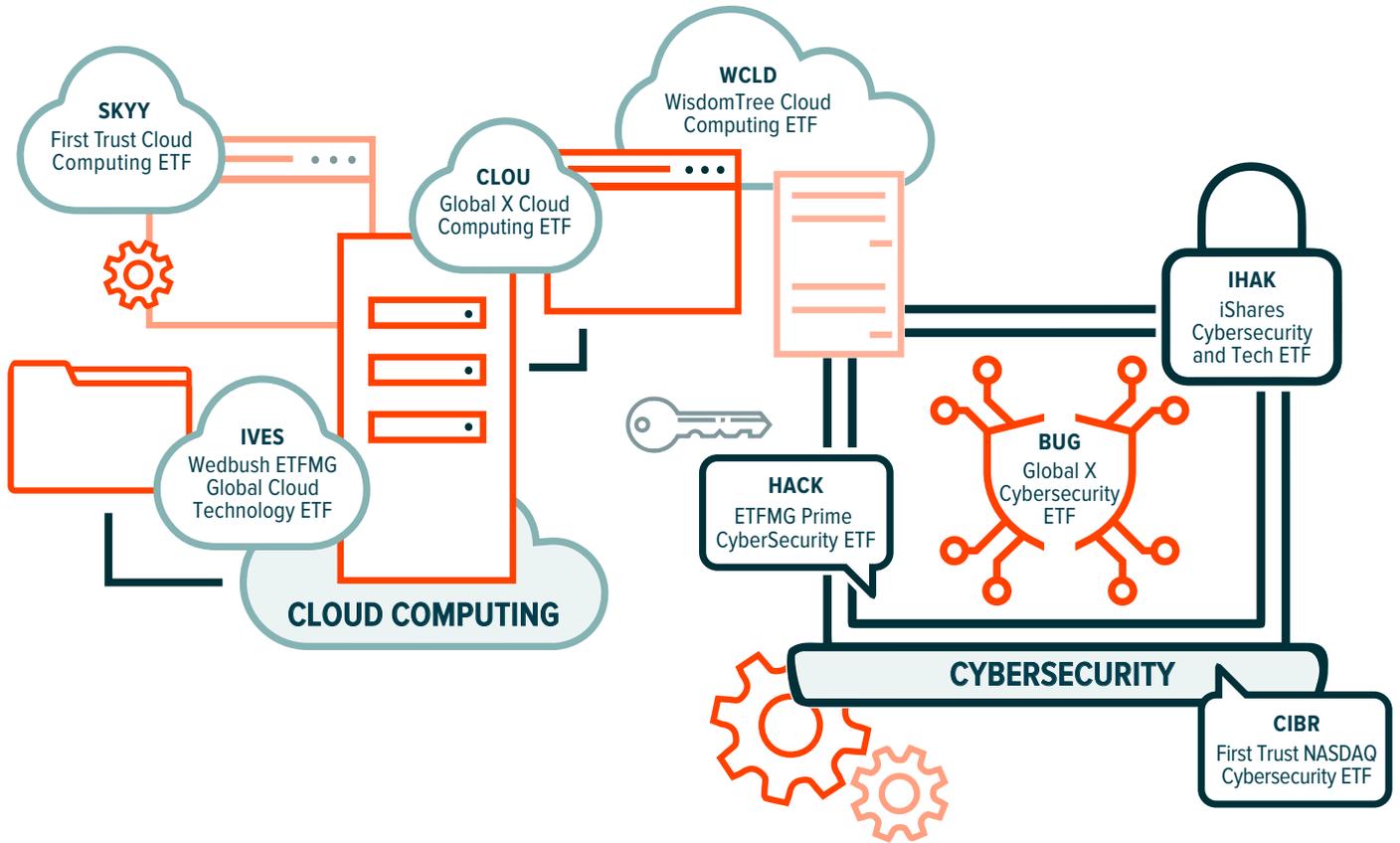
United States, United Kingdom, Israel, Japan, Canada, Other Countries

Note: Pie charts include the largest four cloud computing and the largest four cybersecurity ETFs according to our thematic classification. All Thematic ETFs weighted the same.



HOW TO ACCESS BIG DATA

The graphic below identifies some U.S. listed ETFs that provide direct exposure to the Big Data theme through Cloud Computing and Cybersecurity technology.





BIG DATA FOOTNOTES

- ¹ Flexera, 2021 State of the Cloud Report, 3/15/21
- ² Insight CDCT, Cybersecurity at a Crossroads: The Insight 2021 Report, 2/24/21
- ³ Flexera, 2021 State of the Cloud Report, 3/15/21
- ⁴ Flexera, 2021 State of the Cloud Report, 3/15/21
- ⁵ Grand View Research, Cloud Computing Market Size, Share & Trends Analysis Report By Service (SaaS, IaaS), By Enterprise Size (Large Enterprises, SMEs), By End Use (BFSI, Manufacturing), By Deployment, And Segment Forecasts, 2021 – 2028, July 2021
- ⁶ Cisco, Global Cloud Index (2016-2021), 2/5/18
- ⁷ Flexera, 2021 State of the Cloud Report, 3/15/21
- ⁸ Logicalis, How The Global Chip Shortage Is Driving Data Center Projects To The Cloud, 6/23/21
- ⁹ World Economic Forum, The Global Risks Report 2020, 1/15/20
- ¹⁰ GlobalNewswire, Cybercrime To Cost The World \$10.5 Trillion Annually By 2025, 11/18/20
- ¹¹ Sonicwall, 2021 Sonicwall Cyber Threat Report, 8/29/2021
- ¹² FBI, Internet Crime Report: 2020, 3/17/21
- ¹³ Embroker, 2021 Must-Know Cyber Attack Statistics and Trends, 11/2/21
- ¹⁴ Insight CDCT, Cybersecurity at a Crossroads: The Insight 2021 Report, 2/24/21
- ¹⁵ NPR, A 'Worst Nightmare' Cyberattack: The Untold Story Of The SolarWinds Hack, 4/16/21
- ¹⁶ WSJ, Biden Administration Orders Federal Agencies to Fix Hundreds of Cyber Flaws, 11/3/2021
- ¹⁷ The Register, 'This is the worst I've seen it' says Arista boss as entire network hardware sector battles component shortages, doubled lead times for semiconductors, 8/3/21
- ¹⁸ DataCenter Knowledge, 'It's Little Things' – How the Chip Shortage Is Affecting the Data Center Industry, 5/17/21
- ¹⁹ Logicalis, How the global chip shortage is driving data centre projects to the cloud, 6/15/21
- ²⁰ DataCenter Knowledge, 'It's Little Things' – How the Chip Shortage Is Affecting the Data Center Industry, 5/17/21
- ²¹ McAfee, Cloud Adoption and Risk Report: Work from Home Edition, 5/27/21
- ²² Varonis, 98 Must-Know Data Breach Statistics for 2021, 2021
- ²³ Palo Alto Networks, 2020 Unit 42 IoT Threat Report, 3/10/20
- ²⁴ IoT Cybersecurity Alliance, Demystifying IoT Cybersecurity, 2017
- ²⁵ MIT Technology Review, The computing power needed to train AI is now rising seven times faster than ever before, 11/19/19
- ²⁶ Markets and Markets, Artificial Intelligence in Cybersecurity Market by Offering (Hardware, Software, and Service), Deployment Type, Security Type, Technology (ML, NLP, and Context-Aware), Application (IAM, DLP, and UTM), End User, and Geography- Global Forecast to 2026, May 2019
- ²⁷ ETF Action data as of 2/9/22

Investing involves risk, including the possible loss of principal. Narrowly focused investments may be subject to higher volatility. Technology-themed investments may be subject to rapid changes in technology, intense competition, rapid obsolescence of products and services, loss of intellectual property protections, evolving industry standards and frequent new product productions, and changes in business cycles and government regulation.

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CONNECTIVITY (INTERNET OF THINGS & DIGITAL INFRASTRUCTURE)

Connectivity creates opportunities, and we expect the Connectivity theme to grow as the internet of things (IoT) connects more devices across sectors. Sparked by the continued miniaturization of microchips and receiving a powerful tailwind from the speed and capacity of 5G networks, IoT sensors and connected devices are set to harness the power of collected data. While these technologies appear to occur effortlessly, they rely on an extensive network of towers and data centers. Core to the Connectivity mega theme's growth potential is the significant investment being made to enhance this digital infrastructure.

KEY TAKEAWAYS

- Industrial IoT (IIoT) could be a key component of the Fourth Industrial Revolution (Industry 4.0), which we expect to transform manufacturing and supply chains. IIoT is expected to account for over 70% of all IoT connections by 2024.¹
- Increased connectivity increases the need for investment in digital infrastructure. Between 2016 and 2020, the U.S. wireless industry invested \$140 billion in infrastructure enhancements, building over 417,000 new cell sites in 2020 alone.²
- The Connectivity theme lives up to its name by connecting numerous themes, both innovation-based and physical infrastructure-based. We believe this attribute makes Connectivity particularly dynamic from a portfolio perspective.

WHY THE INTERNET OF THINGS AND DIGITAL INFRASTRUCTURE ARE SUCH POWERFUL FORCES

Connected devices are everywhere and growing more powerful

Connected devices produce an almost unimaginable amount of data. Technology conglomerate Cisco estimates that IoT devices produced 500 zettabytes (1ZB = 1 trillion gigabytes) of data in 2019, and it expects that number to grow exponentially each year as more devices come online.³

In 2021, the average American household had 25 connected devices, up substantially from 11 at the end of 2020.^{4,5} In total, the U.S. had 468.9 million connected devices online by the end of 2021, including 190.4 million data-only devices such as smartwatches or medical sensors. Data only IoT-focused connections have increased 272% in the U.S. since 2013.⁶ Globally, the number of connected IoT devices is expected to grow from 11.3 billion in 2020 to 27.1 billion by 2025 as the chipsets and wireless communication services that enable connectivity become more available.⁷

Cheap and readily accessible sensor and communications chips enhance the capabilities of everyday devices. Microsoft data shows that

the average price of an IoT sensor declined from \$1.30 in 2004 to \$0.44 in 2018.⁸ This trend combined with computing power increasing by a factor of 10 roughly every four years has resulted in even basic products such as toasters receiving a digital upgrade.⁹

In the short term, the semiconductor shortage has increased the prices of chips and other electronic components, demonstrated by the semiconductor producer price index rising from 54.1 to 55.3 in 2021.¹⁰ The long-term trend of declining costs per unit compute is expected to resume once manufacturing catches up with demand, further aiding IoT adoption.

Industrial IoT creates dynamic growth opportunities in the manufacturing sector

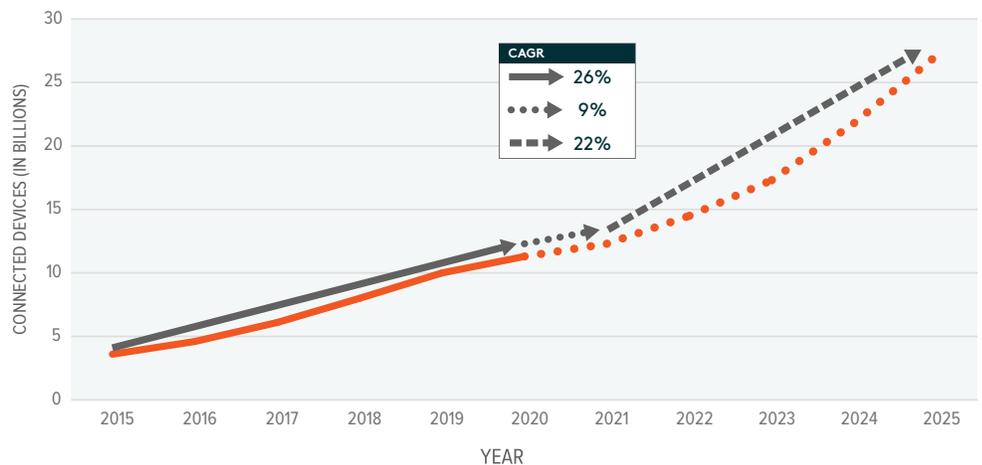
Recent kinks in supply chains indicate that the current production paradigm isn't sufficiently equipped to handle system-wide stress. The solution is to transform traditional and linear manufacturing supply chains into dynamic, interconnected systems. Bringing Industrial Internet of Things (IIoT) technologies into manufacturing facilities will change how products are made and delivered. Adding sensor technology and adaptive control systems to production lines could transform real-time data into actionable insights that may be used to increase manufacturing efficiency.

A key advantage of Industry 4.0 compared to just-in-time manufacturing is a reduction in downtime due to predictive repairs. Production downtime, even for necessary maintenance, can have large costs. By monitoring the current condition of machinery, reacting to warning signs, and cross-checking input and finished good levels, IIoT-enhanced factories can optimally schedule repairs, thereby reducing downtime and increasing facility throughput.

Further efficiency gains can be derived by utilizing IoT for inventory and asset tracking. With GPS technology, complicated logistics can be monitored and simplified. For example, a manufacturer can know in real time when a shipment of raw materials will arrive at a facility or when finished products arrive at a distribution center. This information can help companies maximize profitability by giving them insight on when to replenish inventory or help them locate and recover lost or stolen equipment and goods. McKinsey data shows that firms who implemented Industry 4.0

GLOBAL IoT CONNECTED DEVICES

Source: IoT Analytics data as of September 2021.



“Globally, the number of connected IoT devices are expected to grow from 11.3 billion in 2020 to 27.1 billion by 2025.”



technologies were able to respond to the COVID-19-induced supply chain crisis in 96% of cases, while those firms without these technologies were able to respond just 19% of the time.¹¹

Towers and data centers combine innovation and real estate

Communications networks are essential digital infrastructure because they facilitate connections between the massive processing power of data centers and end users. Significantly, towers and data centers marry elements of growth-oriented technology investing and income-oriented real estate. Data centers provide physical space for customized server infrastructure while addressing cooling, power management, and security responsibilities, in exchange for regular fee payments. Data centers also serve a diverse set of clientele, including big tech companies, government agencies, financial services firms, and health care providers.

In 2020, the U.S. accounted for over 80% of new data center construction and expansion projects globally.¹² Investment in this infrastructure totaled

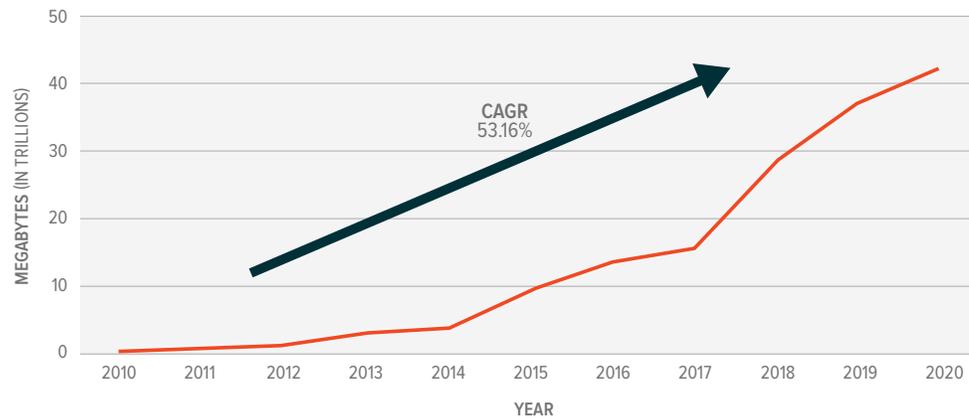
offer a potential solution. Next-generation wireless networks offer more spectrum over more channels, increasing the number of devices able to actively connect to a tower at once, and allocating additional bandwidth to each device. 5G also uses small cell antennas, which have much shorter ranges than their macro counterparts.

The overlapping coverage areas that small cell antennas create raise wireless coverage density, which improves connections while alleviating pressure on any one tower. Coverage remains spotty compared to the more established 4G networks, but 20% of new smartphone sales in the U.S. were expected to contain 5G chips by the end of 2021, so improvement is inevitable.²⁰

Wireless network providers are increasing investment in digital infrastructure. Data from wireless communications trade association CTIA shows that the wireless industry invested \$30 billion into infrastructure projects in 2020, the third consecutive year capital expenditures increased, and the largest year of investment in the last five. Between 2016 and 2020,

ANNUAL U.S. WIRELESS DATA TRAFFIC

Source: CTIA data as of 7/27/21.



“Taking a longer-term view, U.S. mobile data traffic has increased by 108x over the last decade, indicating that much more tower capacity will be needed as data demand continues to expand.”

more than \$700 million.¹³ But more is needed, as demands on digital infrastructure will only increase. The vastly improved bandwidth, latency, and speed that 5G networking technologies offer could be required for widespread adoption of advanced IoT-enabled devices like autonomous vehicles. However, current infrastructure is likely to crack under the additional load, [making the need for cell towers greater than ever](#).

Currently, there are approximately 128,000 macro cell towers in the U.S., but each tower only has so much range and capacity. A typical cellphone only has enough power to reach a tower up to 5–7 miles away, and a single Long Term Evolution (LTE) cell can only manage about 200 active device connections per 5 megahertz (MHz) of spectrum before speeds begin to slow.^{14,15} The expansion of IoT means a higher demand for towers and wireless spectrum to ensure adequate coverage.

Tower demand is expected to remain robust with 6.37 billion active smartphone users globally.¹⁶ But construction and permitting hurdles often limit expansion, making existing towers increasingly valuable. In the U.S., suppliers of macro cell towers increased tower capacity by about 8% from 2019 to 2020.¹⁷ But over the same period, mobile data per smartphone increased 29%.¹⁸ Taking a longer-term view, U.S. mobile data traffic has increased by 108x over the last decade, which indicates that much more tower capacity will be needed to meet data demand.¹⁹

Solutions for capacity constraints coming with 5G, continued investment

With more data being collected by sensor-enabled devices than ever, transferring information in a timely manner can be a challenge. 5G networks

the industry’s investment in infrastructure totaled \$140 billion. Over 417,000 new cell sites were built in 2020, a 35% increase from 2016.²¹ Over the last two years, a lighter regulatory touch facilitated more cell site construction than in the previous seven years combined.

This investment is in addition to the almost \$200 billion spent on wireless spectrum auctions over the same period.²² Spectrum refers to the radio wave frequencies used to transfer wireless signals and is a core component of wireless communications. Auction winners are licensed to transmit on a larger swath of the electromagnetic spectrum, furthering the rollout of 5G technology and increasing the quality of end-user connectivity.

RISKS TO THE CONNECTIVITY THEME

The semiconductor shortage is a headwind for IoT

Surging demand, including demand from 5G expansion plans, forced foundries to focus on high-margin production, typically the newest and most advanced chips. As a result, the production of lower-tier chips took a backseat. These commodity-type chips are typically used in consumer-focused IoT devices because they generally don’t require the fastest networking or processing speeds. An estimated 20 million cellular chipsets will go undelivered due to shortages in 2021, influencing 80% of global manufacturers to report challenges producing digital products and services.^{23,24} The result is increased prices and decreased availability of some connected devices, likely negatively affecting sales of consumer goods in the short term.



VISUALIZING THE MARKET OPPORTUNITY

DIGITAL INFRASTRUCTURE



INTERNET OF THINGS



Expanding opportunity that lays the foundation for the digital future.

The chip shortage also affects the 5G rollout because routers, switches, and base stations face longer delivery times. Smaller network providers indicate that equipment delays stalled deployments by 18–24 months.²⁸ These delays look to be more acute outside of the U.S., given the robust purchasing relationships and financial heft of the large U.S. networks.

IoT devices create more network vulnerabilities

IoT devices can be easy targets for cybercriminals due to the network integration of many endpoint devices. With more points of failure, network maintenance becomes a larger task, increasing the chances of a missed software update or incorrect device setup. Comcast estimates that U.S. households can be exposed to as many as 104 cybersecurity threats per month, with the most vulnerable devices being smart home gadgets.²⁹ The general market immaturity of connected devices is the main reason, as cybersecurity issues are often addressed after product creation and through firmware updates. Connected ecosystems such as Google’s Nest and Apple’s HomeKit could provide solutions, but the risk remains.

THEMATIC INTERSECTION WITH CONNECTIVITY

Robotics & AI and Cloud Computing

The Robotics & AI and Cloud Computing themes intersect with IoT, particularly from an industrial perspective. Industrial IoT can take many forms, but it mainly focuses on increasing operational efficiency via sensor-based monitoring. Future growth in the industrial space could stem from the integration of robotics, cloud computing and connected IoT devices to build smart, automated factories. Artificial intelligence (AI) utilities will rely on data gathered by IoT systems and sensors to present real-time insights about the world around them.

If AI is a system’s brain, IoT acts as the digital nervous system. Connectivity will be essential, with private 5G and low power wide area (LPWA) networks playing a critical role in manufacturing automation that enables real-time and remote monitoring of autonomous systems. Juniper Research predicts that the industrial sector will account for over 70% of all IoT connections by 2024.³⁰

Health & Wellness

Connected fitness trackers record some of the most intimate data an individual can produce. The health and wellness economy is growing, especially after the pandemic inspired many to be more active and conscious about their wellbeing. The global fitness tracker market grew 19.5% year-over-year in 2020, expanding at a faster rate than the overall IoT space.³¹ Fifty-eight percent of U.S. consumers now use smartwatches or fitness trackers to quantify their daily steps, workouts, and sleep.³²

Additional upside stems from clinical settings, where medical grade sensors can provide lifesaving information. For example, blood sugar tracking and advanced heart monitoring are two key growth areas, as they can take readings in real-time and then share and store patient data with their care team.

CONNECTIVITY IN A PORTFOLIO CONTEXT

The Connectivity theme lives up to its name by connecting innovative technology and physical infrastructure. We believe this attribute makes the space particularly attractive from a portfolio perspective. Digital infrastructure is further along the adoption curve, falling into the core of the Early Majority phase, and indicating that adoption levels are high and rising. IoT is growing in interest, moving further into the Early Adopters phase, but remaining at a low absolute level.

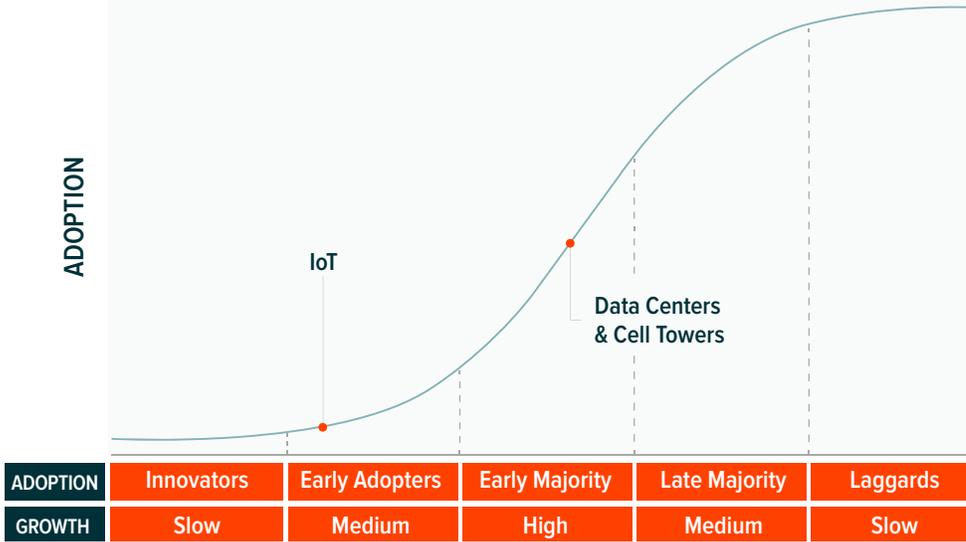
The companies implementing Connectivity technologies are global and stand to benefit as thematic adoption rises across the world. The pie charts on the next page break down the geographic exposure of the largest Connectivity thematic ETF products. We believe there is ample innovation occurring outside of the states, and that limiting exposure to the U.S. will exclude key players to the detriment of investors over the long term.

In our view, thematic equity should be targeted, using screens to ensure the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products. We conducted an overlap analysis between Connectivity thematic ETFs, the S&P 500, MSCI ACWI and the most applicable S&P 500 sector ETF for each exposure, XLK



THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021



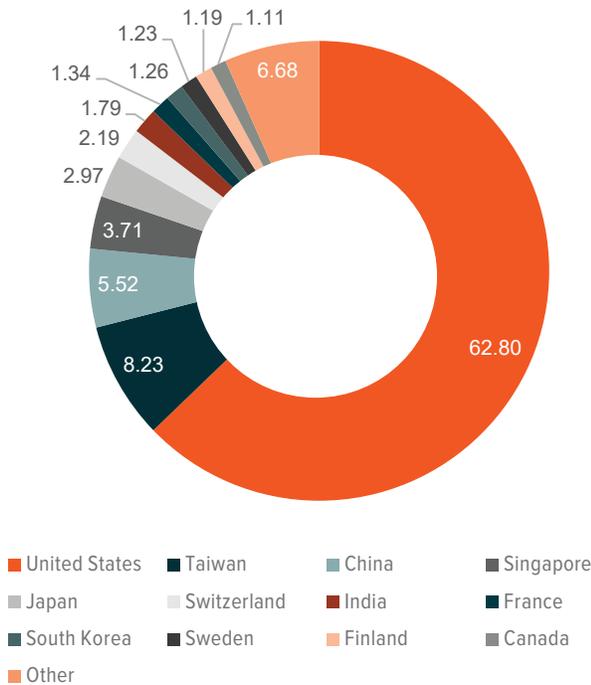
(Technology Select Sector SPDR Fund) for internet of things, and XLRE (Real Estate Select Sector SPDR Fund) for digital infrastructure. We found that average overlap by weight for internet of things was 8.9% when compared to the S&P 500, 7.2% vs. the MSCI ACWI, and 11.7% vs. XLK. Digital Infrastructure scored lower on broad indexes, 2.1% when compared to the S&P 500 and 1.3% vs. the MSCI ACWI, but scored much higher compared to XLRE at 28.0%.³³ These low levels of overlap with broad indexes reflect the benefits of thematic exposure.

The Connectivity theme continues to mature, creating attractive opportunities for long-term investors. The internet of things is now a core technology with connected consumer devices growing in capability and commonality while industrial applications catalyze the Fourth Industrial Revolution. Simultaneously, the digital infrastructure that this connectivity requires continues to advance, including 5G networking technology that provides users with wireless speeds that dwarf those of previous generations.

With data expected to increase exponentially, investment in digital infrastructure has skyrocketed in recent years with wireless providers looking to ensure that their networks can handle the demand. Investment in new and enhanced cell towers and data centers is another sign of the Connectivity theme's maturation, as they can democratize access to the massive processing power of the increasingly connected world.

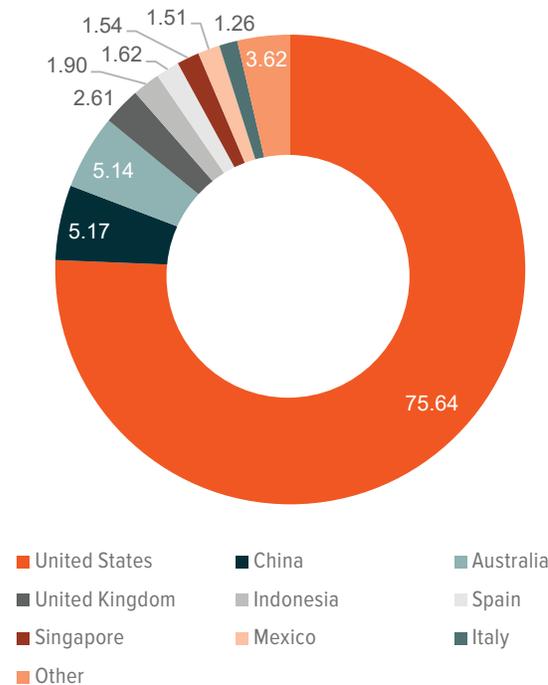
IIOT: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



DIGITAL INFRASTRUCTURE: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.

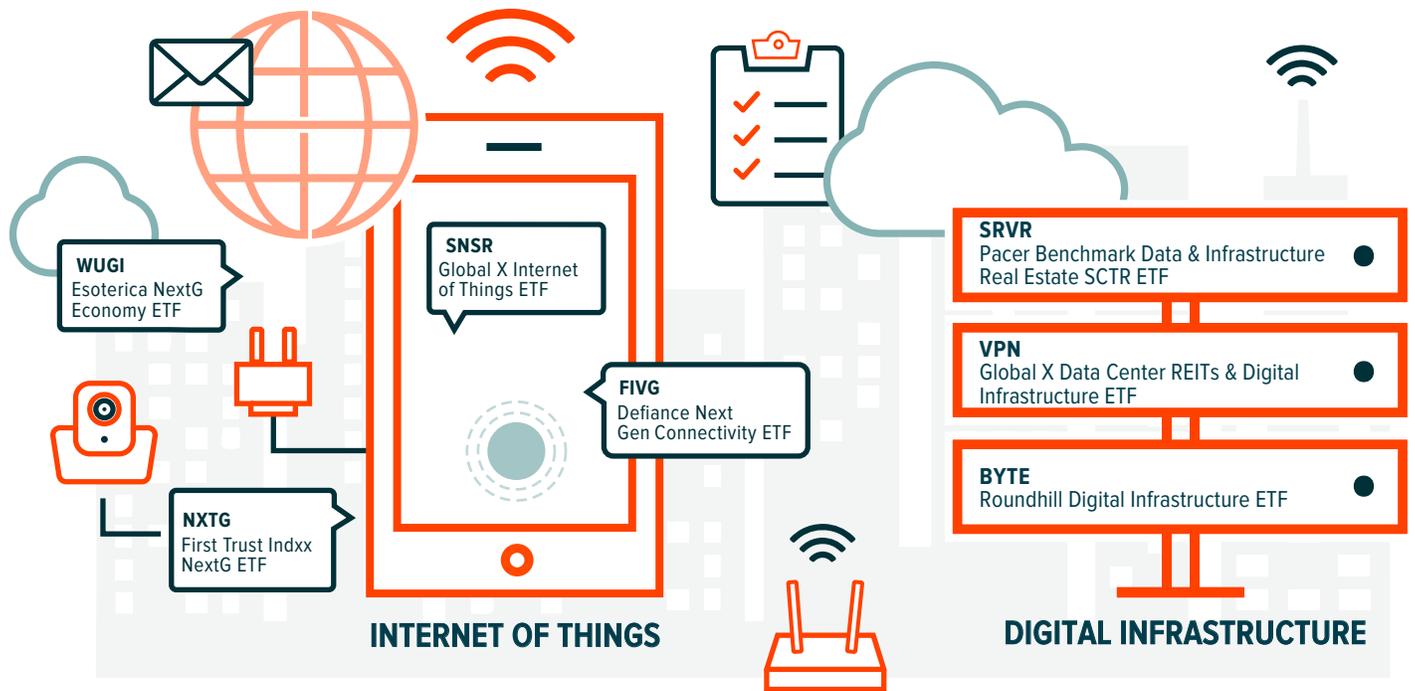


Note: Pie charts include the largest four internet of things and all three digital infrastructure ETFs according to our thematic classification. All Thematic ETFs weighted the same.



HOW TO ACCESS CONNECTIVITY

The graphic below identifies some U.S. listed ETFs that provide direct exposure to the Digital Infrastructure and Internet of Things themes.





CONNECTIVITY FOOTNOTES

- ¹ Juniper Research, IoT Connections to Reach 83 Billion by 2024, Driven by Maturing Industrial Use Cases, 3/31/20
- ² CTIA, 2021 Annual Survey Highlights, 7/27/21
- ³ Sumo Logic, How Much Data Comes From The IoT?,
- ⁴ Deloitte, Connectivity and Mobile Trends Survey: 2020, 2020
- ⁵ Deloitte, Connectivity and Mobile Trends Survey: 2021, June 2021
- ⁶ CTIA, 2021 Annual Survey Highlights, 7/27/21
- ⁷ IoT Analytics, State of IoT 2021: Number of connected IoT devices growing 9% to 12.3 billion globally, cellular IoT now surpassing 2 billion, 9/22/21
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- ¹¹ McKinsey, COVID-19: An inflection point for Industry 4.0, 1/15/21
- ¹² ReportLinker, Data Center Construction Market - Global Outlook and Forecast 2021-2026, February 2021
- ¹³ ReportLinker, Data Center Construction Market - Global Outlook and Forecast 2021-2026, February 2021
- ¹⁴ SolidSignal, How far away can your phone be from the tower?, 4/15/19
- ¹⁵ ExtremeTech, ExtremeTech Explains: What is LTE?, 4/1/15
- ¹⁶ Bank My Cell, November 2021 Mobile User Statistics, Accessed 11/22/21
- ¹⁷ Wireless Estimator, Top 100 Tower Companies in the U.S., 9/11/20
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- ¹⁹ CTIA, 2021 Annual Survey Highlights, 7/27/21
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- ²¹ CTIA, 2021 Annual Survey Highlights, 7/27/21
- ²² CTIA, 2021 Annual Survey Highlights, 7/27/21
- ²³ IoT Analytics, 20 million cellular IoT chips missing in 2021 due to global supply shortage as Qualcomm continues to lead the market, 8/24/21
- ²⁴ ZD Net, Developer burnout and a global chip shortage: The IoT is facing a perfect storm, 5/19/21
- ²⁵ Grand View Research, 5G Infrastructure Market Size, Share & Trends Analysis Report By Component (Hardware, Services), By Spectrum (Sub-6 GHz, mmWave), By Network Architecture, By Vertical, By Region, And Segment Forecasts, 2021 – 2028, July 2021
- ²⁶ Mordor Intelligence, Data Center Services Market – Growth, Trends, COVID-19 Impact and Forecasts (2021 – 2026), 2021
- ²⁷ Mordor Intelligence, Internet of Things (IoT) Market - Growth, Trends, COVID-19 Impact, and Forecasts (2021 - 2026), 2021
- ²⁸ Capacity, When the chips are down, 10/15/21
- ²⁹ Tech Republic, Cybersecurity report: Average household hit with 104 threats each month, 11/30/20
- ³⁰ Juniper Research, IoT Connections to Reach 83 Billion by 2024, Driven by Maturing Industrial Use Cases, 3/31/20
- ³¹ Fortune Business Insights, Fitness Tracker Market Size, Share & COVID-19 Impact Analysis, By Device Type (Smart Watches, Fitness Bands, Smart Glasses, Smart Clothing, and Others), By Application (Heart Rate Tracking, Sleep Measurement, Glucose Measurement, Sports, Running, Cycling Tracking), By Distribution Channel (Online, Retail, and Others) and Regional Forecast, 2021-2028, May 2021
- ³² Deloitte, Connectivity and Mobile Trends Survey: 2021, June 2021
- ³³ ETF Action data as of 2/17/22

Investing involves risk, including the possible loss of principal. Narrowly focused investments may be subject to higher volatility. Technology-themed investments may be subject to rapid changes in technology, intense competition, rapid obsolescence of products and services, loss of intellectual property protections, evolving industry standards and frequent new product productions, and changes in business cycles and government regulation.

Index returns are for illustrative purposes only and do not represent actual fund performance. Indices are unmanaged and do not include the effect of fees, expenses or sales charges. One cannot invest directly in an index. Past performance does not guarantee future results.

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How Data & Connectivity Relate to the **Physical World**

In the digital era, everything is becoming more connected and data dependent. Building on the growing pool of data and connections, improved automation systems are changing how processes are run, impacting the future of manufacturing and mobility.

KEY MEGA THEMES:

- Robotics
- Mobility



ROBOTICS & ARTIFICIAL INTELLIGENCE

A constant throughout history is that humans continually look for ways to make work more efficient. With Robotics & AI themes creeping into everyday life, we believe automation is the next step in society's technological evolution. The adoption of robotic and AI tools combined with internet of things (IoT)-based sensors and massive scale cloud computing is sparking the Fourth Industrial Revolution (Industry 4.0), which we expect to increase the efficiency and effectiveness of factory-based production.

KEY TAKEAWAYS

- Robotics solutions look increasingly appealing as their costs fall while wages rise, populations age, and supply chain pressures persist, the result of which is likely a reshoring of manufacturing.
- By leveraging internet of things and cloud computing technologies, automated production systems can gain in efficiency, capability, and performance.
- The Robotics & AI theme is experiencing accelerating adoption, indicating entrance into the Early Majority stage, and signaling an attractive opportunity for portfolio positioning.

WHY ROBOTICS & AI IS SUCH A POWERFUL FORCE

Robotics and AI are the engines behind an impending Fourth Industrial Revolution

Like previous revolutions, the integration of new technologies could define Industry 4.0, key among them robotics and the internet of things. Together, these technologies are expected to create interconnected manufacturing systems that communicate, analyze, and use data to create positive feedback loops, adapt to changing needs, and increase productivity.

The pinnacle of effective robotic and networking integration is the smart factory — a completely automated production facility that uses data from connected devices to learn and adapt. With this predictive flexibility, smart factories may reduce downtime by auto-scheduling repairs and maintenance when input levels are low or finished product levels are high.

This next-generation production comes as trade wars, supply shocks, and a pandemic reminded the global economy of the fragility and interconnectivity of manufacturing networks. Globalization peaked around 2008, and since then countries have rethought their international trade dependence, reducing the global value of exported goods relative to GDP.¹ COVID-19 only expedited the deglobalization trend. In a 2020 Thomas Industrial survey of 746 manufacturing and industrial companies, 69% of respondents said that they were looking to bring production back to America, and 55% said that they were likely to invest in automation.²

Robot economics are becoming more cost-effective

As manufacturers eye domestic production, the significant cost differential between human and robotic labor grows in stature. Higher wages for humans make automated labor more attractive as firms look for ways to maintain price competitiveness. The average yearly U.S. manufacturing wage neared \$50,400 in September 2021, up from \$46,600 at the beginning of 2020.³ So, for example, despite an estimated upfront cost of \$250,000 for a sophisticated industrial robotic arm, a company could potentially break even in less than two years compared to what traditional labor costs.⁴

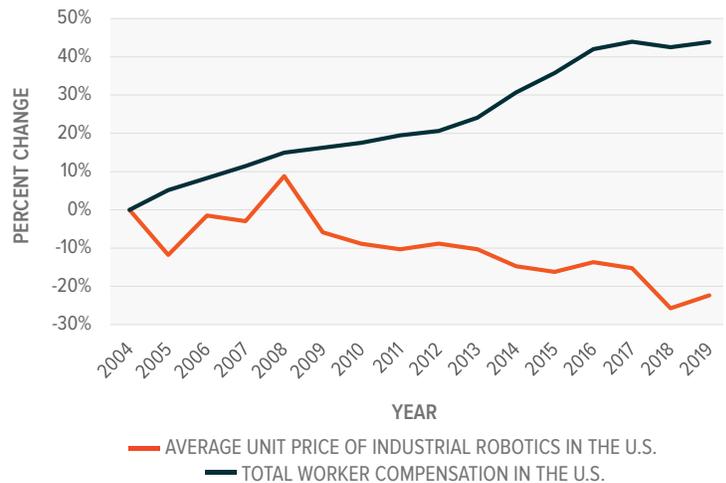
These economics are likely to become more attractive as robotics improve in function and affordability. The average robot price has fallen by more than 50% in real terms over the last 30 years, while labor costs have increased by more than 100%.⁵ These cheaper robots are significantly more advanced than older versions. Along with higher dexterity, advanced 3D vision capabilities and swappable end-of-arm tooling create more dynamic robots that are able to perform multiple functions with the capability to improve with software updates.

Robotics can improve human productivity

Collaborative robots, also known as cobots, work alongside humans, taking on repetitive tasks that are prime sources of boredom and injury. This combination approach plays to the strengths of both labor sources because it decreases the error rate while increasing production efficiency.⁶

PRICE OF INDUSTRIAL ROBOTS VS TOTAL WORKER COMPENSATION IN THE US

Source: International Federation of Robotics, May 2021, Economic Policy Institute, February 2020.



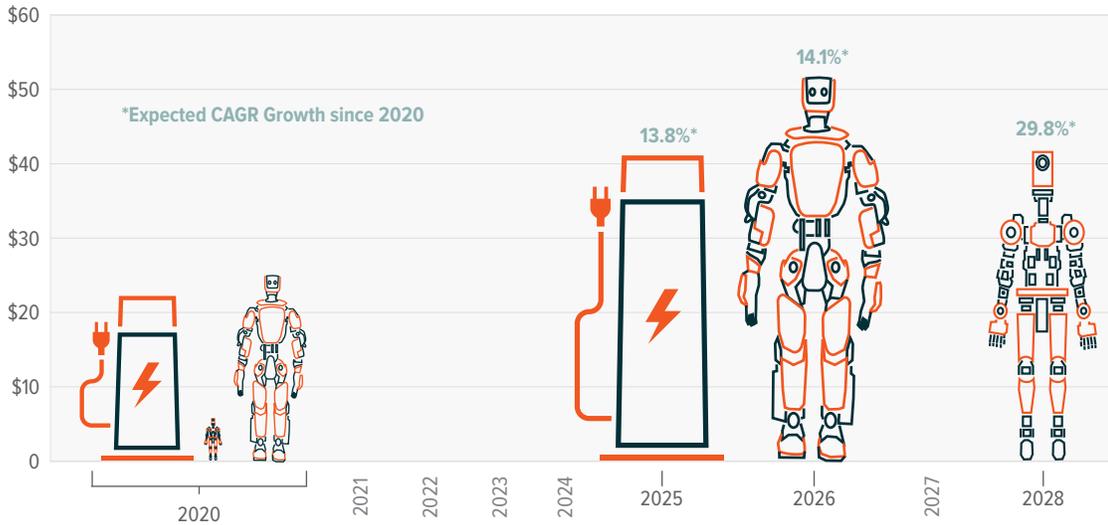
An increasingly automated future may be necessary given the world's rapidly aging workforce. The World Health Organization (WHO) predicts that between 2015 and 2030 the proportion of the global population aged over 60 will nearly double from 12% to 22%.⁷ Domestically, 65+ age bracket comprises an even larger percentage of the population at 16.3% as of the 2020 census, and it's expected to grow to 20%+ by 2030, surpassing the under 18 age group.^{8,9}

This trend is positive overall because it suggests that people are living longer and healthier lives due to advancements in healthcare. However, with age comes metabolic and cellular decline that can compromise physical and mental capacity, which the workplace can expose. This lower productivity at the individual worker level translates into lower GDP growth nationally. A 10% increase in the fraction of the population aged 60+ decreases the growth rate of GDP per capita by 5.5%.¹⁰ Robotics adoption can help offset these declines. A 1-unit increase in robotic density, or the number of robots per 10,000 manufacturing workers, increases labor productivity by 0.04% while potentially freeing up labor for use elsewhere in the economy.¹¹



VISUALIZING THE MARKET OPPORTUNITY

ROBOTICS: EXPECTED GROWTH IN BILLIONS^{12,13,14}



Non-industrial Robotics

Robots and AI used for non-industrial applications, such as health care, hospitality, and consumer uses.



Industrial Robots and Automation

Robots and robotic automation products and services with a focus on industrial applications, such as smart factories.

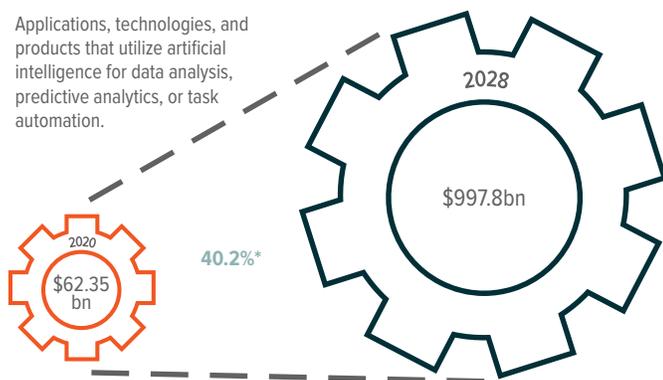


Unmanned Vehicles and Drones

Self-driving or autonomous vehicles and drones for military, consumer, and commercial uses.

ARTIFICIAL INTELLIGENCE: EXPECTED GROWTH IN BILLIONS¹⁵

Applications, technologies, and products that utilize artificial intelligence for data analysis, predictive analytics, or task automation.



The global market for Artificial Intelligence applications is expected to expand at an impressive **40.2% CAGR** to reach **almost a trillion dollars in total value by 2028.**

RISKS TO THE ROBOTICS & AI THEME

A China slowdown could have an outsized impact

China is the largest and fastest-growing global market for robotics, having installed more industrial robots than the next four countries combined.¹⁶ In Q1 2020, when Chinese factories were shuttered due to COVID-19, industrial robotic sales there fell by 20% year-over-year, and international suppliers felt the decline.¹⁷ Then, as the rest of the world shut down and China returned to life, it installed more industrial robotics than the next 15 largest markets combined.¹⁸ This surge resulted in the five largest industrial robotics suppliers by revenue deriving roughly 20% of their income on average from Chinese purchases during 2020.¹⁹

Regulatory risks could dampen U.S. adoption

The U.S. could catch up to China as reshoring of manufacturing continues. However, a risk to large increases in domestic robot density is that it can result in public backlash. We see the potential for robotics adoption to rise alongside income inequality, and we see the potential for policy makers to respond by enacting new taxes and regulations. So-called robot taxes would serve two purposes: To disincentivize firms from replacing workers with robots and to supplement lost payroll tax revenue. By design, these

policies would be destructive for the Robotics & AI theme. While not a near-term issue, if such policies were to have any chance of passing in the future, the stock price reaction would likely be dramatic.

Manufacturing is particularly exposed to cyber threats

Like any technology, robotics manufacturers can be hijacked by malicious actors, whether cybercriminals, competing companies, or foreign states. Verizon data shows that the manufacturing industry had the third-highest level of large-scale data breaches in 2020, with system intrusions due to hacking and malware especially common.²⁰ Unauthorized access is a particular concern because most robotic systems are designed to interact with and manipulate objects in the real world.

However, cybersecurity programs remain underfunded. Manufacturers typically operate on thin margins, leaving cybersecurity a lower priority than capex spending that can increase productivity or output. According to information technology solutions company CDW, just 22% of manufacturing firms who experienced an attack in recent years increased their cybersecurity budgets, while about half did nothing at all.²¹ As production continues to automate, securing connected devices will require additional investment.



THEMATIC INTERSECTION WITH ROBOTICS & AI

Internet of Things and Cloud Computing

The Robotics & AI, IoT, and Cloud Computing themes fit together perfectly. The IoT theme likely represents the biggest integration opportunity because IoT sensors are core to Industry 4.0 and smart factory trends. As sensor costs continue to fall, the accuracy and availability of data captured from robotic systems may increase. These developments should create a positive feedback loop spurring robotic purchases as updated sensor packages increase the effectiveness of machines young and old.

Cheaper processing power due to further maturation of the Cloud Computing theme allows AI tools to make quicker and more accurate judgements from sensor data. We expect such insights to drive efficiency gains, and increased factory performance could promote expansion via further robotics spending.

Cybersecurity

The downside of all this connectivity is that manufacturers are regular targets for digital intrusions. We expect their responses to this growing threat to improve significantly due to the increasing cost of malicious activity and the growing integration of technology in production. To this end, increased spending on robotics necessitates increased spending on cybersecurity initiatives. Co-positioning with the Cybersecurity theme may help to lessen cybersecurity risks from the roboticized manufacturing space.

ROBOTICS & AI IN A PORTFOLIO CONTEXT

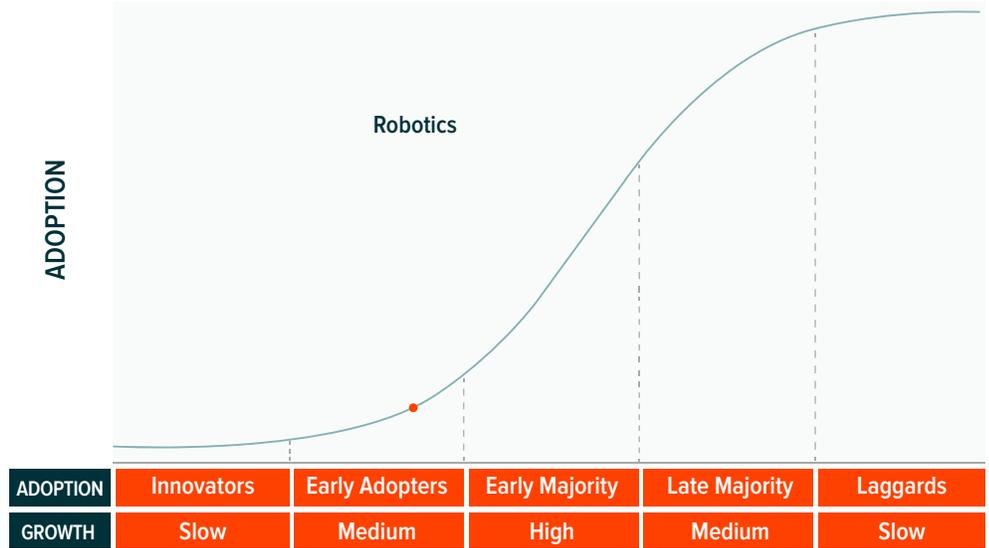
The Robotics & AI theme is quietly humming along, integrating itself into the global economy. Falling squarely into the Early Adopters phase, robotic penetration levels are moderate today, but are accelerating quickly, as technological advancements enable Robotics & AI to play increasingly impactful roles. We believe that adoption levels are set to expand rapidly in the coming years, as firms and individuals leverage robot and AI tech in new and exciting ways.

The companies implementing Robotics and AI technologies are global and stand to benefit as thematic adoption rises across the world. The pie chart breaks down the geographic exposure of the largest Robotics and AI thematic ETF products. We believe there is ample innovation occurring outside of the states, and that limiting exposure to the U.S. will exclude key players to the detriment of investors over the long term.

In our view, thematic equity should be targeted, using screens to ensure the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes, while also differentiating the exposure provided by the theme relative to broad beta products. We conducted an overlap analysis between Robotics and AI thematic ETFs, the S&P 500, MSCI ACWI and the most applicable S&P 500 sector ETF, XLI (Industrial Select Sector SPDR Fund). We found that average overlap by weight for Robotics and AI focused ETFs was 5.7% when compared to the S&P 500, 5.2% vs. the MSCI ACWI, and 2.4% vs. XLI.²² Common holdings included medically focused robotics producers, semiconductor firms that produce AI chips, and heavy machinery manufacturers, collectively totaling just a handful of individual companies. These low levels of overlap with broad indexes reflect the benefits of thematic exposure.

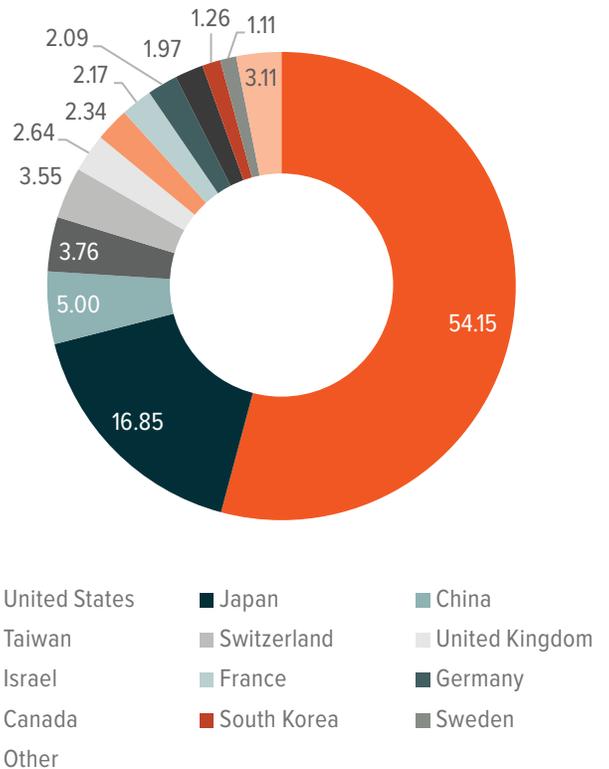
THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021.



ROBOTICS AND AI: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



Note: Pie chart includes the largest five robotics and AI ETFs according to our thematic classification. All Thematic ETFs weighted the same.

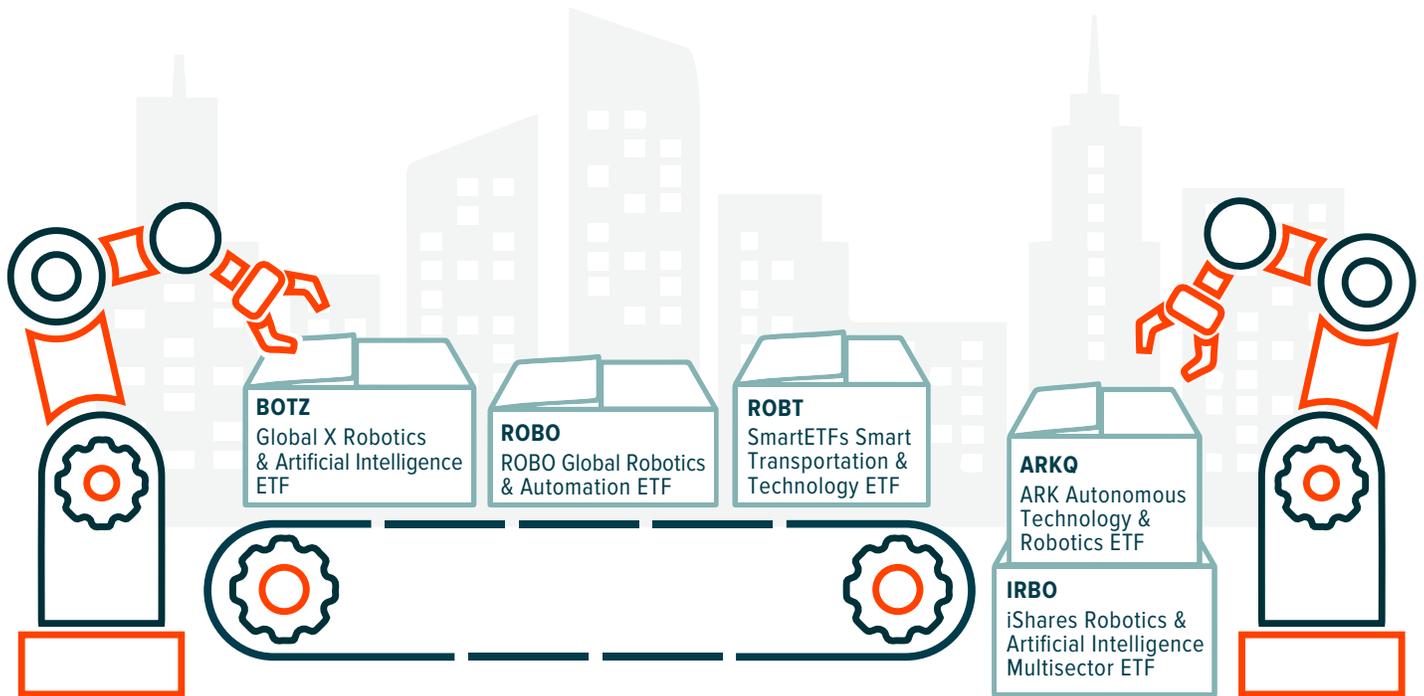


The Robotics & AI theme sits at the crossroads of multiple structural trends that are expected to increase adoption in the coming years. Rising inflation, supply chain disruptions, deglobalization, and aging populations have firms exploring solutions to enhance manufacturing efficiency and reduce costs. As automation becomes increasingly capable, cheaper, and easier to implement, reshoring will likely accelerate as firms see that the benefits of more localized manufacturing outweigh the risks of producing goods far abroad.

From this perspective, the space looks primed for investment as catalysts drive Robotics and AI adoption into the Early Majority stage. The global average robotic density is at just 126 per 10,000 employees, illustrating the scale of the opportunity as automation begins to answer the problems of today with the machines of tomorrow.²³

HOW TO ACCESS ROBOTICS & AI

Eleven U.S. listed ETFs provide direct exposure to the Robotics & AI theme, the graphic below identifies the five largest.





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Investing involves risk, including the possible loss of principal. Narrowly focused investments may be subject to higher volatility. Technology-themed investments may be subject to rapid changes in technology, intense competition, rapid obsolescence of products and services, loss of intellectual property protections, evolving industry standards and frequent new product productions, and changes in business cycles and government regulation.

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MOBILITY (EV/AVs & LITHIUM/ BATTERY TECHNOLOGY)

Electronic and autonomous vehicles (EV/AVs) highlight the Mobility theme's potential, as they represent an entirely new class of everyday consumer goods and services that use artificial intelligence (AI) for their core functionality. The EV/AV revolution runs parallel to electrification via lithium-based batteries, a similarly influential component of Mobility. As disruption in the transportation sector takes hold, we expect the benefits of EVs, AVs, and lithium battery technologies to proliferate across the global economy.

KEY TAKEAWAYS

- Consumer appetite for EVs is high. A recent survey revealed that 7 out of 10 U.S. drivers would be interested in buying when EV charging infrastructure expands, and EV costs drop.¹
- Better lithium-ion technology will increase the amount of lithium used in each EV battery. Lithium demand is expected to more than double from 300,000 mt in 2020 to 1 million mt by 2025 and reach 2 million mt by 2030.²
- We expect the integration of robotics, AI, and internet of things (IoT) technologies to propel the Mobility theme and eventually the adoption of fully autonomous EVs.

WHY AV AND EVS ARE SUCH POWERFUL FORCES

Mobility is becoming cleaner, smarter, and more autonomous

Using AI to compute billions of data points per second supplied from an array of sensors, cameras, and radar systems, AVs can effectively see the road and respond accordingly to changing conditions. By communicating with and integrating data from neighboring vehicles and even the roadways at large, AVs are expected to reduce accident rates, increase throughput and decrease travel time.

Fully autonomous vehicles remain years away, but it's not too early to project the economic efficiencies they could bring. Trucking company Ryder estimates a fully autonomous truck and transfer hub network could reduce costs by 29–40%, decreasing empty trailer time while increasing flexibility.³ Such efficiency gains would revolutionize domestic supply chains, increasing the availability of lower-priced goods. Effective AV technology

will also allow non-commercial drivers to reclaim hours each day spent commuting, which currently total 70 billion hours per year in the U.S.⁴ This found personal time represents a massive opportunity because it creates a distinct space for rest, relaxation, content consumption and productivity.

Regulation remains a key consideration for the development of autonomous vehicles. Recently, the U.S. National Highway Traffic Safety Administration (NHTSA) issued new rules for future fully autonomous vehicles, providing some regulatory clarity to AV OEMs. The new rules eliminate the requirement for driverless vehicles to include manual controls, such as pedals and steering wheels. This change could accelerate the path-to-market for AVs by bringing regulatory policy more in line with the AV development cycle, while ensuring safety standards.

EVs are nearing broad market adoption

With over 1.8 million EVs registered in the U.S. as of the end of 2020, many Americans are already zooming around in emission-free vehicles.⁵ U.S. adoption of electric vehicles slowed in 2021 despite increasing in other regions of the globe. Given polls showing that 7 out of 10 U.S. drivers are interested in buying an EV should charging infrastructure proliferate and costs drop, we believe that a confluence of policy changes and technological advancement will spark higher adoption rates.⁶

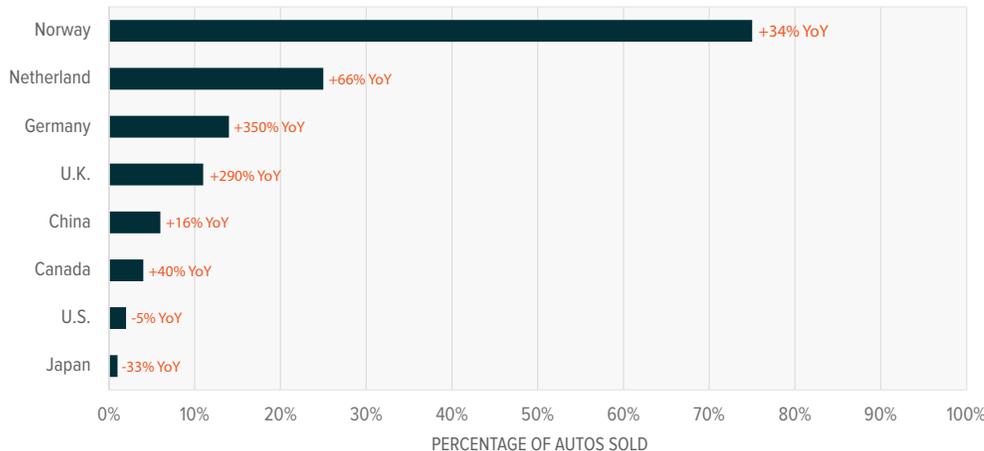
Norway, the global leader in EV adoption, offers a roadmap. In 2020, 75% of cars sold in Norway were electric.⁷ The country plans to sell its last internal combustion engine (ICE) vehicle in 2025, a rapid transition sped up by aggressive policy changes. Policies include an exemption of EVs from a value added tax (VAT) and vehicle purchase taxes, which in some cases can lower the purchase cost by nearly 50% compared to an equivalent ICE vehicle. Another perk is EV access to bus lanes, which can shorten travel times.⁸ The World Economic Forum believes these policies closed the price gap between EVs and ICE vehicles in Norway.⁹

U.S. to ramp up investment in charging infrastructure

The U.S. lags many European nations due in part to limited EV incentive structures. Forty-five states and D.C. offer some form of incentive, but the federal government hasn't passed any new subsidies since 2009, and many popular EV models are no longer eligible.¹⁰ President Biden's Build Back Better bill may be able to address this relative shortfall by restructuring incentive programs and offering expanded tax credits should vehicles meet a wider set of conditions. The bill's passage remains uncertain, but it indicates that policy makers recognize that an enhanced incentive program is key to spur domestic EV adoption.

EV'S SHARE OF AUTOS SOLD IN 2020

Source: IEA data as of April 2021.



Note: Above reflects select markets. Other markets may have +/- EV share, though Norway leads.

“Over 1.8 million EVs registered in the U.S. as of 2020. In the same year, 75% of cars sold in Norway were electric.”



In the geographically expansive U.S., the build-out of charging infrastructure will take time. The number of public charging stations has more than tripled since 2015, but the U.S. has a long way to go. EV charging stations total roughly 48,400, with just 5,398 classed as DC Fast Chargers, compared to more than 150,000 gas stations.^{11,12} More DC Fast Chargers are essential, as less powerful options can take substantial time to recharge, increasing the perceived inconvenience of EVs. The \$7.5 billion in grant funding for a national network of charging stations contained in the Infrastructure Investment and Jobs Act will not solve the charger shortage. However, it is the first federally lead investment in charging infrastructure, and it could portend the strategic direction of future funding.

Private investment is following suit with original equipment auto manufacturers and independent charging companies expanding their networks. Tesla and Electrify America, a subsidiary of Volkswagen, pledged to triple and double the size of their charging networks, respectively, over the next two years. Sizable private investment alongside public support will likely be able to address infrastructure shortfalls in the coming years.

Another factor working against large-scale adoption of EVs thus far in the U.S. and elsewhere is their premium cost. Incentives such as tax breaks and rebates may help close this gap, based on the success of such programs in Europe and China. But even without subsidies, EVs are expected to be cheaper than ICE vehicles in only about five years as battery costs continue to fall.¹³

Cheaper batteries are expected to lower EV prices

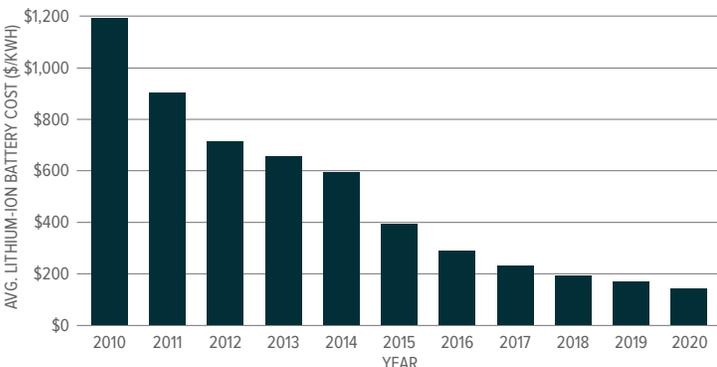
[Global X Research](#) estimates that battery costs could be cut in half by 2030.¹⁴ Worldwide, the lithium battery market is expected to grow by a factor of 5–10x over the next decade.¹⁵ As of this writing, supply restrictions and rising demand increased lithium prices by 225% in 2021.¹⁶ Lithium demand is expected to more than double from 300,000 mt in 2020 to 1 million mt by 2025, and then reach 2 million mt by 2030.¹⁷

At the core of each battery is lithium metal. As demand grows, EVs could use up to 75% of all newly mined lithium by 2025.¹⁸ As the 33rd most common element in the Earth's crust, there is no shortage.¹⁹ But it takes time to bring additional supply online. Improvements to lithium-ion technology will increase per battery lithium utilization. Currently, most batteries use lithium in the cathode component, while next-generation batteries will likely place lithium in the anode as well.

Transitioning to a green energy economy will also require massive capacity of long-duration, grid-scale storage. Lithium-ion batteries are the most common battery storage option today, accounting for more than 90% of global grid battery storage.²⁰ Lightweight and energy dense, lithium-ion batteries discharge quickly and can be assembled into modular and flexible energy storage systems.

DECLINING BATTERY COSTS SHOULD DRIVE EV & LITHIUM DEMAND

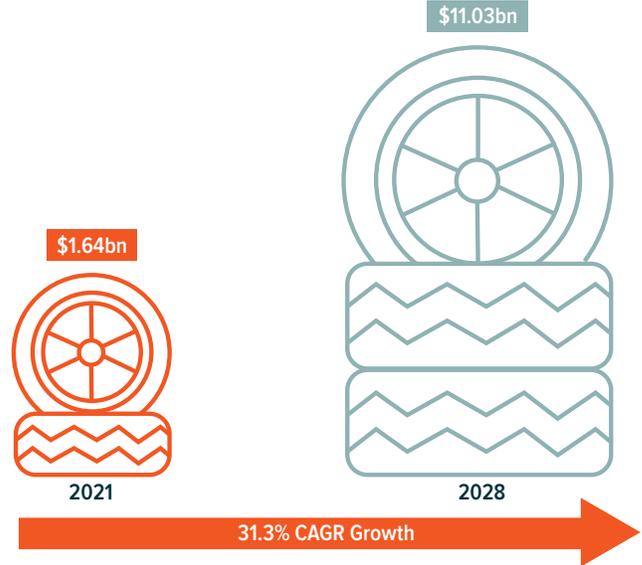
Source: Bloomberg New Energy Finance data as of December 2020.



The Hornsdale Power Reserve in Australia, the largest lithium-ion battery installation in the world when built, prevented a cascading blackout in 2017 when a large coal power plant fell offline. The storage system supplied several megawatts of power within milliseconds and supported the grid until another plant came online. This capability demonstrates the benefits of battery storage, even outside of a renewables context.

VISUALIZING THE MARKET OPPORTUNITY

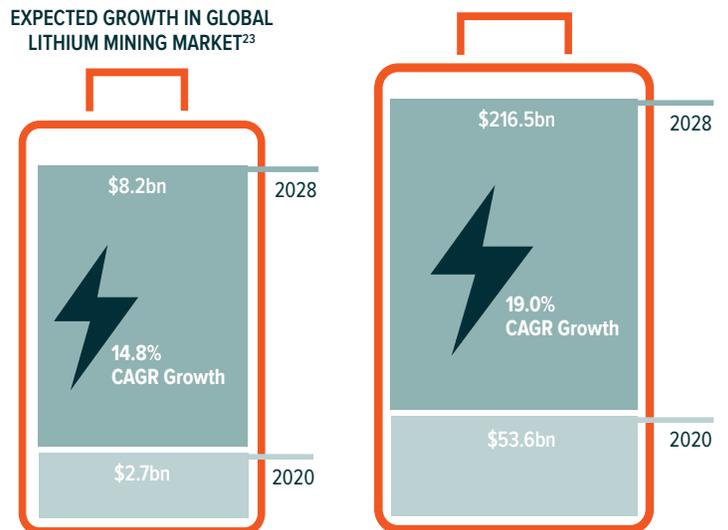
EXPECTED GROWTH IN GLOBAL AUTONOMOUS CARS MARKET²¹



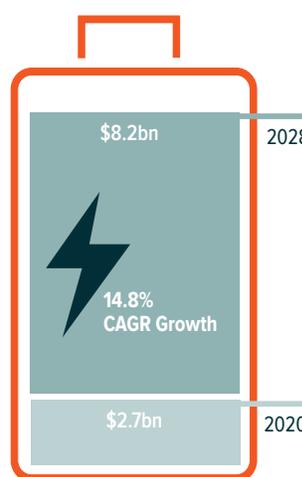
EXPECTED GROWTH IN GLOBAL EV MARKET²²



EXPECTED GROWTH IN GLOBAL LITHIUM-ION BATTERY MARKET²⁴



EXPECTED GROWTH IN GLOBAL LITHIUM MINING MARKET²³





RISKS TO THE MOBILITY THEME

Restrictive regulations could stunt adoption

We believe the main risk to the adoption of fully autonomous vehicles is a mismatch between their technological advancement and consumer expectations. According to the National Highway Traffic Safety Administration (NHTSA), the highest level of autonomous systems currently available in the U.S. is Level 3, where the automated driving system can perform all aspects of driving under some conditions. However, a human driver must be ready to take back control at any time.²⁵

Object detection and classification failures by autonomous systems have led to driver and pedestrian fatalities due to driver negligence. Such events are rare but well-publicized, and they can result in state governments restricting autonomous vehicle testing on their roads. For example, California banned a leading ride share company's self-driving cars for nearly two years following a 2018 crash that resulted in the first documented death of a pedestrian.²⁶

Environmental costs can be high

EVs and battery technology represent green tech, but another risk to the Mobility theme is that they have their environmental problems, too. Extraction and processing of any raw material creates externalities, and lithium is no different. The two most common extraction methods source the metal from underground brine reservoirs or mined lithium containing rocks.

Both methods create carbon emissions while using water and land resources. On average, producing a ton of lithium from hard rock sources yields 9 tons of CO₂, reducing emissions savings of end-use applications.²⁷ Newer methods such as brine recovery limit emissions to a third of traditional methods, but they can cause other issues such as watershed contamination.²⁸ With focus shifting to more holistic supply chains, these issues may grow in stature.

Connected vehicles create opportunities for cybercriminals

Like other themes that rely on connectivity, cybersecurity is a risk for Mobility. In a now-famous story from 2015, Wired magazine worked with a hacker group to demonstrate the vulnerabilities in connected vehicles.²⁹ Remotely accessing a Jeep while it was traveling 70 mph on a highway, the hackers cut engine power, engaged and then removed access to breaks, and changed radio and climate settings. This specific vulnerability was patched, but it illustrates the potential risks consumers face as vehicles become increasingly computerized and connected. To identify and mitigate similar risks, we expect cybersecurity investments from automobile OEMs to increase.

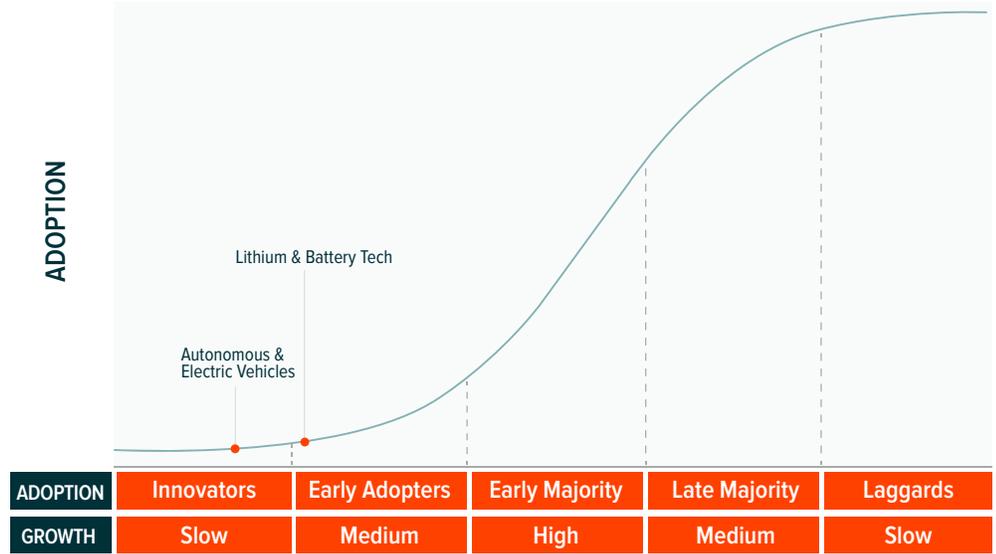
THEMATIC INTERSECTION WITH MOBILITY

Robotics & AI

At the heart of modern-day vehicles is a digital brain powered by a specifically trained AI, the most advanced of which currently enables driver-assist features such as lane departure monitoring. Eventually, this technology could enable full self-driving capabilities. Improvements in these deep learning-based image recognition systems and EV-specific semiconductors could dramatically increase operations per second

THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021.



performance, boosting the speed and ability with which autos model the road environment. This software layer can be improved more rapidly than hardware, and it can be updated and enhanced after a car rolls off of the lot.

Internet of Things

The Internet of Things theme is central to autonomous driving systems, particularly the use of sensor technology. Aggregating real-time traffic data could allow vehicles to more accurately model the world, planning out routes to increase traffic flow and improve safety. Connected sensor-based EV charging stations could monitor the number of EVs in route for a recharge, reducing downtime by automatically scheduling charger maintenance when expected vehicle demand is low. Sensors could also help route incoming vehicles to ideal charging locations with current availability.

MOBILITY IN A PORTFOLIO CONTEXT

The Mobility theme is earlier on in its life cycle than others within our coverage. While adoption of electric vehicles is gaining steam, the theme remains in the Innovators phase, held back by today's self-driving limitations. There are few pure-play EV/AV companies and even fewer are publicly traded. The space is dominated by a large pioneer, while more classical auto OEMs play catchup. Lithium and battery technology is slightly farther along, entering the Early Adopters phase as commercial uses grow and begin to scale. Over the coming years we expect both Mobility themes to progress further into the Early Adopters stage where growth accelerates while remaining at a low absolute level.

Mobility technologies are global and stand to benefit as thematic adoption rises across the world. The pie charts, on the next page, break down the geographic exposure of the largest Mobility thematic ETF products. We believe there is ample innovation occurring outside of the states, and that limiting exposure to the U.S. will exclude key players to the detriment of investors over the long term.

In our view, thematic equity should be targeted, using screens to ensure the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products. We conducted an overlap analysis between Mobility thematic ETFs, the S&P 500, MSCI

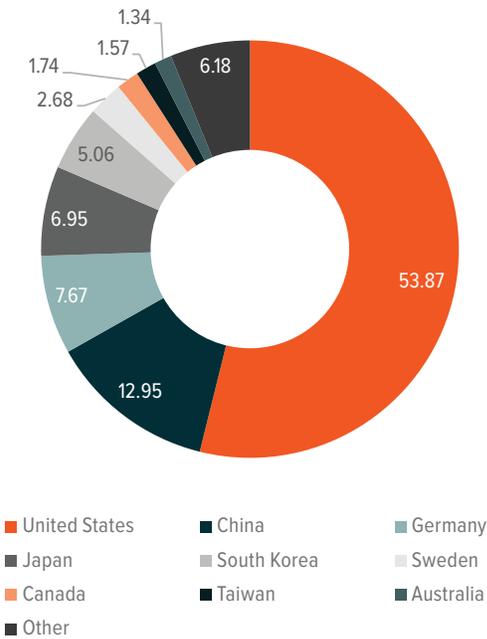


ACWI and the most applicable S&P 500 sector ETFs for each exposure, XLY & XLK (Consumer Discretionary and Technology Select Sector SPDR Funds) for electric and autonomous vehicles, and XLB (Materials Select Sector SPDR Fund) for lithium and battery technology. We found that average overlap by weight for EV/AVs was 8.3% when compared to the S&P 500, 6.7% vs. the MSCI ACWI, 7.4% vs. XLY and 8.3% vs XLK. Much of this overlap stems from traditional vehicle OEMs and large technology companies innovating in the space. Lithium and battery technology scored lower across the board, 2.0% when compared to the S&P 500, 1.6% vs. the MSCI ACWI and 1.9% compared to XLB.³⁰ These low levels of overlap with broad indexes reflect the benefits of thematic exposure, as sector indexes have yet to include substantial exposures towards Mobility themes.

Mobility innovation represents one of the most tangible areas of technological advancement for the average consumer. Battery costs are falling, while technology and performance are improving dramatically. Soon, EVs won't be a luxury choice, but an economical one. Over the next decade, electrification and automation technologies may merge to forever alter nearly all forms of transportation. The ways we commute, travel and trade could receive an upgrade, powered by a new generation of lithium-based batteries and artificial intelligence. Electric vehicles are at the precipice of transforming the automobile market, and look to be an attractive investment opportunity for years to come.

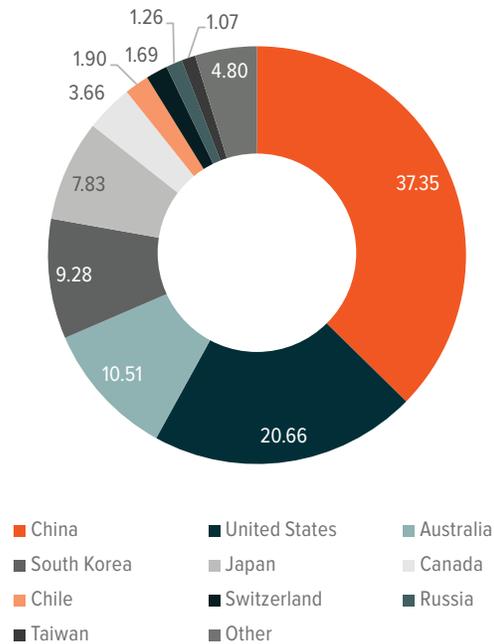
ELECTRIC & AUTONOMOUS VEHICLES: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



LITHIUM & BATTERY TECHNOLOGY: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.

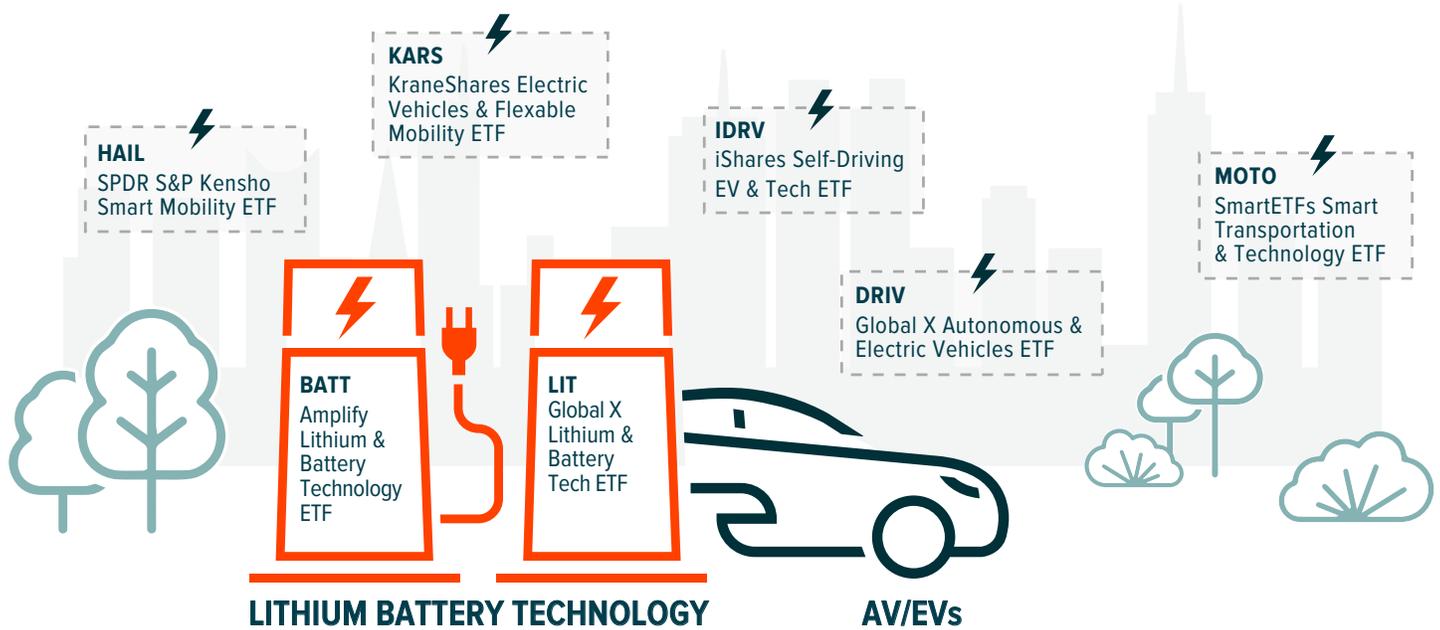


Note: Pie charts include the largest five electric and autonomous vehicles and all two lithium and battery technology ETFs according to our thematic classification. All Thematic ETFs weighted the same.



HOW TO ACCESS MOBILITY

The graphic below identifies some U.S. listed ETFs that provide direct exposure to the Mobility theme through AV/EVs & lithium/battery technology.





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- ²³ Grand View Research, Lithium Market Size, Share & Trends Analysis Report By Product (Carbonate, Hydroxide), By Application (Automotive, Consumer Goods, Grid Storage), By Region, And Segment Forecasts, 2021 - 2028, November 2021
- ²⁴ Grand View Research, Lithium-ion Battery Market Size, Share & Trends Analysis Report By Product (LCO, LFP, NCA, LMO, LTO, Lithium Nickel Manganese Cobalt), By Application, By Region, And Segment Forecasts, 2021 – 2028, July 2021
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- ²⁸ Roskill, CO2 emissions from lithium production set to triple by 2025, 10/5/20
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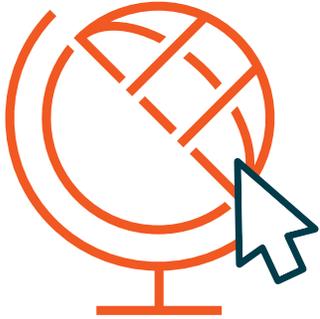
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How Data & Connectivity Relate to the Digital World

As the world becomes more digital, themes naturally converge. The metaverse, which some consider the next iteration of the internet, will transform interactions between humans and computers which could transform social interactions, commerce and so much more. Experiences in the digital world are expanding, and so too are ways to monetize engagement.

KEY MEGA THEMES:

- Digital Experiences
- FinTech



DIGITAL EXPERIENCES (SOCIAL MEDIA AND VIDEO GAMES & ESPORTS)

In 1996, Bill Gates published an essay entitled “Content is King” in which he detailed how content would capture the lion’s share of profits created by the burgeoning internet. His view hinged on users becoming personally involved with the content that they consume. Gates proved prophetic, as digital experiences grew to influence all walks of life economically, politically, and, of course, socially. As an investment theme, we believe Digital Experiences, including Social Media and Video Games & Esports, offers compelling opportunities because of the ongoing quest to monetize the attention of content consumers as the world becomes increasingly digital.

KEY TAKEAWAYS

- Social media and video game technology combine to increase user retention and engagement across social and gaming platforms. As competition in the digital economy intensifies, we expect investment in the Digital Experiences theme to grow alongside it.
- Total social media advertisement spending is expected to reach \$177 billion in 2022, overtaking television as the largest advertising market.¹
- Mobile gaming is the largest and fastest growing video game segment, boosted by widespread smartphones adoption and readily accessible casual, free-to-play games. Revenues increased 7.3% in 2021 to reach \$93.2 billion² and is expected to grow to \$218.7 billion by 2024.³

WHY SOCIAL MEDIA AND VIDEO GAMES & ESPORTS ARE SUCH POWERFUL FORCES

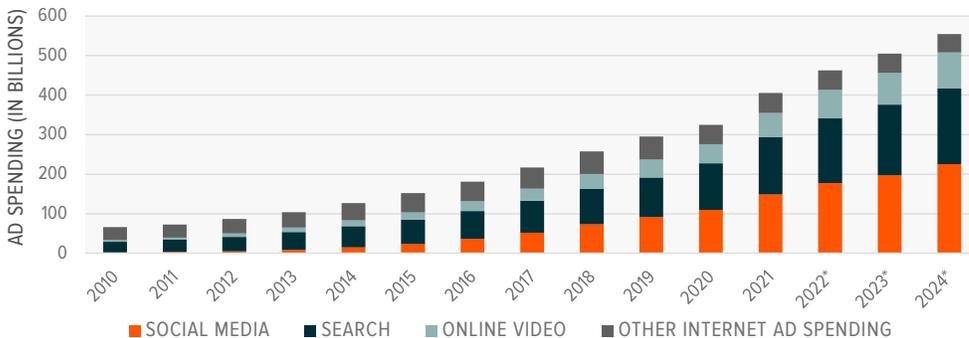
Digital Experience platforms boast large user bases. Today, more than half of the global population (7.87 billion people) use social media.^{4,5} Video games reach a slightly smaller portion of the global population, with over 40% playing video games in some form.⁶ Historically, user growth was the main method of expansion for Digital Experience firms, but now they’re shifting towards increased engagement and monetization.

Maximizing monetization

Social media platforms now focus on maximizing the revenue generated from each user. One way they do that is by selling more ads for more dollars. In 2021, global social media advertising revenue reached \$148.8 billion, equivalent to 20% of total global ad spending, or about a third of all online ad expenditures.⁷ Also, platforms are developing innovative new technologies, such as integrating in-app purchases and cash transfers,

INTERNET ADVERTISING EXPENDITURES

Source: Zenith Media data as of December 6, 2021.



*Predictions as of 12/6/2021

enabling augmented and virtual reality experiences (AR/VR), and more as they search for additional revenue streams. The metaverse, which is more of an emersion experience, and may eventually become a fully formed digital economy, could be the next digital frontier.

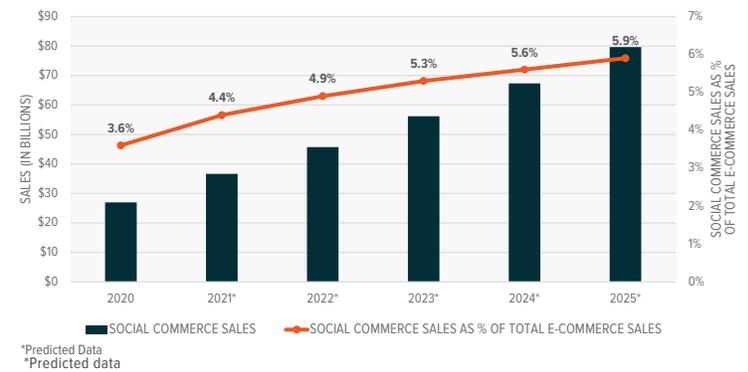
Advertisement services company Zenith Media predicts that social media will be the fastest growing advertising channel between 2021 and 2024. Total social media ad spend is expected to reach \$177 billion in 2022, overtaking television as the largest advertising market as brands leverage social media to spur further growth in ecommerce.⁸

Using social networks for commerce

Combining the visual and curated nature of social media with the ease of in-app purchases, social commerce can help capture customers’ attention and reduce friction in the purchasing process. Eighty-three percent of Instagram users say they discover new products on the platform, indicating the size and scope of the opportunity.⁹ Social commerce excels alongside influencer partnerships, as adding a known face to marketing efforts can sway consumer purchasing decisions. Among internet users in the U.S. and UK, influencers directly impact the purchases of nearly 1 in 5 social media users.¹⁰

SOCIAL COMMERCE SALES IN THE UNITED STATES

Source: eMarketer data as of February 2021, Global X Research



Moving into the metaverse

The metaverse, where the virtual world becomes a place to meet, work, and transact, is the next major step for social media. The company formerly known as Facebook, now Meta Platforms, is betting its future on the metaverse. Accessed via virtual reality headsets, such as Meta’s Oculus, the rise of the digital economy within the metaverse is likely to feature new methods of shopping, socializing, and gaming that leverage the latest technologies to create exciting new digital experiences.

Many of today’s metaverse platforms draw inspiration from the video games of the past. Debuting in 2003, Second Life was a virtual world where players could replicate much of their day-to-day lives,

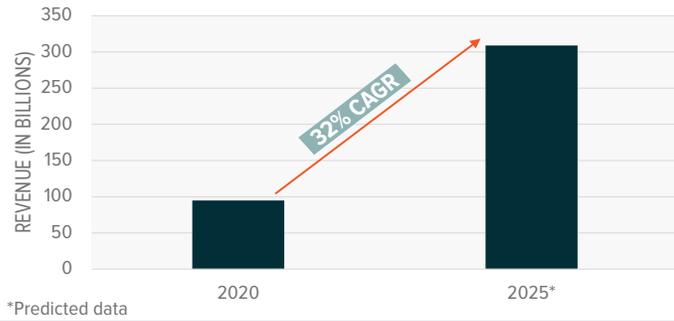
designing avatars, communicating, designing virtual objects, and conducting commerce. The game even coined the metaverse’s first millionaire in 2006, an avatar named Anshe Chung belonging to virtual real estate developer Ailin Graef.¹¹ By integrating concepts first explored by video games, the metaverse can optimize features favored by users.



VISUALIZING THE MARKET OPPORTUNITY

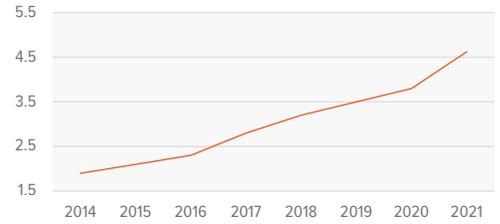
GLOBAL SOCIAL MEDIA REVENUE

Source: The Business Research Company data as of February 2022.



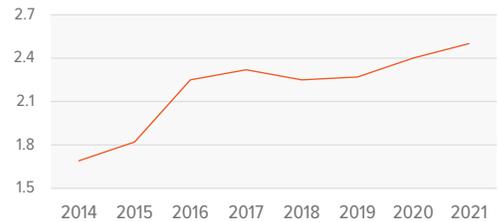
TOTAL GLOBAL SOCIAL MEDIA USERS (IN BILLIONS)

Source: The Business Research Company data as of February 2022.



GLOBAL AVE. DAILY SOCIAL MEDIA USA (HOURS PER DAY)

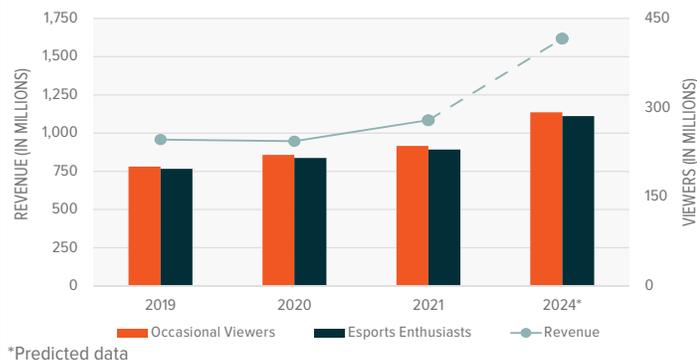
Source: The Business Research Company data as of February 2022.



Companies engaged in digital experiences are **shifting focus** from building user growth and engagement to **monetizing their networks**.

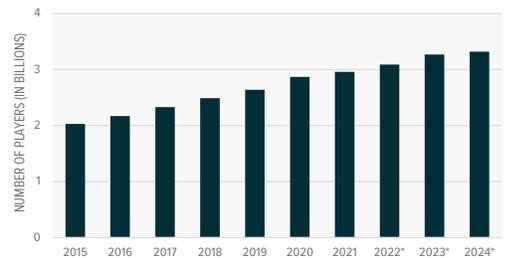
GLOBAL ESPORTS REVENUE & AUDIENCE GROWTH

Source: Newzoo data as of September 2021.



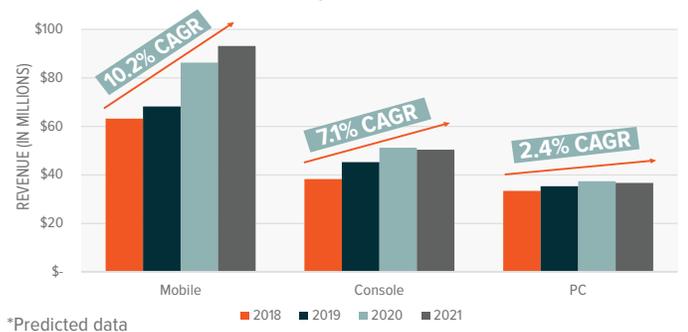
GLOBAL VIDEO GAME PLAYERS COUNT

Source: Newzoo data as of January 2022.



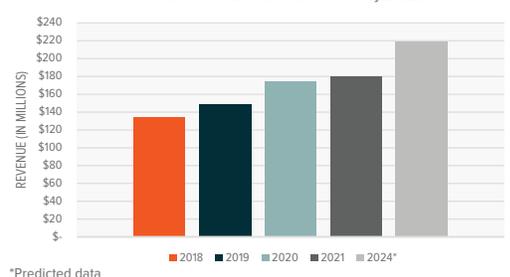
GLOBAL VIDEO GAMES REVENUE BY SEGMENT

Source: Newzoo data as of January 2022.



GLOBAL VIDEO GAME REVENUE

Source: Newzoo data as of January 2022.





Recurring revenue - downloads, subscriptions and microtransactions

Advancements in graphical technology, such as virtual reality and raytracing, make the digital world richer than ever, enticing more people to become regular consumers of video games. As opportunities for recurring revenue streams attract larger user bases and games reach new levels of emersion, we believe the industry can generate outsized returns over the long run.

In the early 2000s, buying a video game required gamers (or their parents) to go to the nearest retail store. Today, near ubiquitous access to high speed internet means that 83% of total video games sales are digital.¹² Digital delivery provides convenient access for consumers with cost benefits to the publisher. Physical distribution requires manufacturing, shipping, packaging, and wholesaling, factors that negatively impact margins. Digital distribution brings the storefront into the living room and puts games just a click away.

Digital distribution also facilitates subscription services. For a low monthly fee, gamers can access hundreds of game titles, ready to play after a quick download. Even though current offerings are largely older intellectual properties, publishers benefit from introducing players to their content.

Revenues from video games service platforms reached an estimated \$6.6 billion in 2020, and are expected to grow at a faster rate than the industry at large over the next five years.¹³

Just as Netflix disrupted the distribution model for movies and TV shows, cloud gaming could have a similar impact on the video game industry. Cloud games are streamed rather than downloaded locally. The cloud provides access to a broad library of games, playable on a variety of compatible devices, without the need to build out an expensive PC or buy a next-gen console. Newzoo, a games market insights and analytics company, estimates 164.6 million players have already switched to the cloud, paying a collective \$1.6 billion to take their games wherever they go. Over 90% of players familiar with cloud gaming have tried it or want to, indicating the size and stickiness of the opportunity.¹⁴ The transition to gaming-as-a-service can drive recurring revenue and allow for valuable usage data to be tracked more easily, resulting in targeted ads to big spending players.

For players who want to play games but don't want to pay, the free-to-play (F2P) video game market is now one of the most popular gaming segments. In F2P, publishers generate revenue via microtransactions that offer players the opportunity to buy skins, weapons, and other digital accoutrements while in the game. By purchasing these aesthetics, players can stand out from their friends and enemies. And these microtransactions add up and are a large revenue driver for the video game industry.

RISKS TO THE DIGITAL EXPERIENCES THEME

Social media regulation - mental health, data privacy and censorship

Regulatory risk is a consideration for the Social Media theme owing to concerns about children and teens who spend a significant amount of their time online. A large study of Ontario elementary and middle school students reported "poor mental health" in half of respondents who used social media for five or more hours per day. The effects were even stronger among girls, who reported a 29% rate of suicidal ideation.¹⁵ At the end of 2021, leaked internal research at Facebook drew similar conclusions. Facebook's data showed that 32% of teen girls said that when they feel bad about their

bodies, the platform made them feel worse. Teens also reported increased rates of anxiety and depression.¹⁶

Another risk to platforms is curbs on data privacy. True to their core value of privacy, in April 2021, Apple updated their on-device privacy controls to limit the tracking capabilities of digital advertisers and encourage users to opt out of data sharing.¹⁷ The change decreases the accuracy of targeted advertisements while also limiting the ability of advertisers to measure the clickthrough and conversion rates of their campaigns. Consequences of the change were dramatic for social media firms, many of which described substantial negative revenue effects on subsequent earnings calls.

Users generally view online ads as annoying, in that ads get in the way of users and the content that they want to consume. But platforms generate revenue from ads, so finding a balanced level of monetization opportunities is critical. From a video game perspective, games that keep too much content behind paywalls or use microtransactions heavily can frustrate players, and either one can lead to lower platform interaction and revenue generation.

Digital experience platform users keep coming back to these platforms because they enjoy the access to content and the community. As a result, platforms must walk a fine line between monetization and the user experience. Platforms also must consider how censorship, and the perception of censorship, can affect the community and their bottom line. For example, social media websites commonly restrict the reach of unsavory content while promoting content suitable for general audiences. This practice can particularly affect user perceptions of how platforms present political content.

Pew survey data showed that 73% of adults believe it is likely to somewhat likely that social media sensors objectionable political viewpoints.¹⁸ The intended effect of content restriction is a more harmonious experience for users, but it can come at the cost of broader user participation on the platform.

Supply chain disruptions affecting next-gen hardware sales

Historically, the Video Games & Esports theme has been limited by hardware and graphics, or the elements that combine to make a game visually appealing: detail, resolution, and framerate. Today, the video game console space is in transition as a new generation of devices bring enhanced features and more realistic experiences. However, supply of this hardware has yet to meet demand, mainly due to the continuing semiconductor shortage.

Component availability prompted manufactures to reduce sales expectations for the newest consoles while increasing production of last-generation hardware.^{19,20} These legacy devices use older chip designs and are easier to manufacture, but they lack many of the advanced graphical features that gamers want. The result is extended technological limitations on game developers and new titles. For the newer consoles, the industry continues to be challenged with supply constraints from component shortages and logistics disruptions, which may pose challenges for growth in the near-term.

THEMATIC INTERSECTION WITH DIGITAL EXPERIENCES

Social Media and Video Games

Video games are now effectively social media platforms that let gamers play and collaborate with one another. Gaming alongside real world and digital friends positively impacts retention rates, especially for max level players who've completed a game's achievement-based content. Higher levels of in-game communication and social relationships are also correlated with player retention levels.²¹ For companies, social gaming translates into greater engagement and greater monetization opportunities, as peer pressure can prompt additional title purchases.



Video game content can also be a boon for social media companies. Browser-based social network games leverage the communication prowess of social media to prompt users to reach out to their real-world friends for help in the game. Social network games extend a user’s average session duration while directly generating additional revenue by prompting users to view advertisements.

Fintech & Blockchain

The combination of social media and fintech results in new funding solutions that democratize access to capital, such as crowdfunding platforms. Compared to traditional financing methods, crowdfunding, powered by social media network effects, offers a low-fee way to access and raise capital quickly for business ventures or charitable causes. By democratizing access to capital, crowdfunding platforms could help spur innovation and bring disruption to the market.

For video games, the rise in user participation and monetization has been facilitated by digital payments. Using fintech solutions, game titles and microtransactions can be bought with the press of a button, simplifying purchase decisions and increasing sales volumes. Content publishers and platforms will likely reap additional benefit as digital payments become further integrated into virtual worlds. A culmination of fintech integration looks to be non-fungible token (NFT) marketplaces, where blockchain ensures tradable ownership of virtual goods. Such online economies would create earning potential for users, connecting economies and linking digital goods to real-world currency.

Cloud Computing & Data Centers

At the intersection of cloud computing, data centers, and video games is cloud gaming, or the use of remote computing resources to render virtual gaming worlds. Gone are the days when an expensive, high-powered computer or console was necessary for high resolution graphics. With cloud gaming, games can be streamed to a mobile device.

Continued development of cloud computing and the proliferation of data centers will enhance remote gaming experiences. Colocated servers

shorten the real-world distance between processing and end users, decreasing latency and lag when split second reactions matter most. Increased compute power enhances the graphical quality available on the go, boosting visual fidelity and user experience. We expect cloud gaming can realize its potential with the continued progression of the Cloud Computing and Data Center themes.

Cybersecurity

As with all digitally focused themes, digital experiences and the platforms hosting such content may be targets for cybercrime. For most websites, a data breach would include personal identifying information such as name, email address, or payment details. Social media is an entirely different animal, as a breach could reveal the most intimate details of a user’s life. A malicious actor gaining access to a user’s files and personal data can have drastic consequences, but add social media access, and that actor can now impersonate the original account. In line with this, robust cybersecurity is essential to moving digital experiences forward, potentially even into the metaverse.

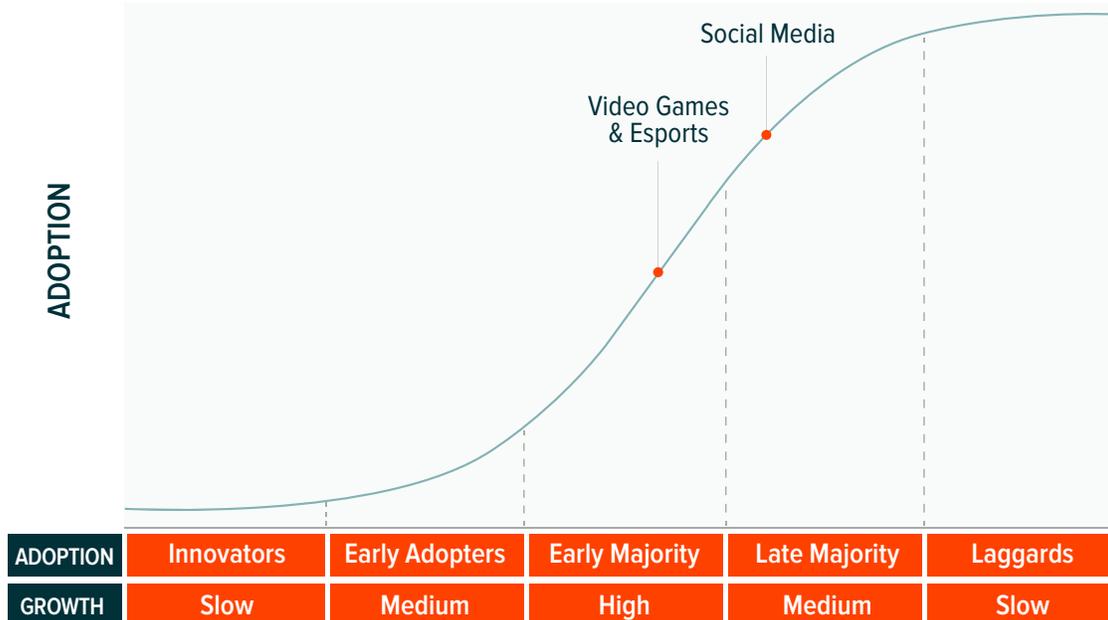
DIGITAL EXPERIENCES IN A PORTFOLIO CONTEXT

The Digital Experiences theme represents the attention economy and the various forms of new media vying for user engagement. Social Media is the most mature theme within our coverage, as its widescale global adoption places it within the Late Majority phase. Social media’s growth is not at an end stage, rather it’s shifting from account growth to user monetization. Conversely, the Video Games & Esports theme is shifting into the latter half of the Early Majority phase as user adoption increases and consumption of digital experiences deepens.

The companies that comprise the Digital Experiences theme are global and positioned to benefit as thematic adoption rises across the world. The charts below break down the geographic exposure of the largest Digital Experiences thematic ETF products. We believe there is ample innovation occurring outside of the U.S. and that limiting exposure to the U.S. will exclude key players, to the detriment of investors over the long term.

THEMATIC ADOPTION

Source: EM Rogers, “Diffusion of Innovations”, 1962, and Global X Research, 2021.





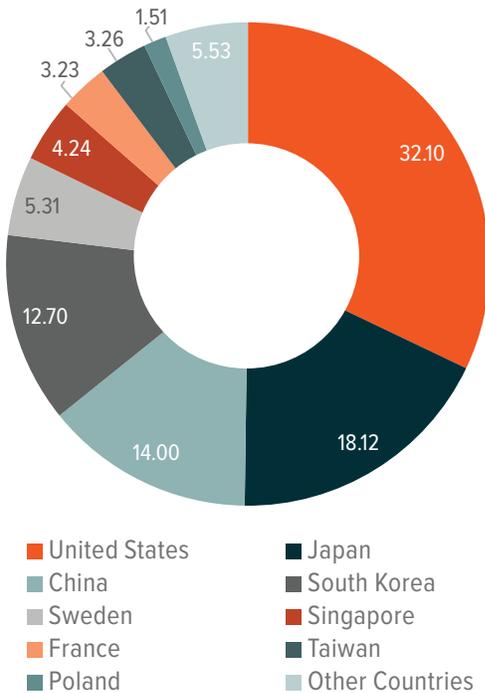
In our view, thematic equity should be targeted, using screens to ensure that the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products.

We conducted an overlap analysis between Digital Experiences thematic ETFs, the S&P 500, MSCI ACWI, and XLC, the Communication Services Select Sector SPDR Fund. We found that overlap by weight for Social Media was 3.6% when compared to the S&P 500, 2.9% vs. the MSCI ACWI, and 21.3% vs. XLC. Higher sector fund overlap levels would be expected for a theme in the Late Majority phase, as Social Media firms have grown to dominate their segment of the economy. Video Games & Esports scored lower on broad beta and sector indexes, 2.4% when compared to the S&P 500, 2.4% vs. the MSCI ACWI, and 8.8% compared to XLC.²² These low levels of overlap with broad indexes reflect the benefits of thematic exposure, as accessing the Video Games & Esports theme requires intentional positioning.

Digital experiences are ubiquitous today. Social media has become a core segment, influencing conversations, culture, politics, and many other facets of society. And video games are mainstream, with more than two-thirds of Americans playing.²³ Now that adoption levels are high, Digital Experience-focused companies are targeting monetization, leveraging the network effects of their platforms and communities to maximize their growth potential. They say that “content is king,” and as we expect digital experiences to reign long into the future, we believe that it is important to position portfolios to capture the growing benefit of this maturing theme.

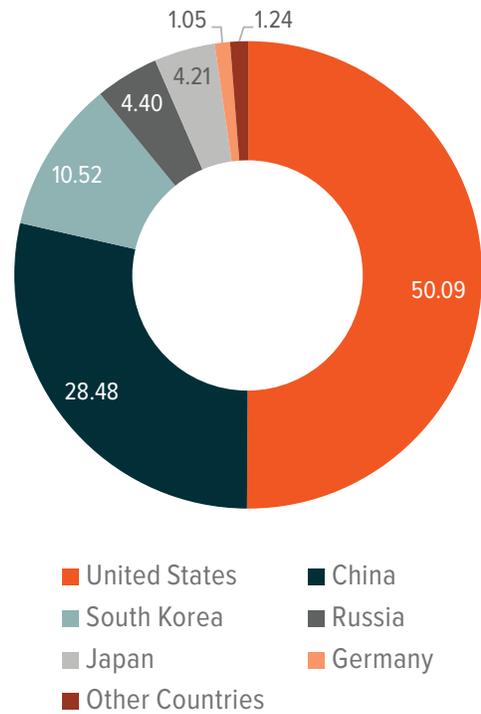
VIDEO GAMES & ESPORTS: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



SOCIAL MEDIA: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.

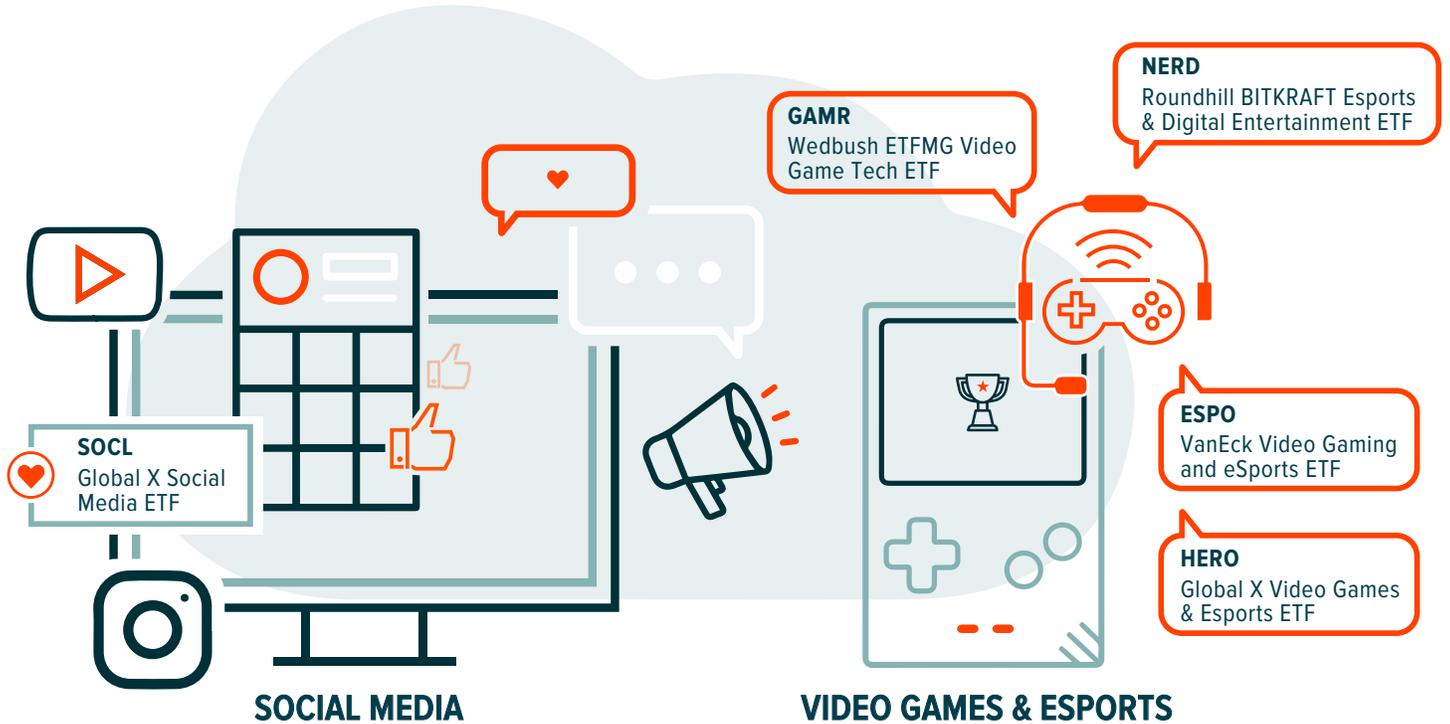


Note: Includes the sole social media ETF and the largest four video games & esports ETFs according to our thematic classification. All Thematic ETFs weighted the same.



HOW TO ACCESS DIGITAL EXPERIENCES

The graphic below identifies U.S. listed ETFs that provide direct exposure to the Digital Experiences theme through Social Media and Video Games & Esports technology. There is only one U.S. listed ETF that provides direct exposure through Social Media technology. Pure play ETF exposure to Social Media is unique due to large overlap with the Communication Services sector.





DIGITAL EXPERIENCES FOOTNOTES

- ¹ Zenith Media, Advertising Expenditure Forecasts, December 6, 2021
- ² GamesIndustry.biz, Newzoo: Mobile game revenue generated \$93.2 bn in 2021, January 20, 2022
- ³ Newzoo, The Games Market's Bright Future: Player Numbers Will Soar Past 3 Billion Towards 2024 as Yearly Revenues Exceed \$200 Billion, July 1, 2021
- ⁴ Pew Research, Social Media Fact Sheet, April 7, 2021
- ⁵ Backlinko, Social Network Usage & Growth Statistics: How Many People Use Social Media in 2021?, September 1, 2021
- ⁶ IGN, Three Billion People Worldwide Now Play Video Games, New Report Shows, August 14, 2020
- ⁷ Zenith Media, Advertising Expenditure Forecasts, December 6, 2021
- ⁸ Zenith Media, Advertising Expenditure Forecasts, December 6, 2021
- ⁹ Instagram, Ads in Explore, 2021
- ¹⁰ GlobalWebIndex, Influencer Marketing: What Retail Brands Should Know, October 24, 2019
- ¹¹ Fortune, Anshe Chung: First Virtual Millionaire, November 27, 2006
- ¹² Newzoo, Three Billion Players by 2023: Engagement and Revenues Continue to Thrive Across the Global Games Market, June 25, 2020
- ¹³ Juniper Research, Video Games Subscription Revenue to Exceed \$11 Billion by 2025, but Cloud Growth Will Be Slow, October 5, 2020
- ¹⁴ Venturebeat, Newzoo: Cloud gaming will reach 23.7M paying users and generate \$1.6B in 2021, August 26, 2021
- ¹⁵ Ontario Center for Addiction and Mental Health, Social Media Use and Mental Health Among Students in Ontario, September 2018
- ¹⁶ WSJ, Facebook Knows Instagram Is Toxic for Teen Girls, Company Documents Show, October 14, 2021
- ¹⁷ Forbes, Apple iOS 14.5.1: Apple Recommends Key Privacy Update for All iPhones, May 3, 2021
- ¹⁸ Pew Research, Most Americans Think Social Media Sites Censor Political Viewpoints, August 19, 2020
- ¹⁹ Bloomberg, It's Going to Get Even Harder to Buy a PlayStation 5, November 10, 2021
- ²⁰ Bloomberg, Sony's PS5 supply shortage solution is to make more PS4s, January 11, 2022
- ²¹ ResearchGate, Achievement and Friends: Key Factors of Player Retention Vary Across Player Levels in Online Multiplayer Games, February 2017
- ²² ETF Action data as of March 21, 2022
- ²³ USA Today, Two-thirds of Americans, 227 million, play video games. For many games were an escape, stress relief in pandemic, July 13, 2021

Investing involves risk, including the possible loss of principal. Narrowly focused investments may be subject to higher volatility. Technology-themed investments may be subject to rapid changes in technology, intense competition, rapid obsolescence of products and services, loss of intellectual property protections, evolving industry standards and frequent new product productions, and changes in business cycles and government regulation.

Index returns are for illustrative purposes only and do not represent actual fund performance. Indices are unmanaged and do not include the effect of fees, expenses or sales charges. One cannot invest directly in an index. Past performance does not guarantee future results.

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Fintech (FinTech & Blockchain)

Paper currency is dying a fast death as technology shifts how people access and interact with their money. Fintech solutions are expanding access and improving the efficiency of financial services. And user interfaces are fast becoming all-digital through online banking, digital wallets, crowdfunding, and buy now, pay later (BNPL) services. But digital disruption remains a work in progress at traditional financial firms. For example, transfers between banks or across borders can still take multiple days to settle. Over time, we expect fintech and blockchain solutions to become more integral across the financial services ecosystem resolving some of these inefficiencies. And as user adoption rises, so too will its prominence in portfolios.

KEY TAKEAWAYS

- We expect the digital transformation to bring financial services, including mobile payments, online banking, and alternative lending platforms to previously unbanked and underserved populations.
- The pandemic put Fintech's adoption into overdrive, with digital payments moving into mass adoption. But the Fintech market continues to expand with emerging segments such as BNPL, alternative financing, and blockchain solutions are key avenues for future growth.
- Necessity will likely encourage more traditional financial services companies to incorporate cloud banking and blockchain solutions.

WHY FINTECH AND BLOCKCHAIN ARE SUCH POWERFUL FORCES

The intersection of financial services and technology, or fintech, is where people go to spend, lend, borrow, invest, and trade. Fintech makes financial services more personal and inclusive. Over the last two years, fintech adoption has increased dramatically, and we expect innovation in the space will continue to increase access to the global financial ecosystem.

Importantly, traditional financial institutions are integrating fintech in their business models. Firms are under pressure to reduce their reliance on legacy infrastructure while strengthening core banking systems to create better consumer experiences. Additionally, the increased focus on data connectivity and analysis to improve corporate decision-making has increased interest in fintech. Global investment activity in fintech, including through venture capital, private equity, and M&A, increased from \$124.9 billion in 2020 and \$148.6 billion in 2019 to \$210 billion in 2021.¹

The rise of the digital payments segment illustrates consumer willingness to adopt new technologies and the enormous growth potential for fintech applications. For consumers, the ease and convenience of buying goods or services by tapping a device on a point-of-sale makes digital payments Fintech's most recognizable segment. For companies, beyond the upfront costs of developing the program and infrastructure to conduct transactions, mobile payment technology is a consumer-friendly way to keep ongoing and variable costs low. With consumers more adept and willing to shop online, more integrated shopping ecosystems are developing.

Emerging segments like BNPL, cloud banking, blockchain-based solutions, and alternative financing solutions like equity crowdfunding and peer-to-peer (P2P) lending will likely be part of the next stage of the industry's evolution.

FINTECH'S KEY GROWTH AREAS

BUY NOW, PAY LATER: Fintech's Fastest Growing Segments Widening it's Appeal

BNPL's growing popularity is a result of continued growth in online shopping. The share of e-commerce transactions paid via BNPL has risen rapidly the last few years with strong U.S. growth.²

- BNPL comprised 1.6% of global e-commerce sales in 2019, rising to 2.1% in 2020 and 3% in 2021.
- Scandinavian countries currently have the highest proportion of their e-commerce sales through BNPL at 12–25%.
- The U.S. BNPL share of e-commerce sales rose from 1% in 2019 and 2% in 2020 to 4% in 2021.

BNPL firms allows consumers to make one upfront payment and settle the remaining balance in installments. BNPL is an alternative to credit cards, with many BNPL plans having 0% APR and no fees unless there are missed payments. BNPL provides credit access to consumers with weak credit scores.

ALTERNATIVE FINANCING: Equity Crowdfunding and P2P Lending Opening Doors

Alternative financing found an audience amid the online investing boom in 2020. Capital raised on equity crowdfunding platforms more than doubled in 2020, jumping to \$214.9 million.³ On the debt side, the \$115.6 billion peer-to-peer lending market is expected to become an \$802 billion market by 2028, rising at a 27.4% CAGR since 2021.⁴

Crowdfunding and P2P lending make it easier to connect investors with those who need capital. They create opportunities for investors to participate in a market that is typically limited to high net worth and institutional investors.

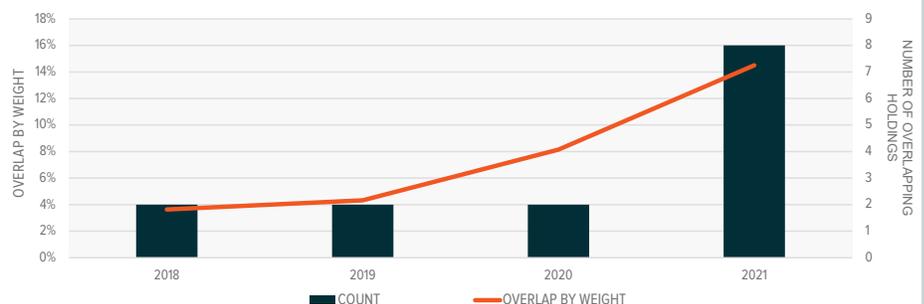
- Equity crowdfunding makes it easier for private startups and small and medium-sized enterprises (SMEs) to raise capital.
- P2P lending helps borrowers find more competitive rates while offering competitive yields for investors.

BLOCKCHAIN-BASED SOLUTIONS: Improved Efficiency

As technology advances and new fintech applications emerge, we believe that blockchain-based digital ledgers will likely become the dominant way people send, manage, invest, and lend their money. To illustrate the growing overlap between blockchain and fintech, we can compare the holdings of two ETFs over time: Amplify Transformational Data Sharing ETF (BLOK) and the Global X Fintech ETF (FINX). The chart shows that in 2021 there was a meaningful increase in their overlapping holdings by weight and number.

HOLDINGS OVERLAP OVERTIME: BLOK & FINX

Source: Bloomberg data as of 4/12/22.





Fintech: Growing adoption across generations and geographies

Fintech adoption remains most prevalent among younger generations. Ninety-five percent of U.S. millennials say that they use fintech applications. Adoption of new technology typically begins with younger generations, but older generations are increasingly adept with these technologies as well. Baby Boomers are the fastest growing demographic for Fintech, with use among individuals 56 and older doubling year-on-year to 79% in 2021.⁵

The global adoption rate of fintech solutions reached 64% in 2019.⁶ Particularly exciting for the industry is its growth potential in emerging markets (EMs) and economies with limited traditional financial infrastructure and unbanked populations. China and India have the widest adoption thus far, reaching 87% in 2019.⁷ Innovations in mobile payments, online banking, and alternative lending platforms bring financial services to previously unbanked and underserved populations. Without existing infrastructure in place, like traditional bank branches and credit cards, EMs can adopt the latest technology without forcing an old business model into obsolescence.

The chart shows the trend in fintech adoption globally across different traditional financial services prior to the pandemic. Since the pandemic, adoption has increased across categories.

Blockchain: A new avenue for growth

In its most basic sense, a blockchain is a type of database focused on recording and maintaining data. Its unique properties stem from its decentralized approach. In a centralized system, a singular authority controls all aspects of transaction verification and documentation. With blockchain's decentralized approach, data is recorded in "blocks" on a digital ledger. Participants, called nodes, are the computers and devices connected to the network that distribute and validate the ledger on a peer-to-peer (P2P) network. While anyone can create data on public blockchains by creating a new block and chaining it to a previous block, the consensus-based approach to validation means nobody can edit or falsify the data after it's received a sufficient number of block confirmations. The result is a structure that generates trust without the need for a third party.

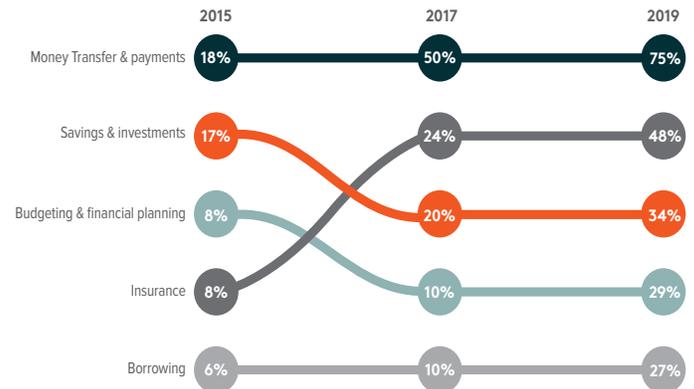
It's conceivable that blockchain networks eventually become embedded in the financial ecosystem because of this key feature: participants don't need to trust a government to back a currency or to responsibly manage the money supply. For the developed world, the significance of this feature may be difficult to understand, though recent economic crises may facilitate comprehension. Trusted financial institutions operating within strong regulatory frameworks that protect investors is not a privilege enjoyed equally around the globe.

The blockchain network provides a mechanism for financial inclusion for unbanked and underbanked populations, particularly in countries struggling with political instability, corruption, or severe inflation. The onset of the war in Ukraine illustrated the benefits of a decentralized form of currency, as people with cryptocurrency wallets continued to have access to currency.

A February 2021 survey by market and consumer data firm Statista indicated that the top 10 countries with the highest frequency of cryptocurrency usage among their populace were all emerging market countries. Nigeria led the way with 32% of respondents indicating that they use bitcoin or cryptocurrency more broadly, followed by Vietnam at 21% and the Philippines at 20%.⁸ The U.S. reported an estimated 16% of adults own cryptocurrency.⁹ The average age of these potential buyers is 44, which suggests digital assets continue to gain acceptance in the mass market.¹⁰

FINTECH CATEGORIES RANKED BY ADOPTION RATE: 2015-2019

Source: EY data as of 8/30/20.

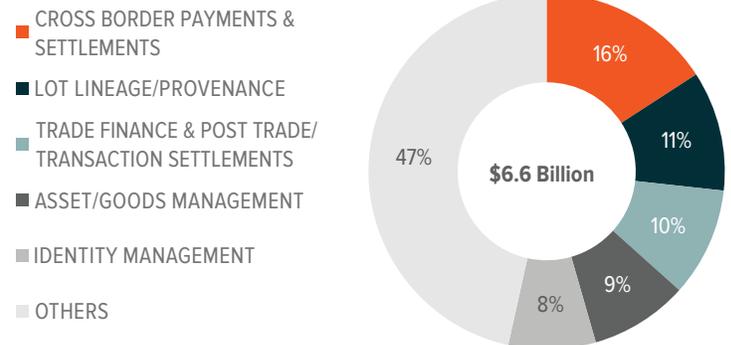


Broad use cases for blockchain

In the short term, blockchain use cases will likely cluster in the banking industry, where financial institutions use the technology to facilitate cross-border payments and transaction settlement. Banking-related use cases accounted for nearly 30% of global blockchain spending in 2021.¹¹ Beyond financial institutions, applications of blockchain technology are vast, touching supply chains, healthcare tracking, and smart contracts.

TOP USE CASES FOR BLOCKCHAIN TECHNOLOGY: GLOBAL MARKET SHARE 2021

Source: IDC data as of April 2021.



Blockchain's secure ledger creates efficiencies for firms keeping tabs on their international supply chains. For example, firms can easily identify and track tainted or tampered products. Health records can be stored in a blockchain by using a unique patient identifier, allowing patients to access their own records and authorize health service providers to access their information in real time. Smart contracts can increase the efficiency of transactions because there is no paperwork involved and no time spent reconciling errors. Secured by encryption mechanisms, participants can trust smart contracts because they're decentralized and transparent.



CRYPTOCURRENCY USE CASES

BLOCKCHAIN-BASED SOLUTIONS:

Crypto's Rise Creating New Opportunities

Blockchain technology is closely linked with cryptocurrencies and other digital assets. Cryptocurrencies are designed to serve as mediums of exchange that use encryption techniques to control the creation of monetary units and to verify transactions. As of this writing, 19,406 cryptocurrencies trade on 526 crypto exchanges. Total market capitalization is \$1.37 trillion.¹²

Growing merchant and financial institution acceptance continues to solidify crypto's foothold in the mainstream. Cryptocurrency price volatility remains high, potentially making blockchain solutions like digital wallets a less volatile way for firms to capitalize on crypto's growth potential.

EL SALVADOR: A Real World Bitcoin Stress Test

In a world first, El Salvador declared bitcoin to be an official currency alongside the U.S. dollar in September 2021. This step was an important trial of a real world transactional use case for cryptocurrencies, and it provided the token with a new measure of legitimacy. But the experiment has had its growing pains. Chivo, El Salvador's official bitcoin wallet, is notoriously unreliable and transactions take time to verify, resulting in businesses losing much of their initial enthusiasm.

According to a poll conducted by El Salvador's Chamber of Commerce, only 14% of responding business reported that they conducted a bitcoin transaction since it became legal tender. Seventy-one percent of those businesses are micro or small businesses.¹³ In our view, it's likely that businesses with less access to traditional banking platforms and payment processors have begun to integrate bitcoin, while larger businesses view the current operational difficulties as a reason to wait. Despite mixed results, we believe that these types of steps are notable on the road to mass adoption.

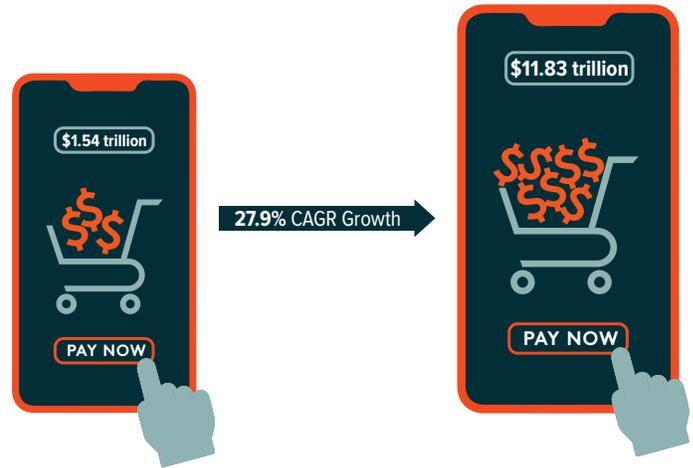
Reaching for Crypto in Times of Crisis

The Russia-Ukraine war has been dubbed the world's first crypto conflict, as both sides have sought to use digital currencies to their advantage. The Ukrainian central bank temporarily halted foreign currency withdrawals and limited daily cash withdrawal in the days following the Russia's invasion. These restrictions resulted in a surge in demand for bitcoin, as Ukrainian hryvnia-denominated trading volume reached a five-month high and the token traded at a 6% premium on Binance's bitcoin marketplace.¹⁴ Crypto is also playing a key role in Ukraine's defense, allowing donations to easily move across international borders. As of this writing, Ukraine's government has received over \$60 million in small donations via various tokens.¹⁵

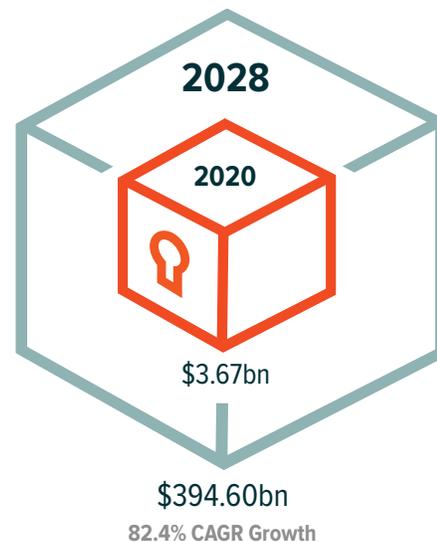
Russians also turned to crypto in an attempt to shield their finances from the devaluation of the ruble as a result of international sanctions. Ruble-denominated Tether transactions hit \$29.4 million in volume on February 28, three times more than a week earlier and the highest daily volume in over a year.¹⁶ This spike occurred on the same day that the U.S. froze Russian central bank assets.

VISUALIZING THE MARKET OPPORTUNITY

EXPECTED GROWTH IN MOBILE PAYMENTS¹⁷



EXPECTED GROWTH IN BLOCKCHAIN¹⁹





RISK TO THE FINTECH THEME

Consumer risks: Unsuitable products, scams, and market declines

Fintech platforms commonly remove the middlemen from transactions, democratizing finance. However, there are downsides. In traditional finance, industry employees are commonly held to a fiduciary standard, bound to act in the best interests of their clients. Before they make recommendations, they screen investment opportunities and products for individual customer suitability. Fintech platforms automate much of this work, simplifying suitability and risk tolerance conversations to questionnaires and prescreening options for a wide range of clients before allowing users to make their own decisions. Easy access to risky or complex financial products can lead to harm if investors lack the knowledge or experience to assess them properly.

Consumer risk is also rife within the cryptocurrency market. Scams, defunct coins, and volatility are common, making the space a metaphorical minefield for investors. In 2021 alone, \$7.8 billion in value was scammed, typically via rug pulls, where “developers” build what appear to be legitimate cryptocurrency projects before taking investors’ money and disappearing.²⁰

Cryptocurrency theft is also common, with roughly \$3.2 billion worth of cryptocurrency stolen in 2021.²¹

Even legitimate tokens bear risk. Data from token tracking website Coinopsy shows that 2,399 coins are now dead.²² Investors need to be cautious in the crypto space, as regulation remains light and illicit activity common.

Cryptocurrency bans, regulation, and federal centralization

China and eight other nations curbed their crypto markets considerably.²³ China enforced crypto restrictions in stages, first prohibiting financial institutions from engaging in any crypto transactions, then banning all domestic crypto mining activity, and finally declaring all financial transactions involving cryptocurrencies illegal. Previously, China was the undisputed world leader in bitcoin-related activities. The country’s three largest exchanges accounted for over 45% of global market transactions, and Chinese miners controlled about 65% of the Bitcoin network’s collective hash rate.^{24,25} Market reactions to each successive restriction were initially negative, indicating the risk to investors should other nations implement similar policies.

A maximum regulation scenario would likely entail governments co-opting cryptocurrencies, as central banks will be hard pressed to relinquish the centralized control they currently have over currencies. Instead, they would issue Central Bank Digital Currencies (CBDC) that modernize fiat for the digital age. China implemented a digital yuan, which as of this writing has been used to settle over \$13.78 billion in transactions.²⁶

Currently, the Federal Reserve (“Fed”) has no concrete plans to implement a CBDC, but it has studied the feasibility of such a currency. Partnering with MIT, the Fed worked to “build and test a hypothetical digital currency oriented to central bank uses.”²⁷ These tokens would be backed by real dollars, which would clearly define their value. Crypto enthusiasts would view this hybrid model as blasphemy because it splits trust between governments and cryptographic proofs, but it would likely view the concept more approachable to the average consumer. A successful CBDC implementation would likely draw demand away from traditional crypto assets, decreasing their value.

Digital asset blockchains require significant energy

The majority of today’s blockchains, including Bitcoin’s, use Proof of Work (PoW) cryptographic proofs to integrate new information and transactions

into the chain. This approach relies on competing miners expending significant amounts of energy to solve computationally-intensive math problems. Miners that guess correctly are compensated for their time, processing power, and energy spent with a block reward and transaction fee. Currently, the Bitcoin network consumes an estimated 204.5 terawatt hours (TWh) of electricity a year to function, comparable to the annual power consumption of Thailand. In the process, the Bitcoin network releases 114.06 million tons of CO₂ in the environment, comparable to the average annual greenhouse emissions of more than 20 million gas powered passenger vehicles.^{28,29}

We expect governments to eventually place limitations on mining as part of the global effort to reduce carbon emissions. Such a change would likely force cryptocurrencies to adapt, or risk declining adoption. An alternative cryptographic proof gaining favor is Proof of Stake (PoS), which allows blockchain participants to validate new blocks based on their ownership stake in the network. With a validator selected at random and no proof to solve, energy consumption plummets.

The Ethereum network is expected to make the switch in Q2 2022, which could lead to a 99.95% reduction in total energy use, as Proof-of-Stake is roughly 2000x more energy-efficient than Proof-of-Work.³⁰

THEMATIC INTERSECTION WITH FINTECH AND BLOCKCHAIN

Fintech and Blockchain

A key advantage of fintech platforms compared to their more classically minded financial competitors is their ability and willingness to integrate new approaches at scale. Fintech platforms can shift their business models over time as new technologies are adopted. The fusion of blockchain and fintech to form decentralized finance (DeFi) is a perfect example.

Together fintech and blockchain leapfrog middleman and bring much needed competition to the banking and finance space. Blockchain implementations can produce substantial savings, up to a 70% cost reduction on financial reporting, and up to 50% across compliance, onboarding, and operations.³¹

Fintech and Internet of Things (IoT)

Fintech platforms and Internet of Things technologies can transform everyday services. For example, insurance underwriters typically operate with incomplete information, which increases the cost of property and casualty insurance policies. Historically, driving record, demographics, and vehicle information determine the price of their auto insurance. While these data points provide a reasonably accurate estimation of future insurance risk, they rely on risk bucketing and generalizations.

However, by using telematic sensors to track GPS and onboard diagnostic information such as speed, acceleration, and breaking behaviors, insurers can form true-to-life risk models based on individualized driver behavior. Privacy focused individuals may view such tracking as invasive, but telematic data collection gives consumers the ability to control their premium costs by incentivizing the adoption of safer driving habits. This integration can increase affordability for lower-risk drivers and coach more aggressive drivers to reduce their incidence of risky behaviors. Such incentives have resulted in accident rate reductions of 10–40%.³²



Sensor data can also assist in fault determination, demonstrating directly whether a driver caused an accident or was the victim of one. For underwriters, that means fewer claims, lower administrative costs, and faster resolutions.

Fintech and Cloud Computing

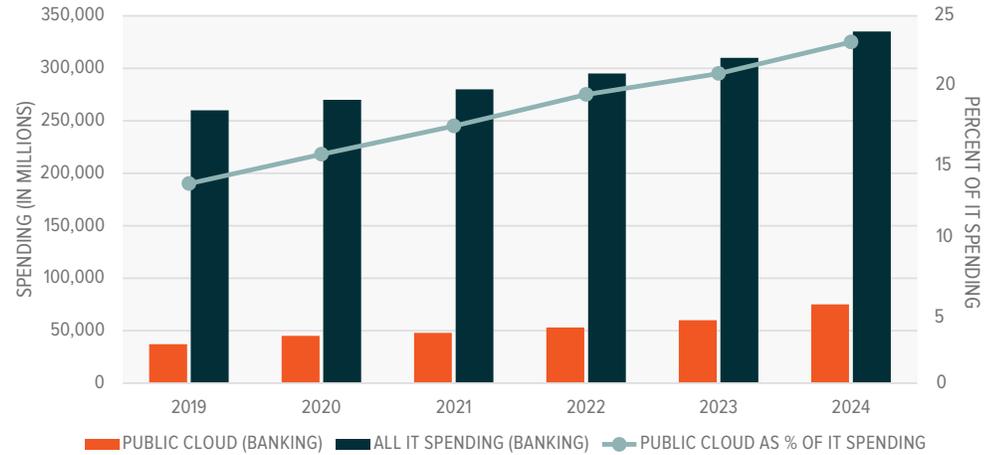
Fintech is viewed as a disruptor of traditional financial services, a well-deserved reputation, but one that doesn't tell the whole story. Fintech firms also offer technologies that help traditional financial services companies enhance their services. Cloud banking is one such growing vertical. Globally, banking industry IT cloud spending is forecast to increase at a CAGR of 16.2% between 2019 and 2024, increasing to roughly 25% of IT budgets.³³

Cloud technology can streamline previously cumbersome processes for banks, such as onboarding new clients, opening accounts, and managing regulatory compliance. Commercial bankers using cloud solutions can see reductions in underwriting times by as much as 81%.³⁴ Other cloud-based approaches can help banks respond to shifting market trends and bring new products to the market up to 16 times faster than the average.³⁵ Importantly, these solutions aren't just more efficient operationally, they also shift expenditures away from significant upfront investments in IT infrastructure to lower-cost, subscription-based software-as-a-service (SaaS) models.

Capital One Bank is a leader in cloud adoption, having shuttered all their internally operated data centers in 2020 to run exclusively on the AWS cloud. Over 80% of their 2,000 applications and software tools were rebuilt to run on the cloud from the ground up, and the migration is already paying dividends. Application updates are much more frequent, improving from a quarterly or monthly cadence to multiple times a day. Disaster

WORLDWIDE BANKING IT SPENDING & PUBLIC CLOUD SHARE: 2019-2024

Source: IDC, Banking on the Cloud: Results from the 2021 CloudPath Survey, August 2021.



recovery tests show downtime falling by up to 70%. These efficiencies and performance improvements from the cloud environment can differentiate the bank from its peers and serve as a model for the advantages of a cloud banking transformation.³⁶

Blockchain and Video Games

Play-to-earn is a new frontier for gaming and non-fungible tokens (NFTs). According to a report on NFT tracking site DappRadar, more than 1 million digital wallets connected to decentralized gaming apps per day in October 2021, representing 55% of the blockchain industry's overall activity.³⁷ Players can earn NFTs from a variety of blockchain games. In Q3 2021, game NFTs accounted for more than 20% of the \$10.6 billion in NFT volumes.³⁸ A key differentiator between blockchain games and other traditional games is the ownership of playable items, and therefore the ability to sell, trade, use, and lend these tokens.

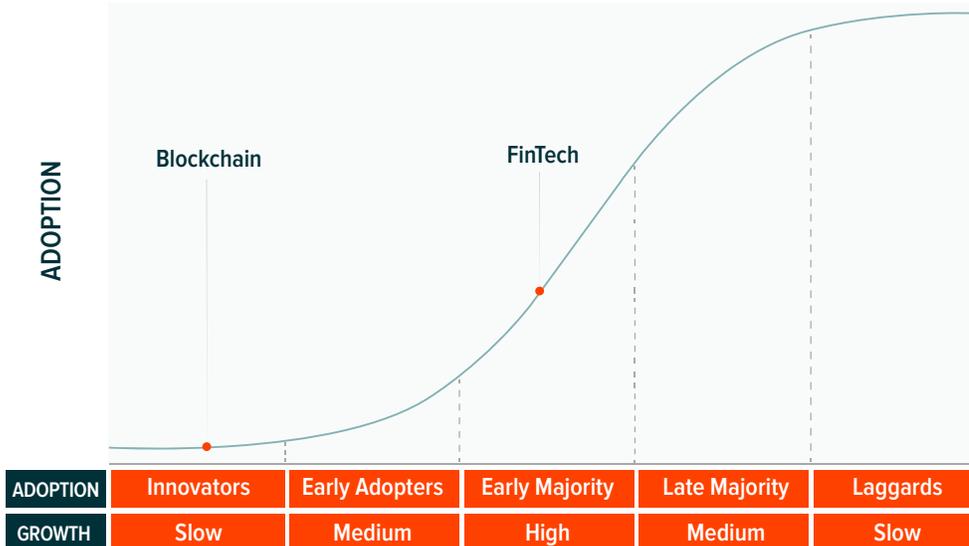
FINTECH AND BLOCKCHAIN IN A PORTFOLIO CONTEXT

Fintech will continue to make financial services more digital and scalable. This transformation is well underway, but it's one that still has significant room to run globally, particularly in EM, where demand for broader access to financial services is generations in the making. In the U.S., consumers increasingly want and expect digital banking experiences, encouraging traditional financial services firms to pivot to keep up with fintech trailblazers.

Fintech's digital payment revolution has reached the point where GICS sector changes are being reviewed. Transaction and payment processing companies are currently classified as a part of the Information Technology sector. In the proposed GICS classification, which is due to be implemented in Q1 2023, these companies will be reclassified as Financials Services.³⁹ Based on current market capitalization, should this sector change occur, the largest payment processing companies will be among the largest companies in the Financial Services sector.⁴⁰

THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021.





For investors, a risk is not having exposure to the continued adoption and integration of this innovative sector. Gaining exposure through an ETF provides access to a group of companies that continue to disrupt how people interact with their finances.

The companies operating in the Fintech space are global and positioned to benefit as thematic adoption increases across the world. The charts, to the right, break down the geographic exposure of the largest Fintech thematic ETF products. We believe that there is ample innovation occurring outside of the U.S. and that limiting exposure to the U.S. may exclude key players, to the detriment of investors over the long term.

In our view, thematic equity should be targeted, using screens to ensure that the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products. We conducted an overlap analysis between Fintech thematic ETFs, the S&P 500, MSCI ACWI, and the two most applicable S&P 500 sector ETFs, the Financial Select Sector SPDR Fund (XLF) and Technology Select Sector SPDR Fund (XLK). We found that average overlap by weight for Fintech was 2.6% vs. the S&P 500, 2.3% vs. the MSCI ACWI, 2.0% vs. XLK, and 0.8% vs. XLF.⁴¹

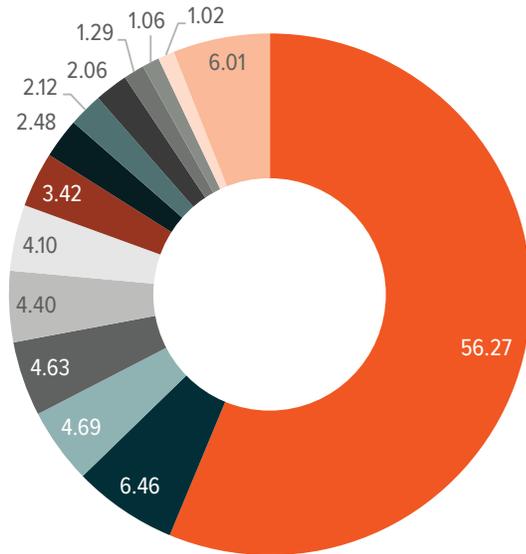
The overlap between broad beta and sector indexes was higher for the blockchain theme. The average overlap between the largest five blockchain ETFs and the S&P 500 and MSCI ACWI indexes was 8.5% and 6.8%, respectively. The overlap with XLK was 11.6% and 4.2% with XLF.⁴²

Because blockchain remains in the innovation phase, the number of pure play blockchain companies is limited. Therefore, many ETFs include large semiconductor manufacturers that design and build crypto mining infrastructure. These companies are also included at a relatively high level in market cap weighted broad beta and technology sector ETFs. Over time, we expect overlap levels to decline as the space matures and the number of pure play companies grow.

Technology continues to extend its reach into the financial industry, rapidly changing how people spend, lend, borrow, and invest. In our view, legacy business models that do not adapt will be left in the dust as the Financial Services sector moves into its digital future. As blockchain technology grows out of its infancy, we expect the scope of end-user and institutional applications to grow exponentially and potentially upend traditional finance.

FINTECH: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

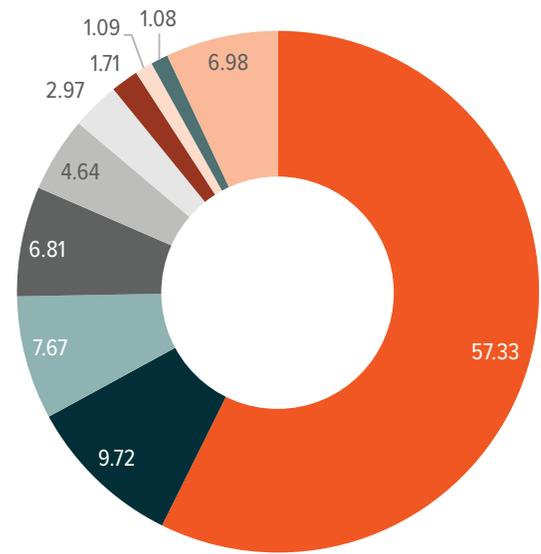
Source: Morningstar data as of 12/31/21.



- United States
- China
- Canada
- Netherlands
- Brazil
- Japan
- United Kingdom
- Germany
- Australia
- South Korea
- Switzerland
- Singapore
- Israel
- Other Countries

BLOCKCHAIN: AVERAGE GEOGRAPHIC EXPOSURE BY THEME

Source: Morningstar data as of 12/31/21.



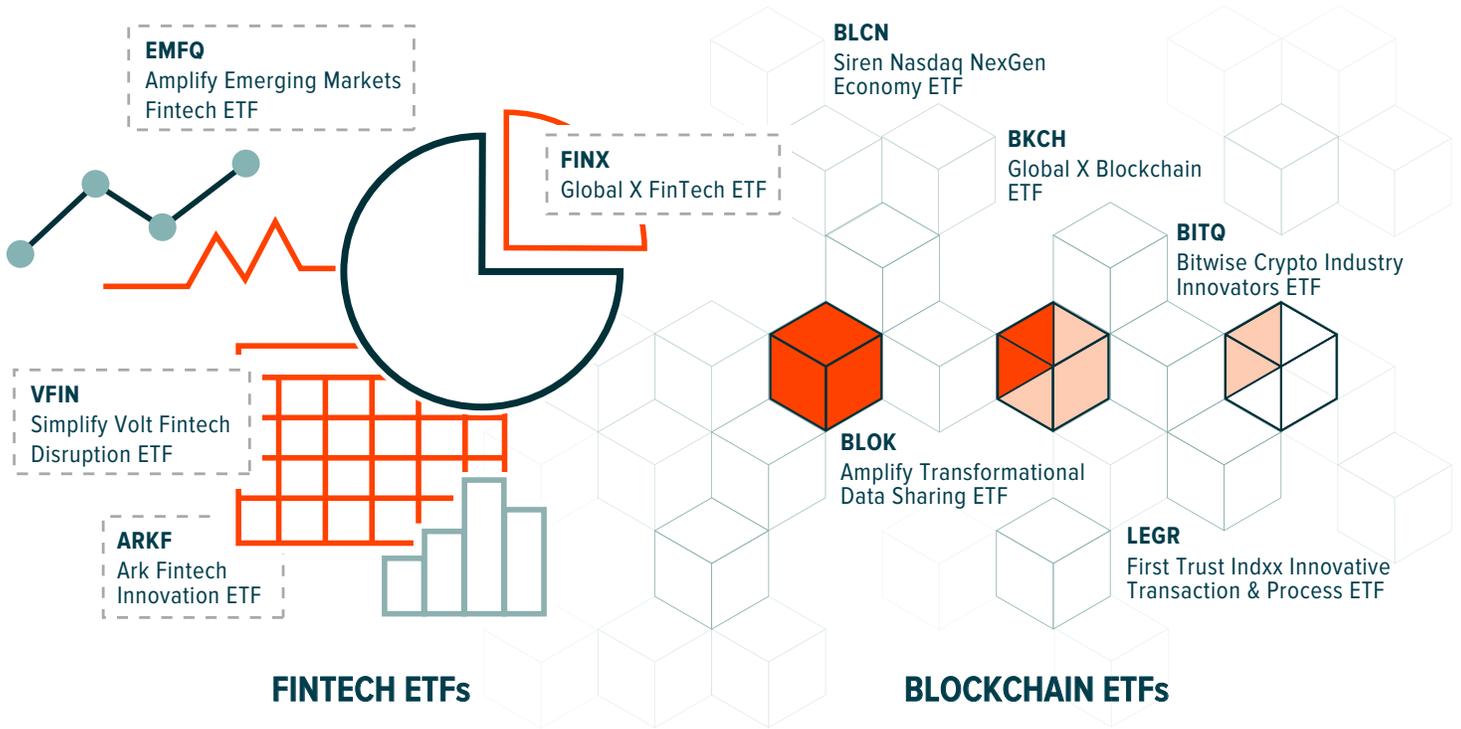
- United States
- Canada
- China
- Netherlands
- Brazil
- Japan
- United Kingdom
- Germany
- Australia
- India
- Switzerland
- Other Countries

Note: Includes the five broad Fintech ETFs and the largest five blockchain ETFs according to our thematic classification. All Thematic ETFs weighted the same.



HOW TO ACCESS FINTECH

The graphic below identifies the largest U.S. listed ETFs that provide direct exposure to the Fintech theme through FinTech and Blockchain technology.





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Investing involves risk, including the possible loss of principal. Narrowly focused investments may be subject to higher volatility. Technology-themed investments may be subject to rapid changes in technology, intense competition, rapid obsolescence of products and services, loss of intellectual property protections, evolving industry standards and frequent new product productions, and changes in business cycles and government regulation.

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Exclusively Thematic	Includes Thematic		
	Asset Allocation Portfolios		
Equity Thematic Disruptors (11/1/2017)	5 Core Series Portfolios (5/18/2018)	Equity Income Portfolio (10/1/2017)	China Sector Portfolio (5/31/2019)
Digital Innovation (6/1/2021)	2 Sustainable Core Series Portfolios (8/1/2020)		
	Equity Sectors and Themes		
Thematic Trends (11/22/2021)	Equity Sectors and Themes (11/1/2017)		

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