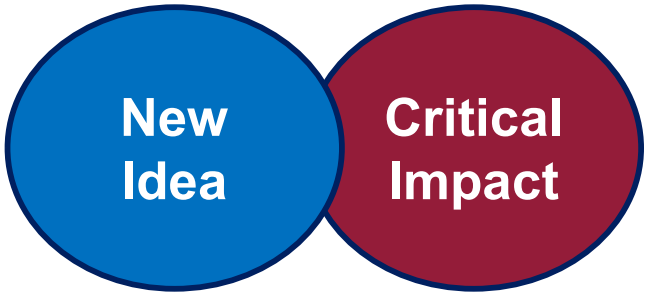
WINDOW INTO OUR FUTURE:

CAPITALIZING ON GLOBAL FUTURE THEMES

David Goerz
CEO & Chief Investment Officer
Strategic Frontier Management

WHAT IS A FUTURE THEME?

#FutureThemes are a thesis or proposition that could have such substantial impact that when recognized can shift consumption, disrupt competition, impact lifestyles or adapt work flows for a significant portion of the population. Higher growth companies isolating notable future themes can leverage sustainable competitive advantages.



In Expanding Market

Consequences of Future Themes

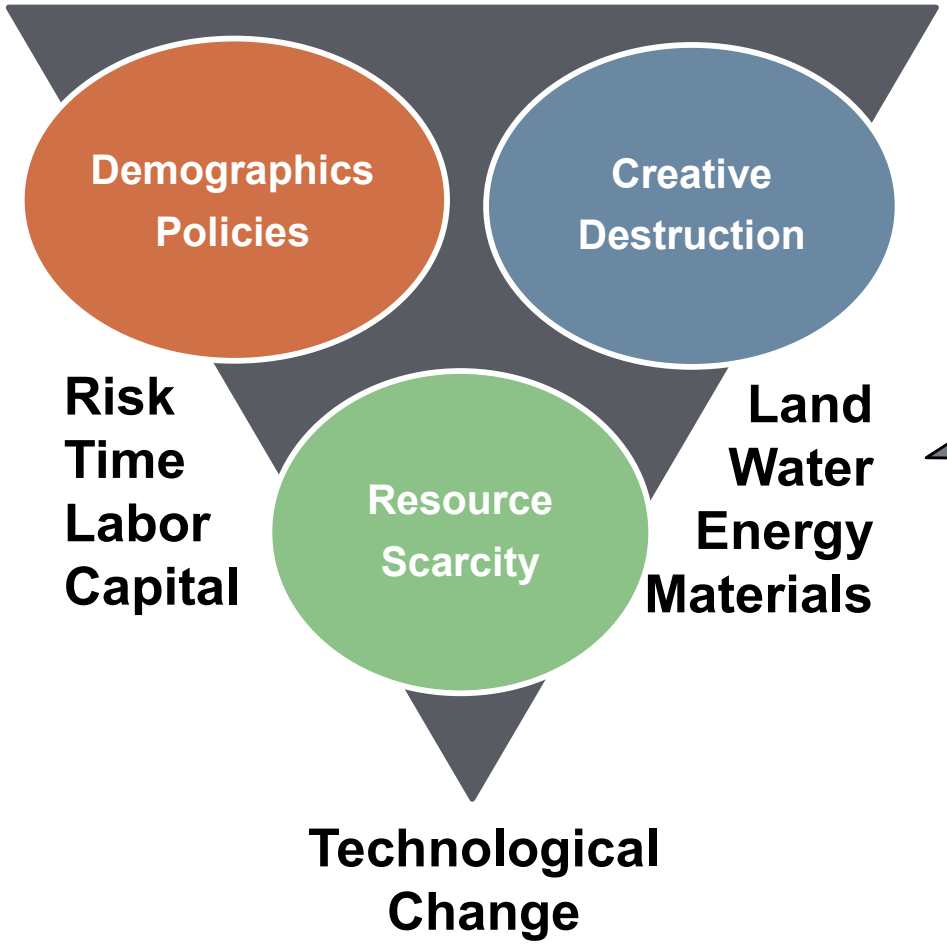
- Creative Destruction and Market Dislocation
- Persistent Disinflation and High Profit Margins
- Rising Potential Growth and Productivity
- Uncomfortable Uncertainty for Individuals
- Expose Sustainable Competitive Advantages
- Enable Predicting the Future by Creating It

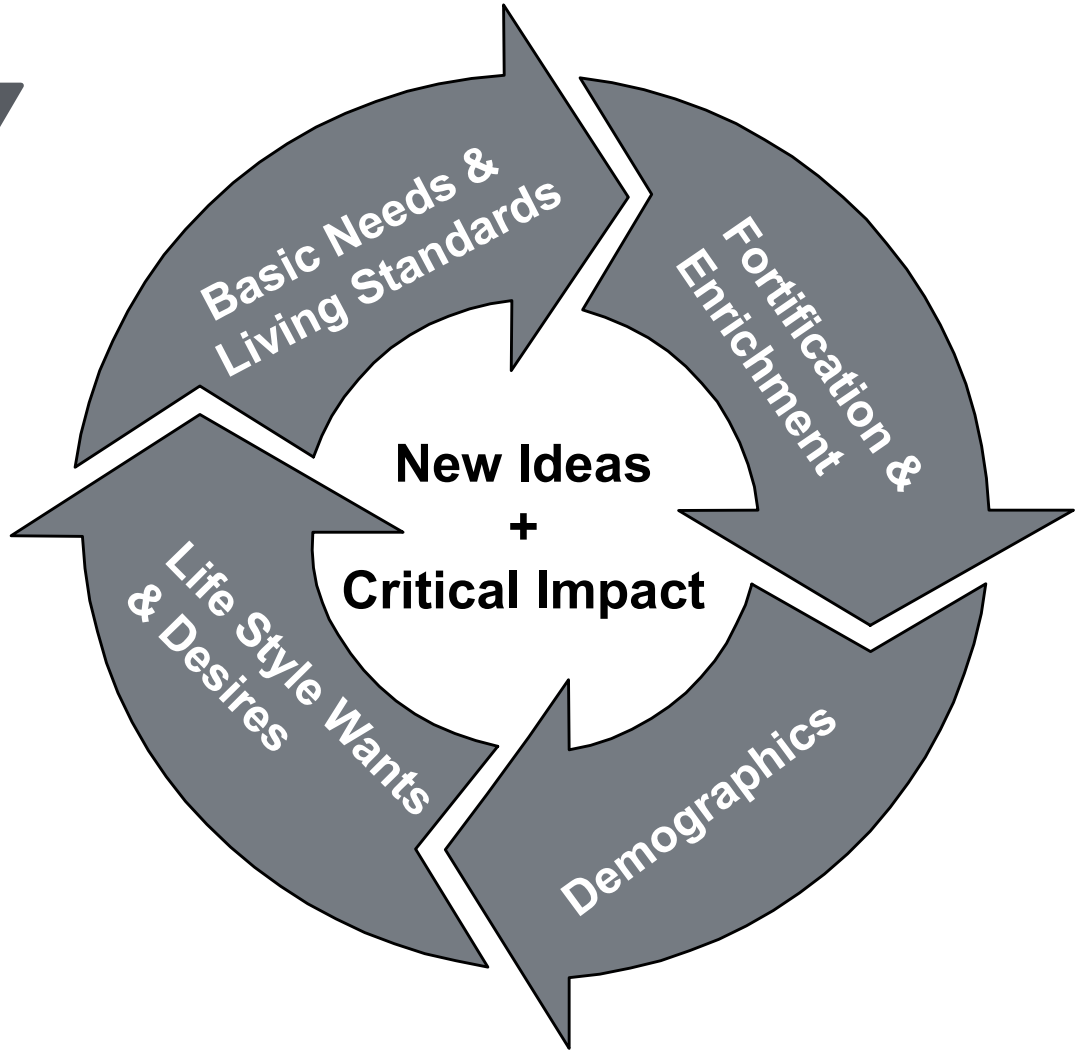
INTERCONNECTED WORLD--BRANDS BECOME VERBS

Inclusion here is not an endorsement or investment recommendation.

KEY FORCES DRIVING FUTURE THEMES

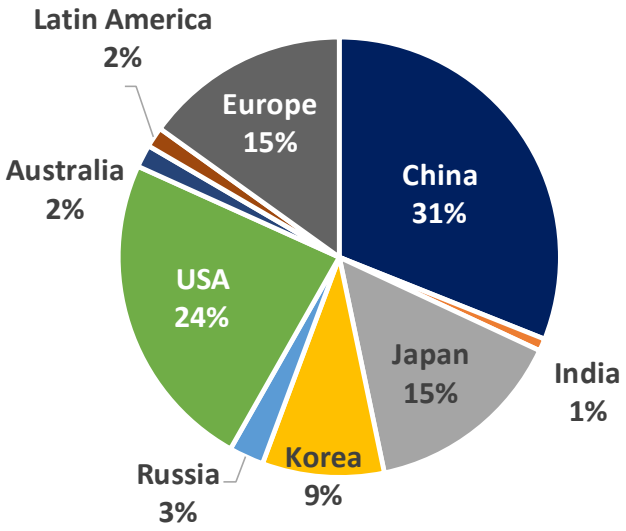
COMMUNICATION REVOLUTION ← **Productivity & Margins** / **INNOVATION** → **MANUFACTURING RENAISSANCE**





RELENTLESS *TECHNOLOGICAL INNOVATION* ACCELERATING *CREATIVE DESTRUCTION*

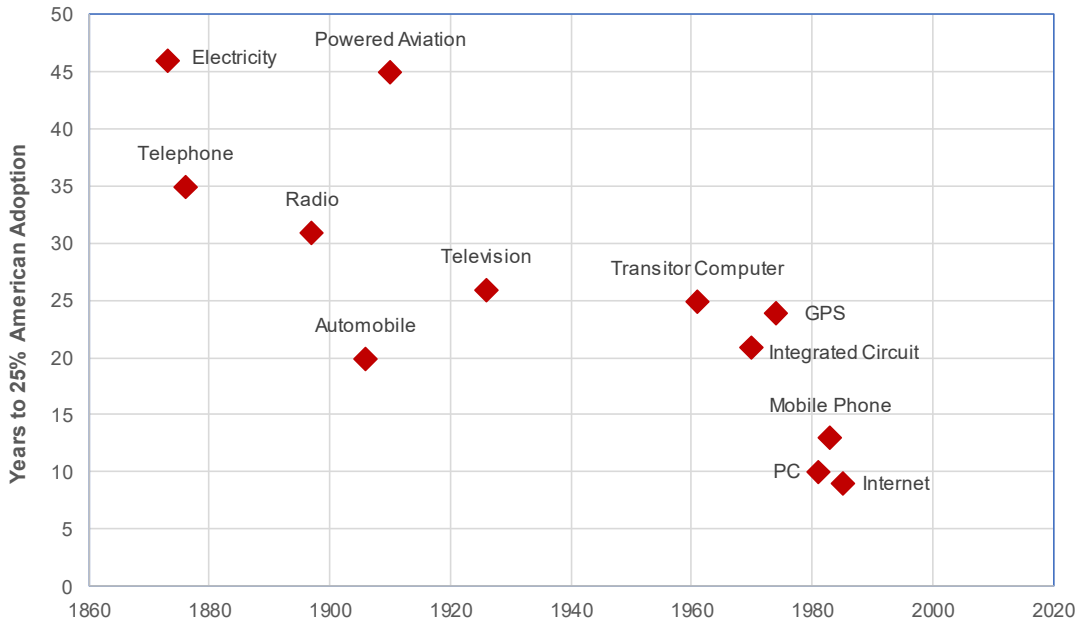
2017 Patent Grants



Source: WIPO statistics database

- Innovation accelerating faster and adopted more rapidly, driving higher living standards faster than ever before!
- Not as significant as *electricity* or *telephone*, but synergies across ***Manufacturing Renaissance*** and ***Communications Revolution***

Adoption Accelerating, Innovation More Frequent



Source: Singularity.com, Strategic Frontier Management

RIPPLING EFFECTS OF iREVOLUTION 4.0

Growth

- Potential world growth normalizes toward 3.0% by 2020 versus 3.5% in 2013---Europe and Japan lag, while U.S. and EMs are higher
- Policy choices matter—slowing growth is a function of demographics (birth rate, immigration)
- Emerging countries benefit from growing middle class and culture of credit supporting *irrepressible demand*, but China faces unique headwinds

Inflation

- Globalization, outsourcing, hyper-competition, innovative creative destruction, efficiency, and increased price transparency drive *disinflation*
- Rising prices for scarce resources, essential services, energy, education, healthcare, and consumer products offset by conservation, substitution, and productivity or efficiency gains (demand destruction or CSI)

Labor

- Higher value-added jobs for most skilled
- Increased automation increases repetitive job redundancy---*creative class* benefits
- Labor cost advantage of Emerging Markets declines as transportation costs increase.
- Reshoring driven by consumer proximity and reordering of national advantages

Profit Margins

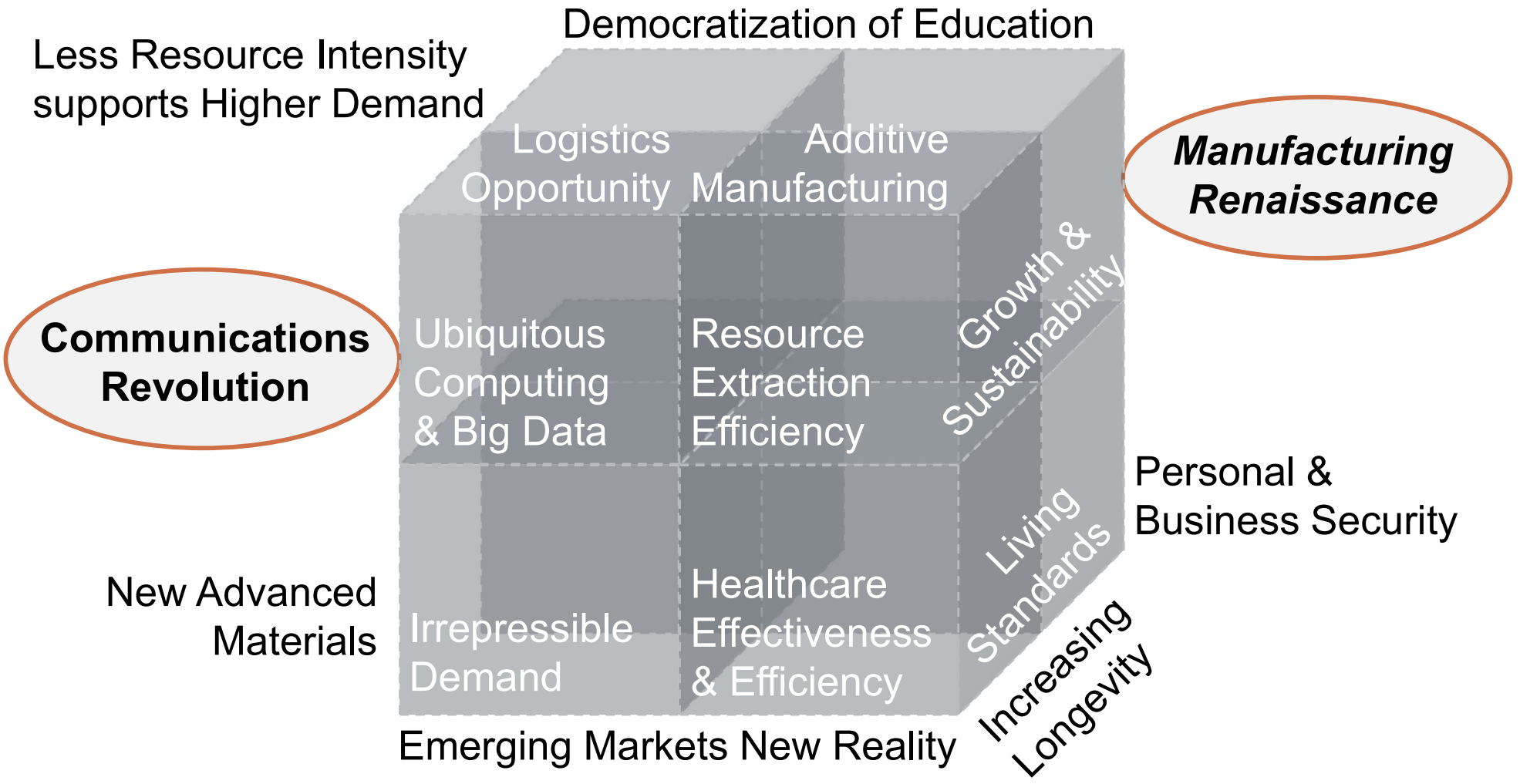
- US high profit margins belie disappointing productivity, but yield robust earnings growth with moderate revenue growth
- Excessive regulation can slows potential growth and reduce margins. Lower EM profit margins as cost inflation erode competitive advantages. Evidence Socialist policies fail time and again, limit margins

Potential Economic Growth = Labor Force Growth + Productivity Growth

GLOBAL ECONOMIC IMPACT

- ***Manufacturing Renaissance*** accelerating innovation by exploiting robotics, new materials, system automation, biological advances, competitive substitution, adaptive software, and smarter customer interfaces, while **displacing labor** in manufacturing, repetitive or systematic services, and construction.
- **Communications Revolution** continues boosting living standards with ubiquitous computing access, available at low cost---5G promises 100X transmission rates.
- **Secular disinflationary forces** remain significant, which combined with productivity and innovation, bolsters **stronger potential growth** in Developed Economies
- Nature of work changing with job skills needs: *Gig Economy*, *Freelance Nation*, rise of the *Creative Class*, geography flexibility, and E-conomy
- *Equality of opportunity* needs **Education Democratization--**MOOCs virtual access offers a brighter future for continuing education and those with initiative
- Sustainability focus and new **Advanced Materials** bolsters *conservation, substitution and innovation*---efficient resource consumption and extraction (secular disinflation)
- **Real global growth is slowing** as Emerging Markets' labor cost advantage narrows, but US still enjoys remarkably low inflation with sustained high **profit margins**

CAPITALIZING ON INTERCONNECTED THEMES



FUTURE THEMES: INDUSTRIAL REVOLUTION 4.0

Thesis or proposition that could substantially shift consumption, investment preferences, disrupt competition or impact lifestyles.

1. **Communications Revolution**
   - Ubiquitous Computing and Analysis
   - Cloud & Big Data: Unprecedented Access

2. **Manufacturing Renaissance**
   - Accelerating Systematic Re-engineering
   - Adaptive Robotics
   - Rapid Prototyping and 3-D/Additive Manufacturing
   - Logistics Transforming Global Supply Chains
   - Better Products and Services at Lower Cost

3. **Energy: Less Intensive, Still Rising Demand**
   - Less Energy-Intensive Economic Activity
   - Driving Energy Efficiency and Increasing Capacity
   - Reducing Emissions More Valuable than Rationing
   - Alternative Power Sources Becoming Viable

4. **Advanced Materials, Lower Resource Intensity**
   - Conservation, Substitution, and Innovation
   - Higher Performance at Lower Cost
   - Exotic Alternatives for Scarce Commodities
   - Efficient Recovery and Utilization of Natural Resources
   - Access/Sustaining Basic Needs (Food, Water, Energy)

5. **Emerging Markets New Reality**
   - Industrialization, Urbanization, Irrepressible Demand
   - Differentiation: Resource Providers vs. Consumers
   - China: Unique Headwinds Slowing Potential Growth
   - Ideological Policy Challenges (Venezuela, Brazil)

6. **Increasing Longevity**
   - Improving Healthcare Efficiency & Effectiveness
   - Bolstering Retirement Savings, Financial Security
   - Luxuries, Convenience, Insatiable Consumption

7. **Personal Security & Cybersecurity**
   - Geopolitical Storms & Resilience of Terrorism
   - Privacy Security, Liberty, and Individual Freedom
   - National Security, Foreign Policy, Espionage
   - Cybersecurity, Intellectual Property Protection

8. **Democratization of Education**
   - Increased Access to Higher Education at Lower Cost
   - New Job Skillsets Needed to Meet Evolving Needs
   - Improved Educational Outcomes and Efficiency
   - Expanded Capacity for Lifelong Higher Learning

CREATIVE DESTRUCTION'S DISRUPTIVE FORCES LOWER INFLATION, BOOST PROFIT MARGINS

1. ***Accelerating Innovation:*** Technological progress is accelerating tackling an ever-increasing abundance of problems to solve, but various adverse consequences for labor markets
2. ***Secular Disinflation:*** Globalization, hyper-competition, outsourcing, and increased price transparency leverage innovation and creativity—keeping inflation low, enhancing productivity.
3. ***Expanding Universe of Inventors****:* Meaningful global invention, innovation, entrepreneurialism.
4. ***Education Democratization:*** MOOCs (Coursera, edX) enables/offers higher education alternatives
5. ***Capital Displacing Labor:*** *Creative Destruction* for repetitive and quantitative tasks with consistency and reliability at lower cost changes workforce needs---*Creative Class* dependency
6. ***Research, Development and Process Engineering*****:** Accelerating global competition, prototyping-development cycles shorter (CAD + 3D), consistency, reliability, physical and process automation
7. ***Financial Liberalization:*** Regulatory reform increases access to and lowers cost of capital that bolsters free market competition, which incentivizes entrepreneurs
8. ***Logistics and Transportation Efficiency*****:** Reducing friction of transportation costs allow a country's relative competitive advantages to flourish
9. ***Ubiquitous Computing*****:** Enabling broad-based, low-cost access to information and applications, or Quantum Computing's hope to solve complex problems exponentially faster than today's leading supercomputers to unlock remarkable discoveries.
10. ***Communication Revolution:*** Facilitating greater collaboration can usher in *Industrial Revolutions*

COMMUNICATIONS REVOLUTION

Communication Revolutions tend to repeatedly reinforce Real Growth & Productivity

- Networking made the world much more ***integrated***
- Ubiquitous Computing: Cloud, Big Data plus 5G coming opened up OPPORTUNITIES
- Smaller devices enhanced *MOBILITY*---unlimited potential: *Internet of Things*
- SaaS applications + adaptive analytics/AI with cloud data access, cheaper storage in mobile devices made it all **useful** and **RELEVANT**
- Media (pictures, sound, video) made it **personal**
- "Internet of Things" complemented by exponential growth in computing power
- Impact of innovation-fed ***Communications Revolution*** felt in every sector:
  - **Telecommunications:** Skype/VoIP, Teleconference, SaaS applications + Cloud-based Data
  - **Consumer:** Streaming music & media, Mobile Personal Applications and Services, Social Media
  - **Financials:** Mobile banking, investment, and payments, fintech applications, information access
  - **Healthcare:** Personal applications, monitoring and expertise, virtual/on-line access (doctor/nurse)
  - **Real Estate/Property:** Virtual tour, smart monitoring, computer aided design (CAD)
  - **Industrials:** Logistics, shipment tracking, inventory, supply chain, 3D prototyping, CAD tools
  - **Technology:** Leveraging itself providing limitless compounding of new opportunities, knowledge,

MANUFACTURING RENAISSANCE BOLSTERS PRODUCTIVITY, BUT ALSO DISPLACES JOBS

Massively disruptive tech affect employment, productivity, competitiveness, and margin, as industrial robots decline in cost.

Adaptive Robotic Systems navigate and execute autonomously in changing environments coping with component failures and communication interruptions, changes in workload, resources, sensor inputs, or mission requirements aided by ***machine learning***.

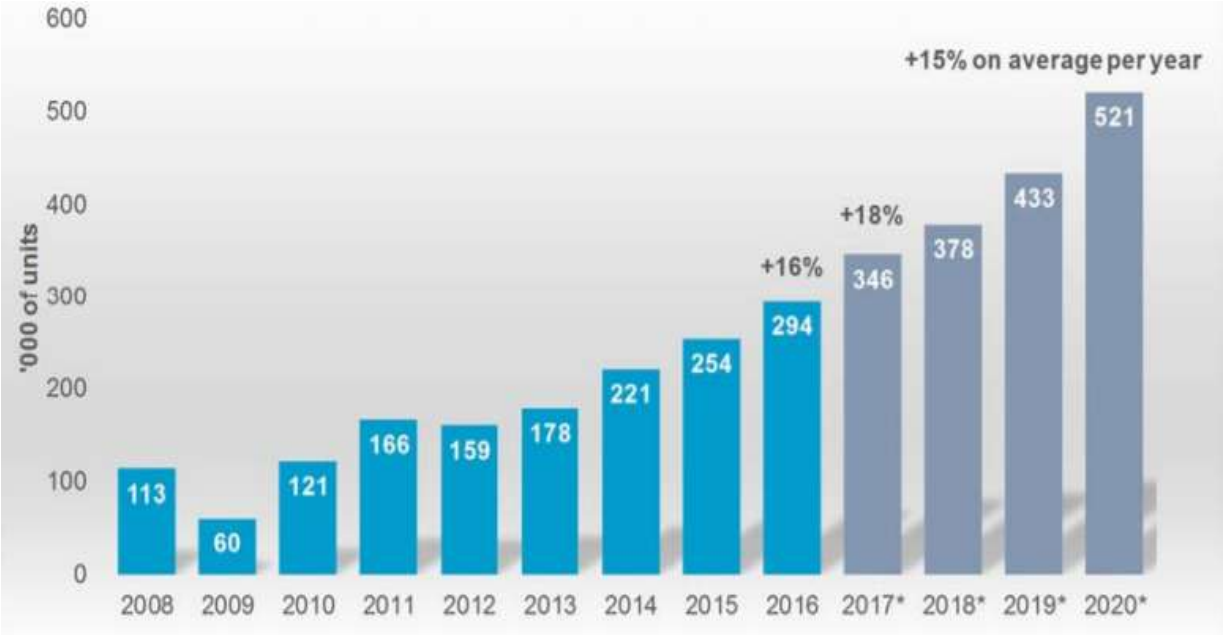
Interactive production robots from firms like Rethink Robotics

*Nano-**spider robots** walk, turn, perform autonomously.*

MANUFACTURING RENAISSANCE: ROBOTICS

- Rising BCG expectations of robotic spending increased from $67B to $87B in 2025 led by consumer (boosted 156% to $23B) and commercial (boosted 34% to $23B)
- Many new applications including medical, agricultural, and construction robots
- Consumer applications expanding exponentially, may exceed commercial spending
- Robotics narrowed the labor cost advantages, beginning to reverse offshoring

Worldwide Robotics spending to reach US$67B in 2025



Source: IFR World Robotics 2017 - Industrial

Adaptive robots: compelling value proposition across every sector. Innovators seeking: Better, Faster, Safer, and more Reliable

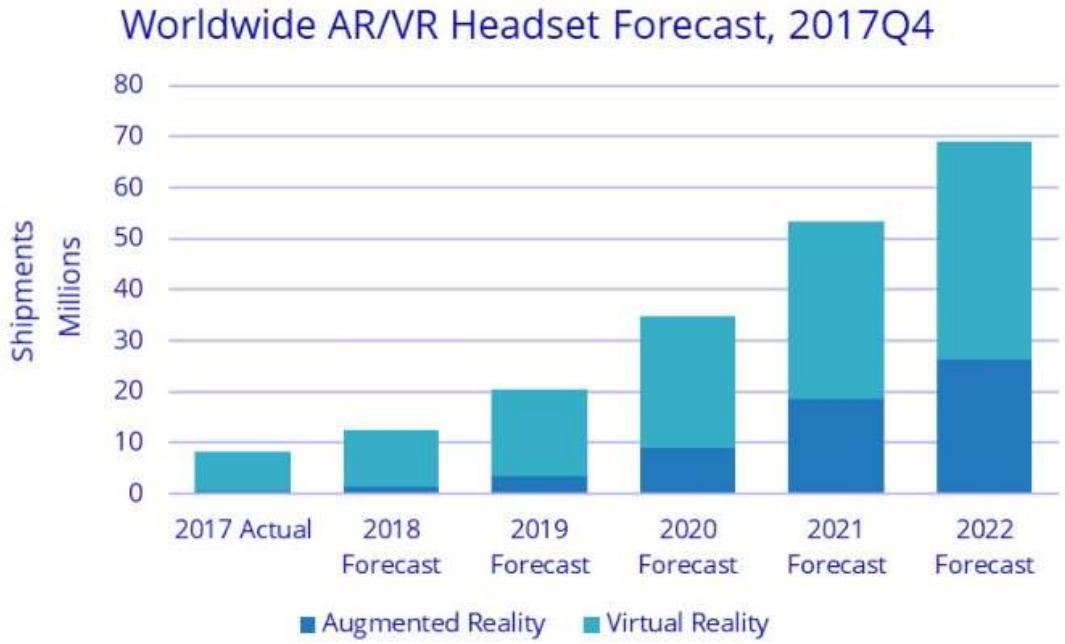
Falling cost is accelerating adoption, and even Cheaper.

ARTIFICIAL/VIRTUAL REALITY & SIMULATION

Many enabling technologies, Simulation and Artificial or Virtual Realty span both the Manufacturing Renaissance and Communication Revolution

- Computer Aided Design and Manufacturing was the first to enable virtual environments for engineering---these tools are critical in product development
- Combining HD graphics with computing horsepower enables interactive analysis and data visualization in many new ways, beyond proof-of-concept entertainment
- Simulation helps quantify fault tolerance in risk management and stress testing

Simulation in a variety of forms has reduced cost of testing and validation, as well as becoming an integral engineering and design tool. From Flight Simulator to many Industrial Applications, IDC's Augmented and Virtual Reality spending estimate of $27 Billion in 2018 is likely understated.



MANUFACTURING RENAISSANCE ACROSS SEVERAL FRONTIERS: 3-D PRINTING

- Rapidly falling prices and expanding commercial applications of ***Additive Manufacturing*** fetches 30-65% cost reduction
- Virtualization & simulation software leveraging potential
- Rapid Prototyping for engineering design, Customized and Personalized manufacturing out of nearly any material
- Highly specialized complex production and repair parts possible “on-site” with fewer defects and less material waste

Additive Manufacturing or 3-D Printing
Print me a Stradivarius--Economist, Feb. 2011

ARTIFICIAL INTELLIGENCE: EXPERT SYSTEMS TO ML, REINFORCEMENT AND DEEP LEARNING

Hal, Open the Pod Bay doors….I'm Sorry, Dave, I can't do that. This conversation can serve no purpose anymore. **---Stanley Kubrick's 1968 film: '2001: A Space Odyssey**

There's no magic elixir that somehow the Sorcerer's Apprentice is conjuring up mysterious intelligence. It's a computer program! **---Harry Markowitz on AI in 2019**

Artificial Intelligence is computer science of deductive logic, reasoning, and planning

- *Expert Systems* embed human ingenuity and discrete information into calculations
- *Machine Learning* is rooted in statistical inference or optimized nonlinear decision
- *Natural Language Processing* (NLP) provides access to unstructured data

Deep Learning and Reinforcement Learning are types of Machine Learning seek to replicate brain/mind or behavioral function—closing *Turing Test* gap

- IBM Watson commercializing high level/logic access to ML/RL/DL/NN tools

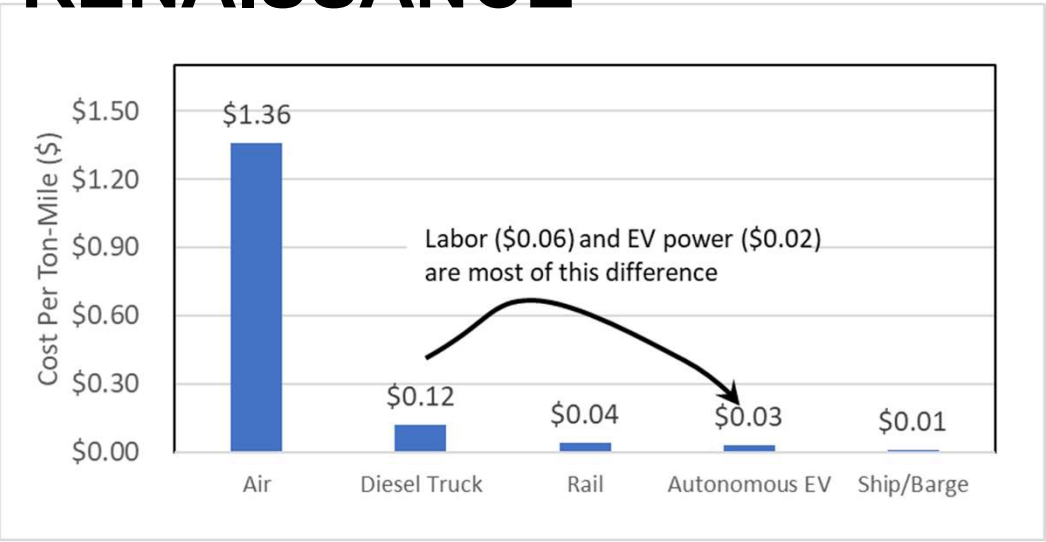
Popular concern about displacing humans and potential for *Singularity*

- S*entient machines* seek to intelligently leverage all of human knowledge, but likely lacks compassion or morality (how about objective fairness?)

Artificial Intelligence evolution (~45 years) is accelerating technological change, as it unravels conventional relationships and changes the nature of work/life as we know it

- Historically, society weathers innovative creative destruction better than feared
- Yet, nothing about AI exists without deliberate control of mathematical algorithms

LOGISTICS FACILITATES MANUFACTURING RENAISSANCE



Transportation of traded goods is big business. *Autonomous electric trucks* offer a less expensive and cleaner shipping option than rail, yet nimble between the endpoints.

Drones appealing for the last mile.

Source: ARK Investment Management

Increasing automation and falling labor costs focus attention on rationalizing transportation costs.

..And stakes on a *New Global Trade Order* were never so significant.

POWERING LESS ENERGY INTENSIVE ECONOMY, GREATER EFFICIENCY FROM RESOURCES

Future theme: **Energy Efficiency and Reducing Emissions**

- Energy consumption, renewable, carbon tax, and climate guidelines are inefficient rigid approaches to limit emissions that restrain potential growth and increase inflation
  - Easier to reduce system emissions by 20% than energy consumption by 20%, and innovation that reduces emissions tend to be adopted globally (US fuel efficiency)
- Competition and innovation can limit emissions more efficiently and directly, which tends to have greater global impact---particularly in less developed countries

Economic Value of Improved Energy Intensity (US$)

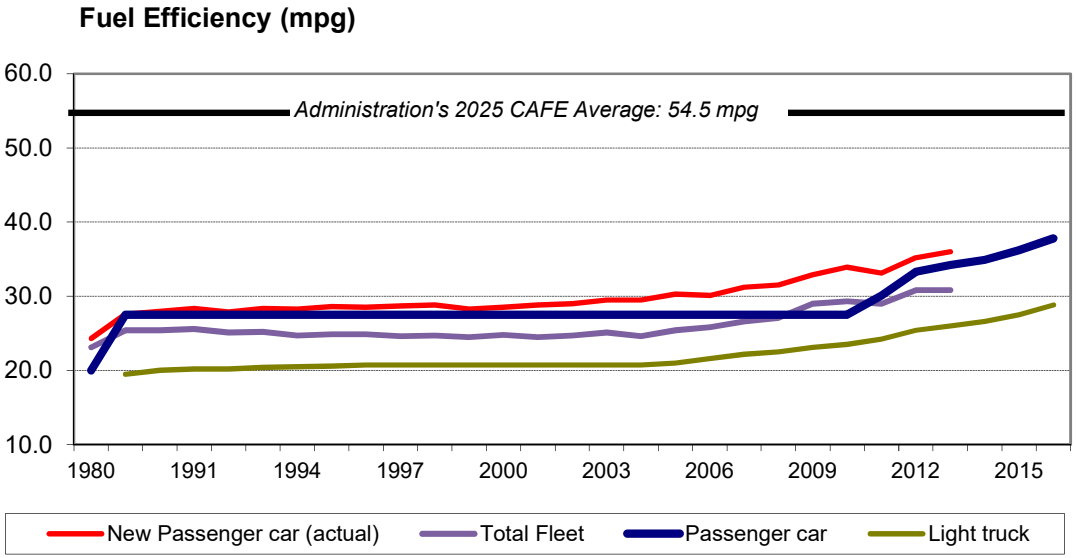
Source: EIA – *Energy Efficiency 2017*:Energy productivity in GDP bonus (US$Bs / year)

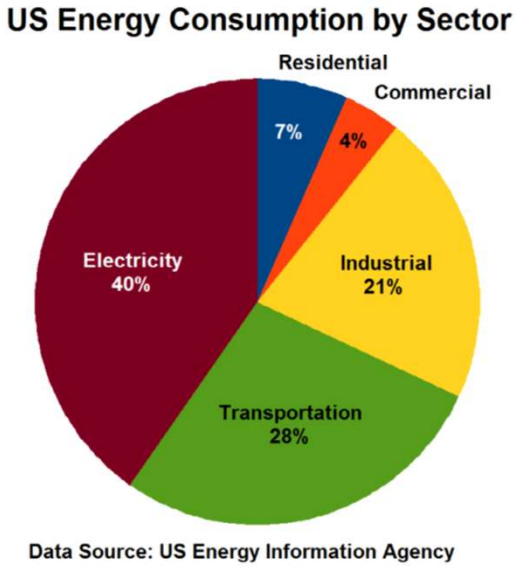
Global Energy Intensity declined to 1.8% in 2016, compounding $2.2 trillion higher GDP. Energy intensity declined 2.1% per year since 2010 vs. 1.3% during 1970 – 2010 with wide variation globally. Declining energy intensity implies greater GDP per unit of energy consumed.

- China > US > EU > Japan

MODERATING OIL/ENERGY INTENSITY, EVEN AS GROWTH DRIVES MILES DRIVEN

Transportation consumes about 60% of a barrel of oil globally





71% of all petroleum used in the United States goes to the transportation sector.

Table 1. Average Required Fuel Economy (mpg)

	2012	2013	2014	2015	2016	Change
Passenger Cars	33.3	34.2	34.9	36.2	37.8	13.5%
Light Trucks	25.4	26.0	26.6	27.5	28.8	13.4%
Combined	29.7	30.5	31.3	32.6	34.1	14.8%

Obama Administration: By 2025, average U.S. fuel economy required to meet 54.5mpg requirement.

Source: Bureau of Transportation Statistics, U.S. Energy Information Administration (EIA)

EXPLOITING NEW ADVANCED MATERIALS

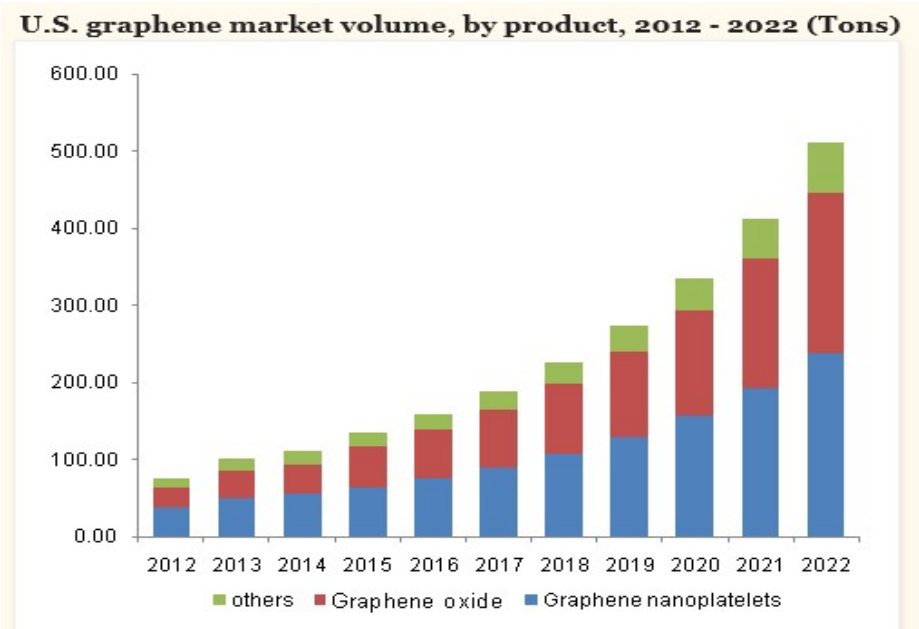
Industrial and Construction Materials

- Higher performance, lower weight
- Cheaper or abundant material substitution
- “Smart”: self-diagnostic, self-healing, feedback
- Bioactive or sensor embedded biomaterials
- Shrilk–superior performance and biodegradable

Shrilk

Graphene

Graphene: one-atom-thick sheet of carbon in honeycomb crystal lattice



Source: Grandview Research: Industry Growth Analysis Report, 2016

DEMOCRATIZATION OF EDUCATION

Massive Open Online Course (**MOOC**) emerged in 2012 aimed at open access to unlimited high quality advanced education via the internet, leveraging traditional course materials with interaction between students, professors, and TAs.

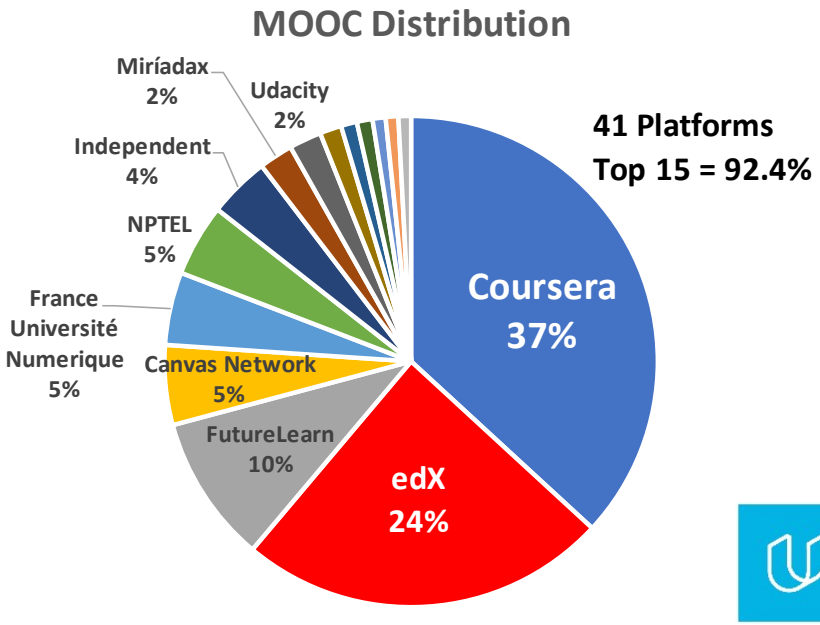
Stanford University · Yale · MIT · University of Oxford · Harvard University · Berkeley University of California · Sorbonne Université

the Atlantic

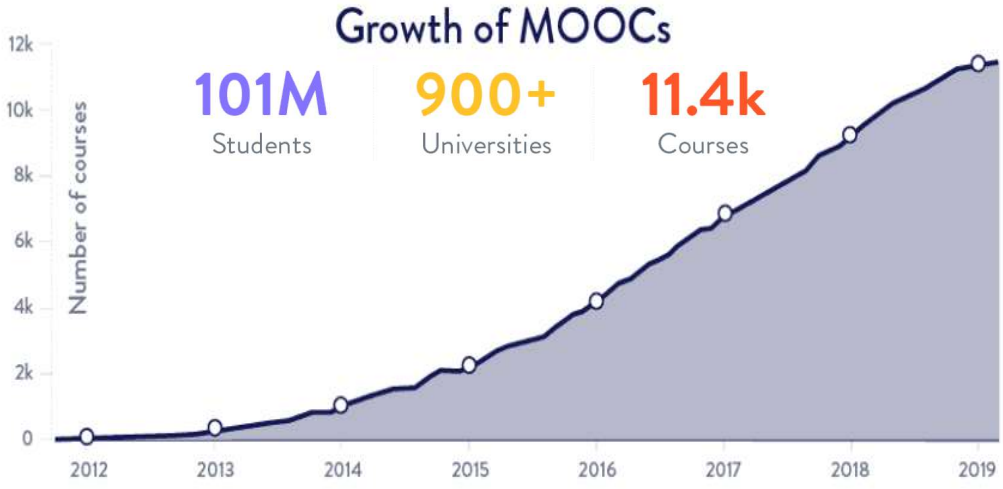
The Single Most Important Experiment in Higher Education: ***Coursera and edX (2012)***

Webcasting drags elite education into 21st century.

Free world-class education



Source: Class Central



Source: Class Central

Udacity · Future Learn · edX · coursera education for everyone · canvas NETWORK · NovoED · FUN · KHAN ACADEMY

FUTURE THEMES IN FINANCIAL SERVICES

***Competition* and *Substitution* drive down service cost and margins, volumes rise**

Fintech Payments: Efforts to promote cashless society, beyond direct debit & bill pay

- Global duopoly of Visa and MasterCard (or American Express) limits competition
- High credit card interchange fees paid by merchants should incentivize competition
- Retail foreign currency transactions costly (buy-sell spread) despite $5 trillion/day
- Cryptocurrencies are commodities, not currencies or fit for cashless society (risk)

Consequence: lower inflation and increased growth if fees were reduced

Investment and Financial Advice Revolution: Tremendous Household Net Wealth

- Asset management and security trading costs trending lower benefiting net return
- Fintech adept at targeting *financial planning* and *systematic investment advice*
- Fee transparency increasing with adoption of *Robo-advice* platforms and *ETFs*
- *SMA Platforms* competitive, increasing customization and tax efficiency at low cost
- *Thematic* and *Alternative Beta* products expand tactical opportunities

Risks**:** Transaction and wealth tax sought to raise revenue can slow growth

Public vs. Private Markets: Continued rotation toward capacity constrained private markets, despite disappointing net returns and less diversification than expected with high management costs undermining private fund appeal

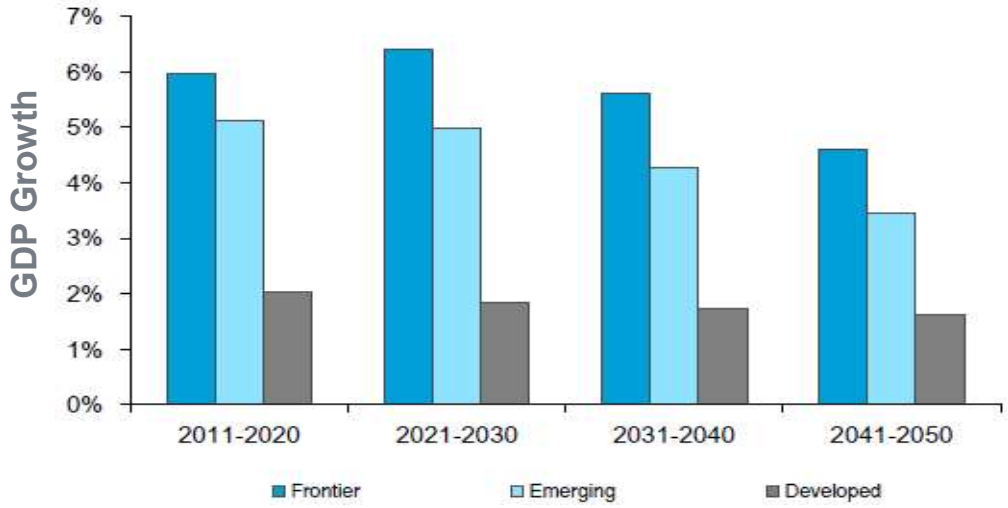
Risks**:** Liquidity risk, fewer listed reduce transparency, stretched private valuations

EMERGING MARKETS AND BEYOND

Compelling Global Secular Themes

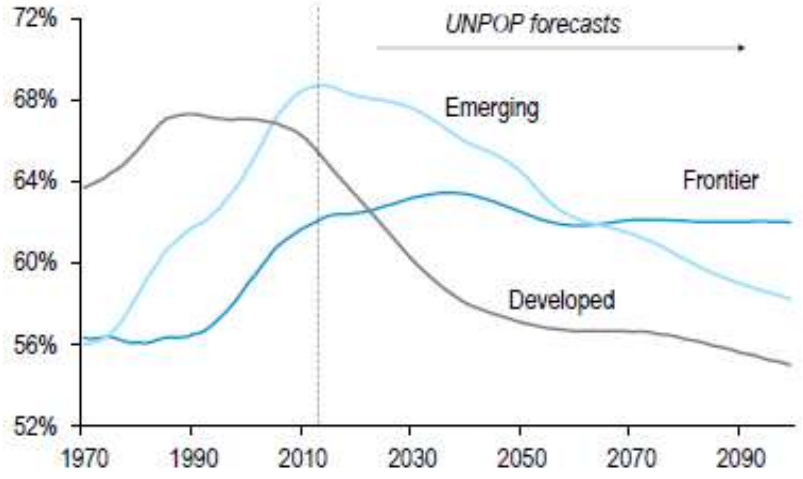
- Drivers: Urbanization, Industrialization, Insatiable Consumption, Culture of Credit
- Infrastructure Needs: Construction (housing, buildings, airports, rail, ports, roads, housing), Telecom, Essential Services (power, sewer, water, waste management)
- Financial Services: Retirement/Wealth management Solutions, Insurance
- Resources: Recovering or substitution of critical basic materials efficiently, sustainably
- Longevity Themes of Healthcare Needs and Agriculture demand
- Africa: 60% of World's uncultivated arable land, vast untapped natural resources
- *R*elative competitive advantages in trade, but *New Order in Global Trade* emerging

The Rise of "Frontier Markets"



Source: Citigroup Research.

Workforce Population Growth



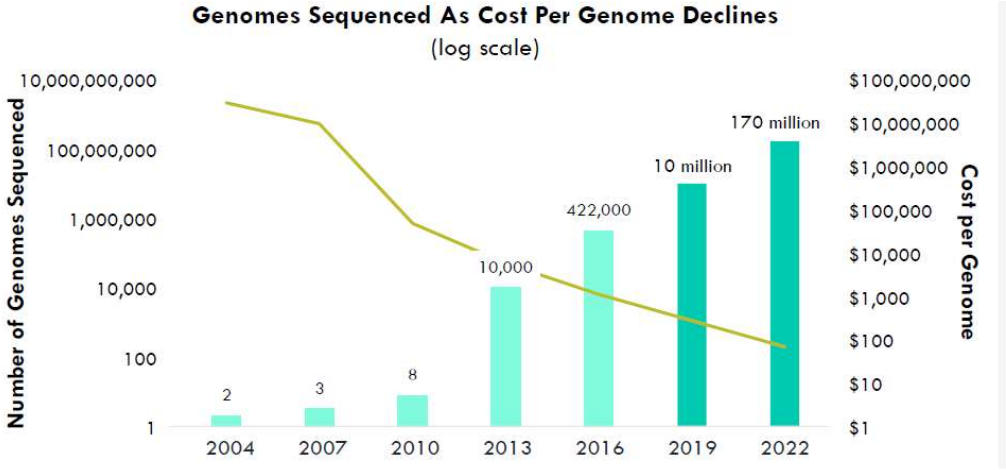
Source: United Nations.

CHINA'S TIPPING POINT IN YEAR OF THE PIG

- Emerging countries benefited from global urbanization and industrialization combined with insatiable consumption, emerging culture of credit, labor cost advantage, and rapid income growth that drove strong secular growth. Developed economies enjoyed cheaper consumer goods.
- However, secular forces driving potential growth are moderating, even China.
  - China faces challenges to its economic goals in *Made in China 2025*, seeking to comprehensively upgrade Chinese industry to be more efficient and integrated
  - Bolstering productivity are limited by Socialist policies and restricting entrepreneurialism
  - Appropriated innovation and intellectual property masked dire demographics
  - Labor cost advantage undermined by soaring wages + benefits, challenged by adaptive automation and distance to consumer markets that reverses offshoring
- US Trade agreement likely to reduce China's export growth and competitiveness, even as US tariffs on China still lower than those imposed on US goods. Risk to China is that other countries follow suit, including Canada, Japan and Europe.
- **Impact:** China's real growth slowed to ~6.5% (2018), but potential growth should decline further toward 4% through 2025 as export growth slows without sufficient productivity, as profit margins declined with rising labor costs—lags U.S. by ~45%

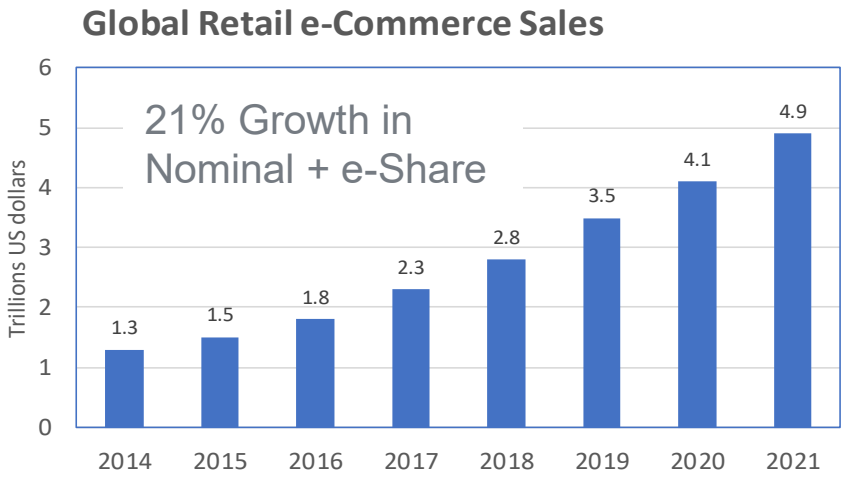
LONGEVITY: HEALTHCARE AND AGRICULTURE

- Agriculture benefiting from system automation, efficiency, and biologic advances
  - Water conservation and automation to nutrients and genetic/hybrid engineering
  - Nutrition science, plant protein substitution for meet, pest control
- Preventive Medicine & Practice Management yields cost efficiency gains
  - *Bending Cost Curve* (inflation) with new drugs + therapies improve outcomes
  - Disease prevention and health improvement (vaccines, etc.), DNA
  - CRISPR's toolbox disrupts more than medical DNA therapies—think agriculture
  - Earlier detection and diagnosis, digestible sensors, and *nano*-robots
  - Automate workflow, no-shows, referrals, insurance reimbursement, privacy
  - Medical decision support integrating machine learning algorithms
- Personalized healthcare:
  - DNA analysis/diagnostics personalizes solutions
  - Telemedicine, diagnostic tests, mobile interaction
  - Increased choice, health cost management
  - Obamacare and regulation impeded competition

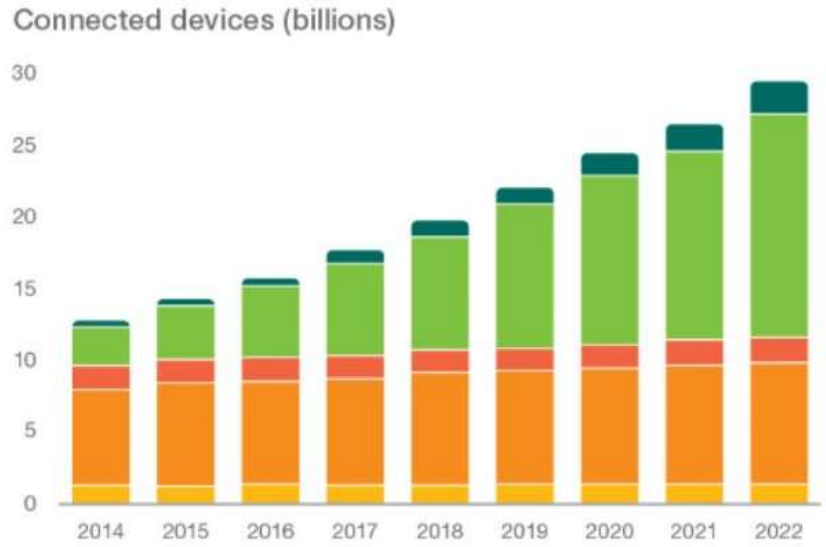


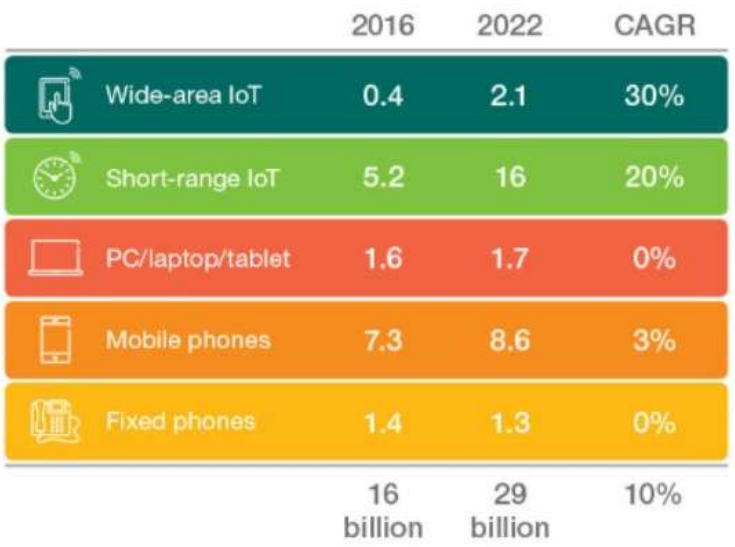
Source: ARK Investment Management, 2017

PHYSICAL SECURITY VS. CYBERSECURITY



- Rising privacy concerns of unprecedented data collection and blurring differentiation between social media platforms vs. publishers increasing regulatory risk
- Ramping 5G networks and Internet of Things improving lifestyles and work efficiency, but also expose users to greater hacking vulnerabilities
- Electronic and direct debit payments increasing exponentially exposes individual accounts to fraud
- Autonomous vehicles and microchip implants will further redefine “connected” users





Source: Ericsson

KEY FUTURE THEMES IN GOVERNMENT POLICY

Legislative and Executive Reform: Encourage free market competition, enhance global competitiveness, restrain inflation, reduce tax administrative costs, balance federal budget, and promote equal opportunity to increase potential growth, bolster productivity.

1. **Tax policy changes and regulatory reform** increased U.S. potential growth toward 3%.
   - Lower **Corporate Tax Rate of 21%** and **Repatriation Tax Rate** (0% on foreign earnings) increased global competitiveness, while encouraging greater investment and income growth
   - Other countries may follow suit, as in the 1980s
   - Hauser's Law: Federal tax revenue never exceeded 20% of GDP since 1934, despite tax rates
2. **Balanced budget** (spending restraint) could banish fiscal deficits with exception for recessions. Such principals are as relevant for state and local governments, as for federal.
3. **Infrastructure Program** likely funded with a combination of Public-Private partnerships, loan guarantees, and privatization of existing land + property assets---not deficit spending
4. **New Order In Global Trade:** Increasing net exports enhance U.S. potential growth
5. **Lessons in Government** program failures: ARRA-2009, California High-Speed Rail, Obamacare
6. **Corporate and University Research** lead Defense and Government labs but policy change likely
7. **Incentivize retirement savings** and improve access to **prudent investment advice**---DC and IRA contribution limits should increase. Tax-advantaged retirement savings defer taxes but compound greater investment gains. Imposing national wealth tax is unconstitutional.

BEWARE OF MISLEADING THEORIES

- *Risk-on/Risk-off* (*Countries Still Matter,* Global Asynchronous Expansion)
- *New Normal*-New Neutral Hypothesis (Subpar earnings potential misguided)
- Alternative Equity Valuation (i.e., Shiller CAPE, Market-cap/GDP misleading)
- *MPT alternatives* flawed (i.e., Min Risk/Max Diversification, LDI, Risk Parity)
- *Smart Beta* (Naïve Active Quant Investing, Alternative Betas—new dimensions)
- Indexing/ETF Risk (*Passive Carnage Is Illogical*, competition + lower fee)
- *Diversification Illusion* of *Private Markets (M*ark-to-market latency)
- *Liquid Alternatives* (Hedge Fund replication: Alpha is not systematic)
- *Systemic Risks of Money Market Funds* (*Cash* better than Commodities, Gold)
- *Cryptocurrencies* are commodities, not currencies or fit for *cashless society*
- *Free services* (ad-supported), social marketing (FB/Cambridge Analytica) and content streaming struggle to deliver profits before privacy/regulatory concerns`

EASIER TO DO THE COMFORTABLE THING

What is the difference between a bleak and a bright future?

- Rapid innovation has fundamentally lifted our living standards
- Its persistence lies in entrepreneurship and free market incentives
- Investment in research & development and education are critical
- Simultaneous *Communications Revolution* & *Industrial Renaissance*
- Potential economic growth of 2-3% is normal–return to risk capital is rewarded incentivizing research, development, and innovation
- Somebody else's *New Normal* doesn't have to be our destiny

Investment Opportunity
We believe many opportunities can be exploited to add value.

*"**The best way to predict the future is to invent it**. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's Laws."*
— Alan Kay, inventor of Smalltalk

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