

Under the *Macroscope*

Policy, politics and technologies scuffle in a new era



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Executive summary

Allianz Global Investors set out to better understand why the US economy has remained lethargic for so long, how it could snap out of its malaise and the implications of these issues, as well as their potential solutions, for investors. We identified one short-run and two long-run developments that promise to reshape the economy and economic policy well into the future. Failure to heed these developments could lead to major policy errors by governments and central banks. Businesses that do not recognize and adapt to these developments could experience historic missed opportunities as well as unprecedented threats to their profitability and viability.

Key takeaways

- Several Fed officials now realize that central-bank monetary and supervisory policies may be restraining real economic growth.
- A new bias in favor of raising interest rates now prevails within the FOMC, as long as labor market conditions remain strong, inflation continues to accelerate, and financial and currency market conditions stay orderly.
- Cultural shifts that broadened populist movements in several countries will empower more radical governments. Under attack will be the mix of fiscal policies, regulations and their enforcement; trade relations among nations; immigration and environmental policies; and, in the US at least, the functioning of the executive branch of government.
- The next phases of what the Davos World Economic Forum called “the fourth industrial revolution” will be relentless, influencing labor market conditions, capital spending and the structure of industries.
- Ubiquitous general-purpose technologies and their adoption at an exponential rate will continue to disrupt existing industries, companies and occupations. Over the short run, their adoption may eliminate output and destroy productivity, even as they boost business profits and improve the lives of individuals.
- Failure to account for the magnitude and direction of disruptive technological innovations could result in mismeasurement of macroeconomic activity, errors in the formulation of economic policy and lost opportunities to boost business profits, enhance business efficiency and compete more vigorously.

Concluding that central-bank policy impedes real economic growth

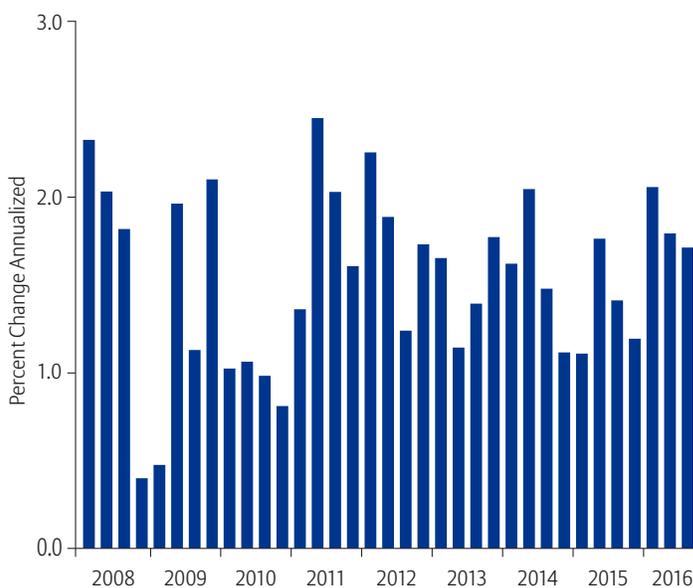
Throughout 2015 and 2016, the US economy has been unable to break out of its narrow and relatively subdued growth range. Real Gross Domestic Product (GDP) rose each quarter by between 0.8% and 3.2% annually, never reaching 3% until the third quarter of 2016. Though inflation did accelerate, price increases climbed in only very small increments, typically by 0.1% or 0.2% at a time. By these standards, the US economy has been “dull.” (See Exhibit 1.)

Allianz Global Investors set out to understand why the US economy remained lethargic for so long, how it could snap out of its lethargy and the implications of these adjustments for investors. We found part of the answer in the speeches and papers written by US Federal Reserve (Fed) officials starting last summer that revealed a growing perception that central-bank policies are having a diminishing or, perhaps, a negative economic impact.

Throughout most of the post-crisis period, the Fed argued that the weak economic growth, productivity and capital spending and have been due to insufficient aggregate demand. Consequently, the central-bank implemented aggressive monetary accommodation to stimulate total spending and, for a while, it succeeded. Alternative liquidity facilities and the first quantitative easing (QE1) clearly made a positive difference.

However, in the six years since the Fed initiated QE2 (followed by “calendar-based” forward guidance, Operation Twist, QE3 and the use of various moving targets to signal its wish to sustain the negative real Fed funds rate), GDP growth has decelerated and business investment has been subdued. QE2 and QE3 aimed primarily at reducing long-term interest rates and did so.

Exhibit 1: Core Personal Consumption Expenditure Price Index
Slowly accelerating inflation reflects cyclical dullness



Source: Federal Reserve Bank of St. Louis; Allianz Global Investors as of 11/29/2016.

As it turned out, the primary positive effects of QE2 and QE3 were at least partially the result of the fiscal actions of the Fed, not the growth in its balance sheet that repressed interest rates. Specifically, an important contribution of unconventional economic policies to growth came from the Fed’s backstopping of the mortgage-backed securities market. Housing construction and sales rebounded on the wings of low mortgage rates and an implicit guarantee by the Fed that defaulting mortgage loans would not linger on bank balance sheets. (See Exhibit 2.)

Exhibit 2: Federal Reserve large-scale asset purchases (LSAP) and forward guidance

Timeline since the financial crisis

Date	Program or Action	
11/25/2008	QE1	LSAPs announced: Fed to purchase \$100 billion in GSE debt and \$500 billion in MBS
3/18/2009	QE1	LSAPs expanded: Fed to purchase \$300 billion in long-term Treasuries and an additional \$750 billion and \$100 billion in MBS and GSE debt, respectively
3/11/2010	QE2	QE2 announced: Fed to purchase \$600 billion in Treasuries
8/9/2011	Switch to calendar-based guidance	The Fed expects low rates “at least through mid-2013”
9/21/2011	Maturity extension program	Fed to buy \$400 billion of Treasuries with remaining maturities of 6 to 30 years and sell an equal amount with remaining maturities of 3 years or less
1/25/2012	Calendar-based guidance extended to 2014	The Fed expects low rates “at least through late 2014”
9/13/2012	QE3	QE3 announced: Fed to purchase \$400 billion of MBS per month as long as “the outlook for the labor market does not improve substantially...in the context of price stability”
	Calendar-based guidance extended to mid-2015	The Fed expects low rates “at least through mid-2015”
12/12/2012		The Fed expects low rates to be appropriate while unemployment is below 6.5% and inflation is below 2.5%

Source: Bank for International Settlements; Federal Reserve; Allianz Global Investors as of 11/28/2016.

Otherwise subdued economic growth reminded the Federal Open Market Committee (FOMC) this year that ultra-low interest rates alone cannot directly influence the non-monetary determinants of economic performance. Instead, structural changes in the economy, demography and the worsening income and wealth inequality heightened pessimism and lowered real growth expectations.

In June, James Bullard, president of the St. Louis Fed, stunned the financial markets by proclaiming that he no longer had confidence in his ability to make point forecasts of the US economy and the path of interest rates. Bullard implied that unprecedented policies interacting with a unique economic environment, operating through many potential channels of influence, make it difficult to anticipate the impacts of Fed policies on the real economy.

Several weeks later, John Williams, president of the Federal Reserve Bank of San Francisco, concluded that dramatic restructuring of markets made obsolete the expected economic, financial and policy-related outcomes based on long-standing and generally-accepted economic theory. Economic theory proved to be faulty. Consequently, the Fed's actions not only fell short of their targets, the targets themselves were wrong. The real neutral policy rate targeted by the Federal Reserve had come down—but its precise level was not constant.

Then, in October, Stanley Fischer, vice-chairman of the Fed's board of governors, made two especially bold statements:

- Interest rates are below the level that would increase economic growth optimally and thus may be restraining real economic growth.
- Much tighter capital, liquidity and solvency standards enacted since the financial crisis distorted credit markets that, like ultra-low for long interest rates, may actually be holding down real economic growth.

More evidence of dissatisfaction with the current policy stance emanated from the September and November FOMC meetings. Several members of the FOMC expressed strong disagreement with the current low level of policy interest rates and pushed hard for an immediate increase. Though the majority of the committee voted to leave rates unchanged, the implication was clear: The FOMC is moving toward a new upward bias in its interest rate policies. The committee will now need to be talked out of raising rates at each meeting instead of being talked into raising them.

Central-bank policies went too far: The evidence

Detailed analysis of the impacts of central-bank policies on the US economy supports the conclusion that interest rates have been too low for too long. The mix of ultra-accommodative monetary policy, heightened regulation of business (particularly financial services) and the composition of the federal budget likely restrained real economic growth in the following ways:

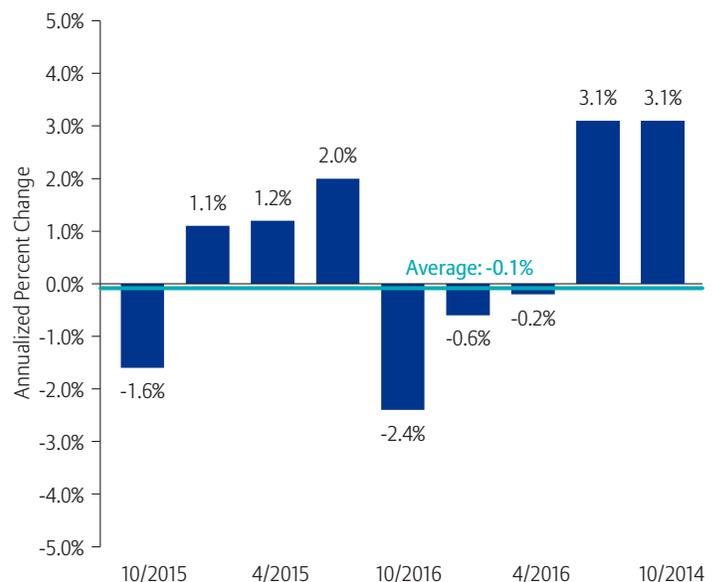
- Dimmed expectations of future disposable income led to more precautionary saving, and real consumption did not quite kept pace with real disposable income.
- Persistent ultra-low interest rates changed the intertemporal spending and saving preferences of households. Uncertainty about

future taxes, the long-term outlook for jobs, the out-of-pocket costs of health care and housing, and the soaring cost of insurance premiums led individuals to economize on current spending, delaying consumption until well into the future. Rising income inequality in many, if not most, countries created political conditions evermore favorable to entitlement programs and eventual tax increases. Individuals felt compelled to increase their saving rate in order to reach their retirement savings goals.

- While monetary policy lowered the real cost of capital, other government economic policies raised the hurdle rates on business investment decisions. Expectation of future mandated expenses and regulatory burdens complicated the calculation of expected rates of return on investment. Inevitable widening of government budget deficits and deepening indebtedness raised expectations of future tax increases, causing businesses to manage cash flows and liquidity more tightly.
- Businesses took a conservative approach to replacing aged equipment and software, while also trimming large expansion plans. Instead of ramping up domestic investment, the monetary, fiscal and regulatory policy mix encouraged business expansion overseas and the buying of foreign firms for tax reduction purposes (tax inversions). In response to some government-mandated expenses and labor laws, some businesses also relied more on part-time workers.
- The combination of diminished domestic capital spending and reliance on contingent workers dampened productivity growth. (See Exhibit 3.)
- Businesses continue to take advantage of the ultra-low financing costs to issue bonds, using the proceeds to buy back shares to meet

Exhibit 3: Real output per hour (nonfarm business sector)

Sluggish US productivity growth contributes to cyclical dullness



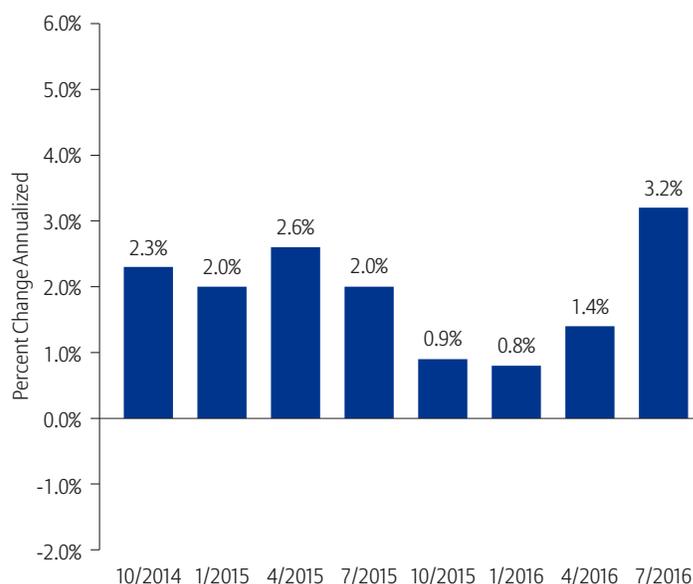
Source: Federal Reserve Bank of St. Louis; Allianz Global Investors as of 11/29/2016.

the demands of yield-hungry investors. Rising corporate leverage and higher cash distributions to stockholders may be efficient shareholder relations, but they result in less investment and less potential growth.

- In the US, over the past several decades, repos have been an important alternative, off-balance sheet source of funding for lending by both regulated banks and non-bank lenders. However, the massive expansion of the Fed’s balance sheet over the past decade has withdrawn a large amount of low-risk collateral from the market that cannot be rehypothecated, making repo funding of loans and other financial transactions harder to arrange.¹ In a similar way, the enactment of the supplementary leverage ratio requirement (a policy that includes the quantity of repos in the regulatory measure of leverage) announced in 2012 also has reduced the supply of repo funding. This new requirement increases the cost of repo finance by regulated US institutions.
- It is likely that, on net, the effect of low interest rates on stock prices raises capital investment a bit, as suggested by Tobin’s Q model of investment.² However, capital expenditure has not responded very favorably to monetary policy thus far in the recovery and expansion, and the growing funding problem for defined benefit (DB) plans may be part of the explanation. Keeping interest rates low for a protracted period of time can reduce the net worth of corporations that have large outstanding long-term debts and that operate DB pension plans. With US DB plans only about 80% funded and with a \$570 to \$600 billion deficit, the low interest rates make asset-liability matching extremely difficult. Funding of pensions typically supersedes funding of capital investment.
- Tight mortgage credit standards and more onerous administrative costs constrained mortgage originations, despite localized housing-market strength in some regions.
- Recent increases in minimum capital ratios and tougher liquidity and solvency standards have limited the ability of banks to transform their excess reserves into loans and deposits. Many banks have become reluctant to lend to all but the most credit worthy potential borrowers.
- Experience during the financial crisis taught senior bank management to protect bank equity staunchly. Banks typically target low default risk and respond to a shock that reduces banks’ market value of equity either by raising capital or by reducing risk. Default risk reduction via loan supply contraction is the most common bank response. This partially explains why the expansion of the Fed’s balance sheet has resulted in a huge persistent expansion of excess reserves rather than a substantial increase in bank lending.

Exhibit 4: Economic growth stays range-bound

Real GDP growth has been modest, but sustainable



Source: Federal Reserve Bank of St. Louis; Allianz Global Investors as of 11/29/2016.

Despite all of the negative unintended side effects of the economic policy mix, there is little doubt that it has helped to offset and reverse powerful downward influences on real economic growth and prices in an array of asset classes. The questions are: By how much, when did it do so, and is it still working as expected? Indeed, the US economy has gone some seven-and-half years without a recession and the expansion likely will continue indefinitely. Meanwhile, household and corporate balance sheets have been repaired, the federal budget deficit has been halved, equity valuations have reached all-time highs, the US dollar is riding a wave of strength, corporate default rates are stunningly low and corporate profits are strong.

Yet these outcomes and many others not listed here have not sparked economic growth, as growth stimuli and drags counteract one another. Over the months ahead, the FOMC almost certainly will examine ways to adjust monetary and regulatory policies in ways that, perhaps, will enable the economy to be less dull. (See Exhibit 4.)

New fiscal priorities must account for the fourth industrial revolution

Monetary policy over the years ahead will have to account for cultural shifts that broaden populist movements in several countries and empower more radical governments. (See Exhibit 5.)

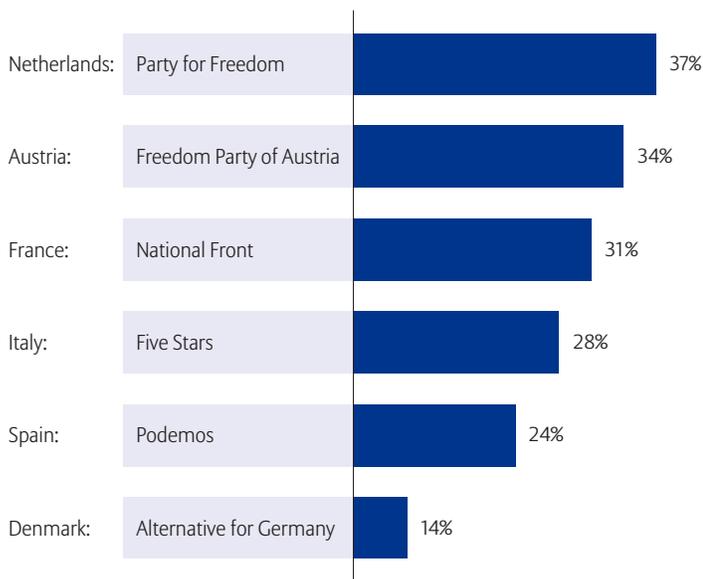
Under attack will be a mix of fiscal policies, regulations and their enforcement, trade relations among nations, immigration and

1. Unfortunately, the Fed’s role as a repo counterparty since 2013 does not offset the collateral drain produced by the accumulation of repo collateral on its balance sheet. The Fed lends its collateral into the market in exchange for cash that cannot be rehypothecated in other transactions. (Rehypothecation is the practice by banks and brokers of using, for their own purposes, assets that have been posted as collateral by their clients. Clients who permit rehypothecation of their collateral may be compensated either through a lower cost of borrowing or a rebate on fees.) Similarly, the “reverse repos” the Fed plans to use to eventually remove monetary accommodation do not provide collateral that can be used by other repo market participants.

2. Of course, low interest rates raise the present value of firms’ expected future cash flows from operations, and this can boost stock prices for many firms.

Exhibit 5: Intentions to Vote for Populist Parties

Share of individuals intending to vote



Source: Pew Research; Allianz SE; Allianz Global Investors as of 9/7/2016.

environmental policies, and, in the US at least, the functioning of the executive branch of government. Renewed emphasis on fiscal policy can be expected to result in lower taxes and increased central government spending on infrastructure and national defense.

Advocates of fiscal austerity, whose voices were heard so prominently just a couple of years ago, will face stronger opposition from a growing populist sentiment that monetary policy alone cannot, and will not, generate more rapid economic growth and inflation. Meanwhile, investors will be forced to pay extra attention to the impacts of proposed, enacted and implemented fiscal policy changes upon:

- Inflation and inflation expectations.
- The foreign exchange value of currencies, most notably, the currency-crosses between the US dollar and the currencies of China, Japan, the euro zone, Canada, Mexico and other emerging-market countries.
- Changes in relations among trading partners
- Issuance of sovereign debt securities and the prices they fetch in new-issue and secondary markets.
- The level and structure of interest rates and their impact on interest-rate sensitive sectors of the economy.
- Ability of pension plans to match assets and liabilities.
- Saving rates and investor preferences for risk, safety, income and capital appreciation.

Each of these factors, as well as others not listed, will influence the timing, pace, scale and scope of adjustments in central-bank monetary and supervisory policies.

Meanwhile, central bankers will have to consider more fully the rising tide of populism globally that reflects a release of frustration over

politics and policies, economic malaise and financial changes that seem not to be working in favor of large segments of the population.

A combination of globalization, technological change, political stalemates and geopolitical crises has resulted in declines in inflation-adjusted incomes and widening of both income and wealth disparities. (See Exhibit 6.) For many, the world has become too complex and vast, even as populations in developed countries continue to age and become more reliant on government for health care and income security. However, many of the forces driving modern-day populism cannot and will not be reversed under any set of economic policies.

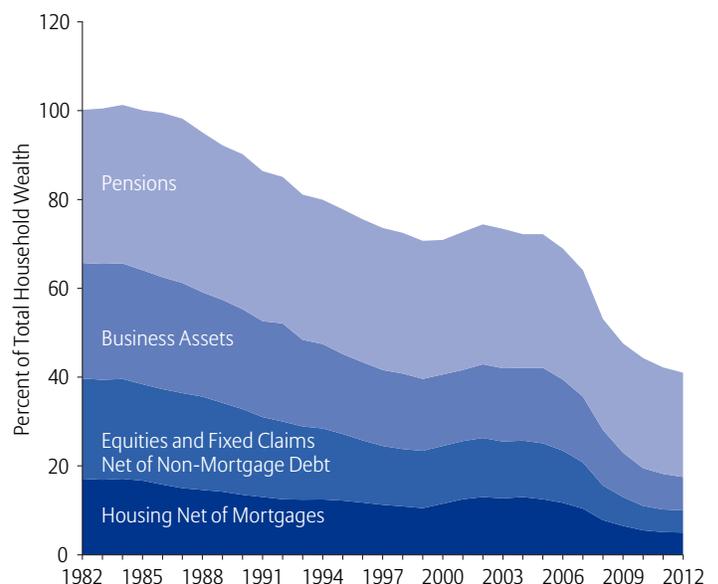
Notably, for example, the development, marketing and implementation of new technologies have radically reshaped the organization of businesses. This includes business location decisions, the demand for and supply of labor, the physical structure of work places, and the demand for resources. These developments are transforming the activities of individuals, businesses and governments, as well as the globalization process itself.

Presently, some of the discussion in political and central-banking circles focuses on the efficacy of infrastructure spending as a way to stimulate real economic growth over the short run while also meeting existing economic and social needs. Yet just as advances in technological innovation have generated changes in the stock of private-sector capital, infrastructure comprises much more than roads and bridges. Modern infrastructure must adapt to facilitate the expansion of a modern economy changed dramatically by the fourth industrial revolution.

Production now depends less on physical equipment and structures and more on four categories of intangible assets: intellectual property, organizational capital, user-generated content and human capital.

Exhibit 6: The decline of middle-class wealth in the US

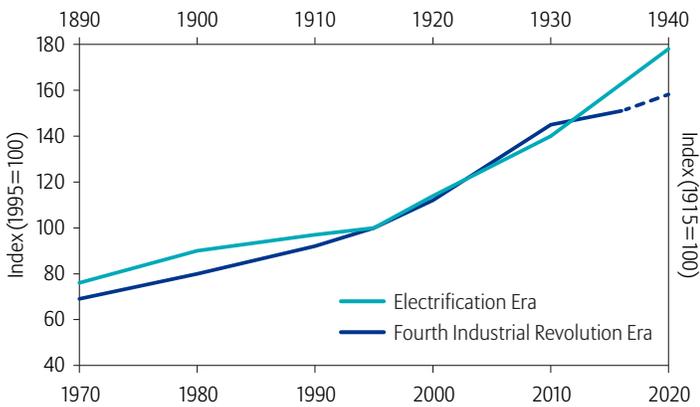
Wealth share of the bottom 90% of households is declining persistently



Source: Saez and Zucman, 2016; Allianz Global Investors as of 12/31/2012.

Exhibit 7: Productivity gains in two eras

Industrial revolutions yield delayed productivity surges



Source: US Bureau of Labor Statistics; Brynjolfsson and McAfee; Allianz Global Investors as of 11/30/2016.

As a benchmark, investment in information processing equipment and software now comprise nearly one-third of all business fixed investment, up from 10% in 1990; investment in structures comprises only 20%, down from 70% in the 1980s.

Intangible capital, then, must be a sizeable component of capital spending. The website of the US Department of Homeland Security states: “Our daily life, economic vitality and national security depend on a stable, safe and resilient cyberspace.” Key issues it identifies include secure federal networks, cyber incident response, information sharing, protected critical infrastructure, combat against cybercrime, and cyber safety, insurance and privacy.³

Chain reaction of technological progression

In this context, six words describe a chain reaction of technological progression that leads to enormous upheaval and opportunity—digitalization, deception, disruption, demonetization, dematerialization and democratization.⁴ (See Exhibit 7.)

Digitization—Anything that could be digitalized can spread at the speed of light or, at least, the speed of the Internet and become free to reproduce and share. This spreading takes place at an exponential rate. In 2005, for example, some 500 million devices were connected to the Internet. By 2015, that number rose to 12 billion, with an estimated 100 new devices connected per second. Modern exponentially growing organizations tend to focus on information technologies, dematerialize what once was physical, and create new revenue streams in months or even weeks.

However, digitalization also reduces the marginal cost of production virtually to zero in more and more applications. Advertisers using, say, social media potentially can reach customers all over the world again and again at no extra cost. Photographers using digital cameras can shoot an unlimited number of photos, modify them with software, eliminate unwanted shots and distribute a photo album electronically without buying any additional materials.

Deception—Follows digitalization and takes place when exponential growth goes largely unnoticed. For example, the doubling of the number of megapixels in a camera from .01 to .02 and then to .04 seemed like miniscule change. However, when improvements brought movement in whole numbers, from 1 megapixel, to 2, 4, and 8, photographers noticed massive improvement in photographic quality. The camera quality in modern cellphones now far exceeds that of the first generation of digital cameras and enables everyone to get picture quality professional photographers could not obtain even two years ago. Camera and film companies as recently as the 1990s failed to recognize the exponential growth potential of digital photography combined with mobile phones. Today, many of those companies no longer exist.

Disruption—In simple terms, disruptive technology creates new markets or leads to drastic changes in existing ones. For example, 3-D printing will be increasingly disruptive to any industry whose end product can be customized. As a result, one-stop manufacturing will soon become commonplace in homes and offices or rented through the cloud. With infinite computing, researchers can ask the cloud to run automobile design simulations, experimenting with every possible location for the motor and a range of different materials and thicknesses, resulting in not just an adequate design, but the best design. (See Exhibit 8.)

Demonetization—Refers to the production and sale of billions of goods and services without money changing hands, creating a shadow economy. In some cases, businesses offer their “loss leader” free of charge, for example, but they make money from the information they gather along the way. Open-source technologies, such as Wikipedia and Linux, actually are free. Skype demonetized long-distance telephony; Craigslist demonetized classified advertising; Napster demonetized music sales. More critically, because demonetization also is deceptive, almost nobody in these industries anticipated such a radical change.

Dematerialization—While demonetization describes the vanishing of paid transactions for goods and services, dematerialization is about the disappearance of the goods and services. Anyone who uses Google Maps or Waze, for example, gets GPS access without the use of a physical product, such as a physical navigation device. Following the invention of the smartphone and its high-quality megapixel camera, the digital camera dematerialized picture-taking. Not only did the camera come free with most phones, consumers expected it to come free with phones. In 1976, Kodak controlled 85% of the US camera business; by 2008, one year after the introduction of the iPhone and its high-quality digital camera, the snap-and-shoot market no longer existed. (See Exhibit 9.)

Democratization—Occurs where high-performance computing is abundant, reliable and affordable. Accordingly, physical objects are turned into bits and hosted on a digital platform in such high volume that their price approaches zero. Today, computational speed available

3. See the website of the US Department of Homeland Security at www.dhs.gov/topic/cybersecurity.

4. Discussion of “the six D-words” appeared in *Bold* by Peter H. Diamandis and Steven Kotler.

Exhibit 8: Industries being disrupted by 3-D printing

Future applications of 3-D printing will revolutionize production

Industries	Current Applications	Potential Applications
Commercial aerospace and defense	Concept modeling and prototyping	Embedding additively manufactured electronics directly onto parts
	Structural and non-structural production parts	Complex engine parts
	Low volume replacement parts	Aircraft wing components
Space	Specialized parts for space exploration	Other structural aircraft components
	Structures using light-weight, high-strength materials	On-demand parts and spares in space
Automotive	Rapid prototyping and manufacturing of end-use parts	Large structures created directly in space, circumventing launch vehicle size limitations
	Parts and assemblies for antique cars and race cars	Sophisticated auto components
	Quick production of parts or entire vehicles	Auto components designed through crowdsourcing
Health care	Prostheses and implants	Developing organs for transplants
	Medical instruments and models	Large-scale pharmaceutical production
	Hearing aids and dental implants	Developing human tissues for regenerative therapies
Consumer products/Retail	Rapid prototyping	Co-designing and creating with customers
	Creating and testing design iterations	Customized living spaces
	Customized jewelry and watches	Growing mass customization of consumer products
	Limited product customization	

Source: Diamandis and Kotler; Allianz Global Investors as of 12/31/2012.

to anyone in the world outstrips the computational capabilities of the US Defense Department in 1990. Chips in a cellphone manufactured in 2016 can perform about one billion calculations per second. By 2020, a cellphone chip will cost about one penny to manufacture

Over the decade ahead, technological breakthroughs will open the door to a flood of advanced technologies. Technologies and their interfaces will be fused across physical, digital and biological domains in:

- Smart and connected machines and systems
- Quasi-artificial intelligence
- Quantum computing
- 3-D printing
- System robots
- Big data
- Medical imaging
- Gene splicing and genomics
- Nanotechnologies
- Virtual reality
- Machine learning

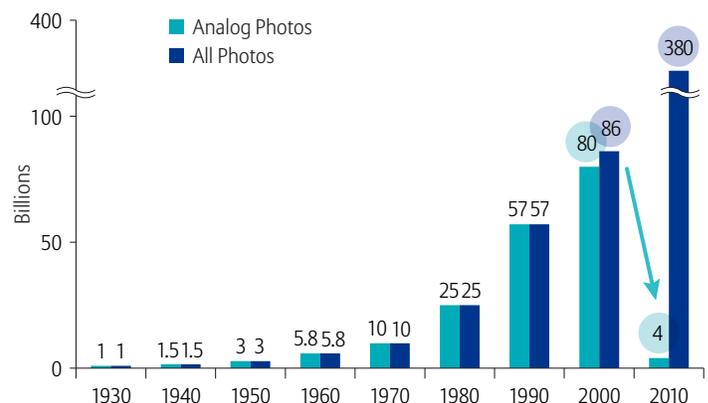
Fusing of complementary technologies will result in myriad breakthroughs—and they will emerge rapidly. Machine intelligence and billions of interconnected brains working together will change the entire way businesses build outputs, distribute them and sell to customers and clients. Meanwhile, how individuals and households

interact with businesses will change quickly, fusing shopping, payment and delivery technologies in ways that will customize buyer satisfaction. Already, the results are stunning and underpin some of the political unrest globally. A laptop computer can be assembled in the US by workers at a cost of about \$40 per hour; in China, the cost is \$4 per hour; by robot, the cost is \$0.75 per hour.

Combining the modern domains of innovation will be transformative across industries and sectors in more ways than were possible in past industrial revolutions that focused on mechanization, electronics and digitalization. Modern domains are largely

Exhibit 9: Number of photos taken by decade

Digital cameras enabled explosive growth in photos taken



Source: www.digital-photography-school.com/history-photography/; Allianz Global Investors as of 12/31/2010.

nonspecific and can be used at all levels of companies across pretty much all sectors.

Due to exponential, digital and modern recombinant powers, useful artificial intelligence (AI) and connections among most people on earth can take place via a common digital network. AI enables machines to complete cognitive tasks, with capabilities in pattern recognition, complex communication and other domains once thought to be exclusively human. To take one example, innovators at the Israeli company, OrCam, combined a small, but powerful, computer, digital sensors and special algorithms to give key aspects of sight to the visually impaired.

With big data and advanced medical imaging, a rapidly advancing example of combined technologies, doctors will be able to provide more accurate and thorough examinations, diagnoses and treatments. No doctor could possibly know the content of millions of articles, 25,000 more per week, and every medical book ever written the way IBM's "Watson" could. Devices equipped with AI also can learn from experience and they never forget anything.

By comparison, only after 30 years, long enough for original managers to retire and be replaced by a new generation, did the introduction of electric motors and devices change factory layouts. The benefits of electrification stretched for nearly a century as more and more complementary innovations were implemented. However, unlike the steam engine or electricity, the current industrial revolution advances at an exponential pace, creating even more opportunities for combinatorial breakthroughs and their adoption in years, if not months.

Given the irreversibility of technological breakthroughs, existing companies will be forced to change their business model, just as traditional car companies have adapted to autonomous vehicles and brick-and-mortar retailers have turned cellphones into shopping carts. Fusion of technologies also will help lead to environmental and infrastructure solutions. In the process, jobs will be eliminated, with the biggest losses in the places that experienced the biggest changes (e.g., among the 3.5 million truck drivers). Perfect machine translation of language means that anyone in any country can do just about anything.

Governments and central banks that fail to master the implications of this industrial revolution not only will miss their policy targets, they will set the wrong targets. For example, the dynamics of inflation have been altered irrevocably by online shopping and the ability of consumers to engage in price comparisons quickly, at no cost and internationally before making purchases. Not surprisingly, goods inflation has remained muted for an entire generation.

In addition, failure to adjust economic policies and regulations will further weaken real economic growth and productivity over the long run. Inertia will encourage a further shift of output and incomes to emerging-market countries and the most forward-looking developed countries.

Statistically, the proliferation of free products represses GDP expansion. If the cost of creating and delivering an encyclopedia to your desktop is a few pennies instead of thousands of dollars, the decrease in the use of materials and costs lowers GDP even if the consumer is better off. In an experiment, it took 22 minutes, on average, to find the answer to a complex question in a brick-and-mortar library; using a search engine, it took seven minutes. When you multiply the 15-minute time difference across all of the queries and average American poses, and assume a \$22 average hourly wage, the savings work out to about \$500 per adult worker per year.

For businesses, the failure to rethink and redirect business strategy, investment, governance and organization in light of revolutionary technological change will result in lost competitiveness and opportunities to enhance profits. As the fourth industrial revolution proceeds, substantial new opportunities will open up in companies that will become the industrial leaders of the next generation. As the head of the investment committee of an internationally-known California-based technology giant told Allianz Global Investors last year, "We are always one innovation by a startup company away from being knocked out of business."

Even if this warning turns out to be exaggerated, its message about the relentless change in the industrial landscape remains sound. Central banks and government need to take notice or else their economic and regulatory policies will focus on the wrong targets—and the populist movements will gain deeper traction for longer periods of time.

Appendix 1: Ongoing conflicts in the world

Dozens of conflicts rage all over the world

		Hot Spots	Nature of conflict
Africa	29 countries, 214 conflicts involving militias/guerillas, terrorist/separatist/anarchistic groups	Central African Republic	Armed clashes between Muslims and Christians
		Democratic Republic of Congo	War against rebel groups
		Egypt	War against Islamic State
		Libya	Civil war
		Mali	Clashes between army and rebel groups
		Mozambique	Clashes with Mozambican National Resistance rebels
		Nigeria	War against Islamist militants
		Somalia	War against al-Shabaab Islamist militants
		Sudan	War against rebel groups in Darfur
		South Sudan	Clashes with rebel groups
Asia	16 countries, 169 conflicts involving militias/guerillas, terrorist/separatist/anarchistic groups	Afghanistan	War against Islamist militants
		Burma-Myanmar	War against rebel groups
		Pakistan	War against Islamist militants
		Philippines	War against Islamist militants
		Thailand	Coup d'état by army (May 2014)
Europe	10 countries, 80 conflicts involving militias/guerillas, terrorist/separatist/anarchistic groups	Chechnya	War against Islamist militants
		Dagestan	War against Islamist militants
		Ukraine	Secession of self-proclaimed Donetsk People's Republic and self-proclaimed Luhansk People's Republic
		Nagorno-Karabakh	Clashes between Azerbaijan army against Armenian army and Nagorno-Karabakh army
Middle East	7 countries, 244 conflicts involving militias/guerillas, terrorist/separatist/anarchistic groups	Iraq	War against Islamic State Islamist militants
		Israel	War against Islamist and Palestine statehood militants, especially in Gaza Strip
		Yemen	War against and between Islamist militants
The Americas	6 countries, 26 conflicts involving drug cartels, terrorist/separatist/anarchistic groups	Colombia	War against rebel groups
		Mexico	War against narcotraffic groups

Total number of countries involved in wars: 67

Number of militias/guerillas and terrorist/separatist/anarchistic groups involved: 734

Source: Wars in the World List of Ongoing Conflicts; Allianz Global Investors as of 10/16/2016.

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WP-31-1216 | 86634 | 02096

