American Innovation Under Structural Erosion and Global Pressures

BY DAN STEINBOCK | FEBRUARY 2015

While America has recovered faster from the global financial crisis than other nations, structural trends in innovation convergence have not disappeared.

For most of the postwar era, the United States has enjoyed superior leadership in innovation, whether measured by student skills, research and development spending, patents, or high-technology industry output. As Western European economies caught up with the global innovation frontier and Japan followed, this superiority began to erode. The U.S.-led IT revolution of the 1990s seemed to slow down this innovation convergence, but only until the bubble burst in the early 2000s.

While America has recovered faster from the global financial crisis than other nations, structural trends in innovation convergence have not disappeared. On the contrary, the technological advancement of large emerging economies, such as China, has clearly delineated other nations' growing innovation advantages. Despite signals from global innovation indicators and the relative decline in U.S. innovation performance, there is not yet a sense of crisis in Washington.

However, this report argues that U.S. innovation suffers from structural corrosion domestically, which is compounded by U.S. erosion globally. In the absence of significant increases in investment for innovation (from both direct spending and tax incentives for business to invest more in innovation), the current budget sequestration is likely to pave the way for further relative decline in innovation with accompanying slower economic growth and weakened global standing. It is not an inevitable scenario, however. The United States could once again lead in the race for global innovation advantage with an appropriate innovation strategy — one that's credible, bipartisan and medium- to long-term in nature.[1]

CONVENTIONAL WISDOM: WE'RE NUMBER ONE

"The first step in winning the future is encouraging American innovation." So said President Barack Obama in January 2011. "None of us can predict with certainty what the next big industry will be or where the new jobs will come from... What we can do—what America does better than anyone else—is spark the creativity and imagination of our people."[2] As President Obama introduced his initiative, *A Strategy for American Innovation*, he captured the basic tenets of U.S. innovation as they are commonly understood. But how viable are these tenets today?

While the first global competitiveness debates emerged as early as the late 1960s, it was the catch-up growth of Western Europe and the rise of Japan in the 1970s and 1980s that turned research questions into contested and consequential policy issues. This new outlook was boosted by a slate of pro-innovation policy successes. U.S. policy makers from both sides of the aisle responded with a suite of innovation and competitiveness policies like the Bayh-Dole Act, the R&D credit, the Cooperative Research and Development Act, the reorganization of the National Institute of Standards and Technology, the creation of the Small Business Innovation Research program, and a host of other policies and programs.

International R&D rivalry is no longer driven just by the U.S., Europe, or Japan, but also by Asia and particularly South Korea and China.

In the early 1990s, after the end of the Cold War, most advanced economies began to intensify their efforts to foster innovation, and upgrade competitiveness. It was then, too, that Columbia professor Richard R. Nelson and his colleagues initiated a major research project on national innovation systems.[3] While this project acknowledged pressures toward structural corrosion and relative global erosion of U.S. innovation leadership, the recommendations were lost amid the feel-good years of the 1990s, characterized by triumphalism and the dot.com bubble. Nuanced recommendations and warnings gave way to a far simpler but less substantial view that, while the U.S. had innovation competition, it had successfully withstood the charge, in large part because of inherent and hard-to-replicate advantages like its risk-taking, entrepreneurial culture.

Perhaps because of the perceived success of first-wave policy responses to global competition in the 1980s, the conventional view today remains that while the U.S. innovation system faces increasing domestic cost pressures and international challenges, it is still vastly superior. On top of that, political polarization has meant that one party now seems to be focused almost exclusively on keeping government from doing too much meaningful work, other than removing some barriers, to spur U.S. global, innovation-based competitiveness while the other party seems to have become enthralled with a new anti-business populism that looks single-mindedly to redistribution as the solution to America's economic woes.

THE REALITY OF GLOBAL COMPETITION FOR INNOVATION

A more nuanced picture of global competition for innovation tells a very different story. International R&D rivalry is no longer driven just by the U.S., Europe, or Japan, but also by Asia and particularly South Korea and China. In the past decade and a half—particularly after China joined the World Trade Organization (WTO) in 2001—these global trends have accelerated dramatically across the spectrum of innovation activities, as evidenced by significant shifts in student performance, R&D, and patents. While patents tend to tell us more about past glory, R&D may be more reflective of current and future trends. In turn, student performance today anticipates future trends.[4] Taken together, these indicators tell a story of gradual erosion.

Shifts in Student Performance

As recently as the 1980s, the United States led the world in its share of young adults with a college degree. Today it ranks just 12th.[5] Unfortunately, the erosion of student capabilities is accelerating. According to the Organization for Economic Co-operation and Development (OECD) Program for International Student Assessment (PISA) performance assessments, students in the U.S. are falling behind their counterparts in China and emerging Asia (Figure 1).[6] Since 2000, the U.S. has no longer been featured in the top-10 PISA lists for mathematics, science, or reading.[7] By 2012, the U.S. lag was particularly severe in math (36th), but weak in science (28th) and reading (24th).

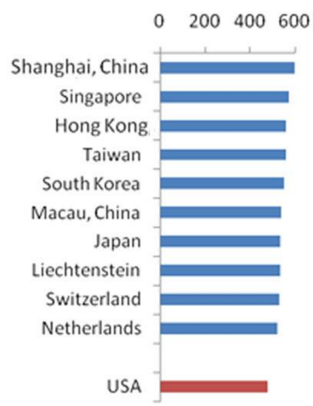

Figure 1: Student Performance in Math, 2012[8]

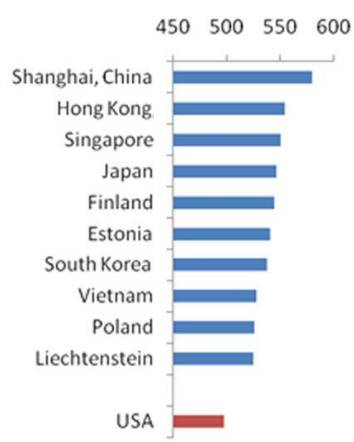

Figure 2: Student Performance in Science, 2012

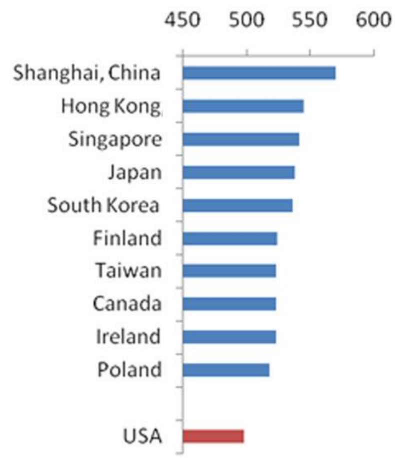

Figure 3: Student Performance in Reading, 2012

Shifts in Patents

According to the World Intellectual Property Organization (WIPO), the United States dominated in total patent applications received from the early 1880s to the late 1960s, after which Japan surpassed the United States, until the early 2000s when U.S. briefly regained leadership. In 2010, China's patenting overtook Japan, and two years later it surpassed the United States to become the largest in the world, according to WIPO. Although many of these patents are not high quality, they do indicate a trend. In the century before 2011, only three patent offices—those in Germany, Japan and the United States—dominated the world's patent markets. That era is now over. (Figure 4)[9]

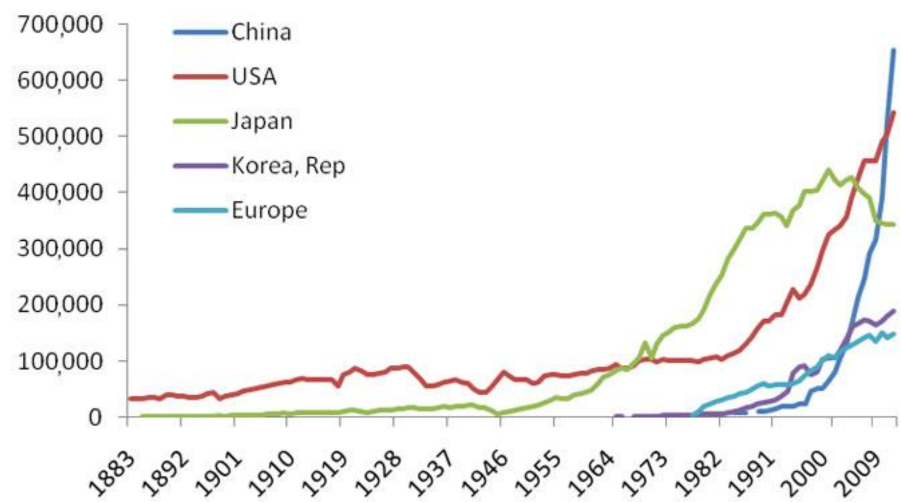

Figure 4: Global Patents Race: Trend in Patent Applications: Top Five Offices[10]

As noted, data on the numbers of patents granted provide no indication of patent quality. Triadic patents, in which inventors simultaneously seek patent protection in three of the world's largest markets—the United States, the EU, and Japan—may better illustrate those patents expected to have high commercial value.[11] The contributions of the United States, the EU, and Japan have stayed roughly equal (at around 30 percent each) until recently. However, from 1999 to 2011, the overall share of global U.S. triadic patent filings decreased from 32 percent to 29 percent.[12] In fact, the overall global decline in triadic patent families since 1999 can be explained entirely by fewer patents from the United States. While total triadic patents declined by 3 percent over the period, growth of triadic patents from firms outside the United States actually grew by 2 percent. (Figure 5)

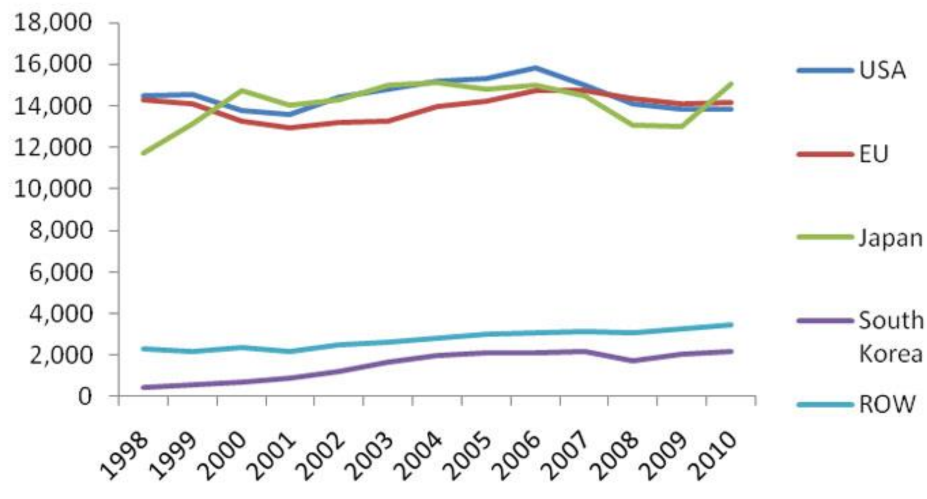

Figure 5: Global Triadic Patent Families By Selected Economy, 1998-2010[13]

With adjustments for increases to the U.S. working age population, the U.S. actually generates 25 percent fewer triadic patents per person than it did in 1999. As ITIF has noted, "This troubling statistic sharply contrasts with the United States' reputation as a leader in global innovation, especially in the advanced fields where triadic patents are common."[14]

In the process, the United States has fallen behind Japan (31 percent) as the top filer of triadic patents. Adjusting for the population, Japan actually files 2.5 times more triadic patents per person than the U.S., which remains behind a number of European economies (Switzerland, the Netherlands, Denmark, Finland, Sweden, and Germany), in per capita terms.[15]

Shifts in R&D

In the aftermath of the global financial crisis of 2008–2009, global R&D growth has slowed. This slowdown can be attributed primarily to the ailing Eurozone and the lingering U.S. recovery and Japanese stagnation.

Only half a decade ago, the U.S., Canada, and Mexico accounted for nearly 40 percent of global R&D. That share has dropped to about 34 percent, with the U.S. shrinking from a 34 percent share in 2009 to 31 percent now. Meanwhile, Asia's share of R&D investments has risen from 33 percent to nearly 40 percent, and China's has grown from 10 percent to nearly 18 percent. In turn, China's total R&D investments have grown to more than 60 percent of those of the U.S. In other words, between 2009 and 2014, Asia has been replacing the NAFTA economies as the global R&D driver. (Figure 6)[16]

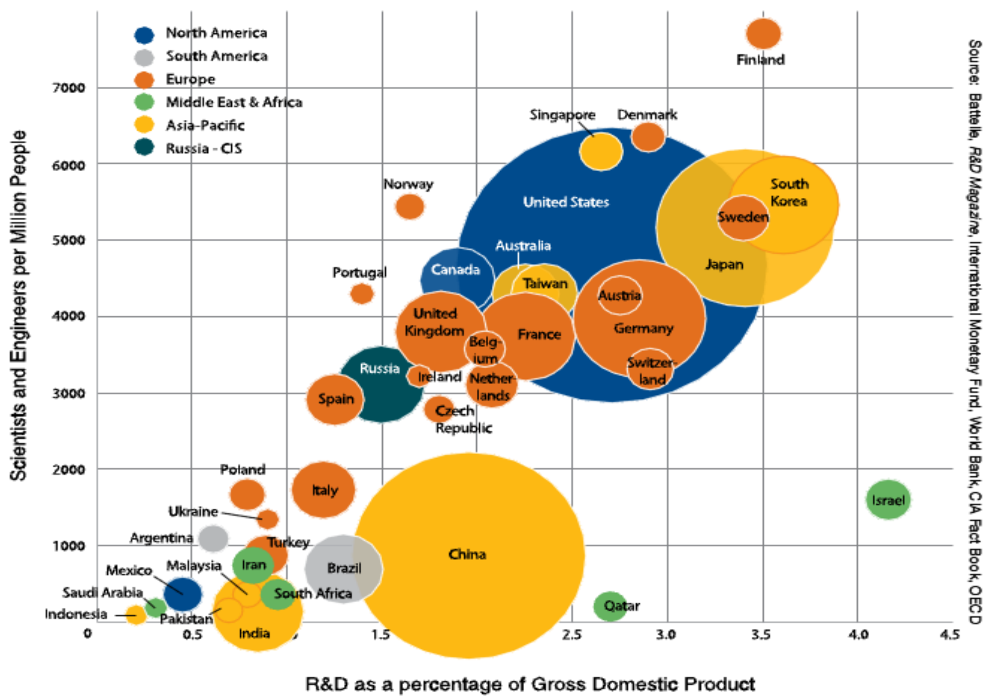

Figure 6: World of R&D: After Global Crisis[17]

On the surface, China is fueling much of this change. It is likely to surpass Europe in total R&D spending by the end of the 2010s and the U.S. by the early 2020s. However, official government figures on Chinese R&D are often contested in the West, where critics consider it likely that they are overstated. Nevertheless, China's R&D growth is significant. Furthermore, there are structural trends that may favor China in the coming years. The new Chinese reform agenda seeks to accelerate the role of private R&D spending, even in the context of decelerating growth.

Erosion of Federal Funding for Innovation

In absolute terms, U.S. R&D investment has been the highest among the advanced economies in the postwar era. The launch of Sputnik in 1957 triggered huge increases in R&D, particularly in defense, and also led to the launch of the Defense Advanced Research Projects Agency (DARPA). If World War II dramatically mobilized and expanded the U.S. national innovation system, the Cold War sustained the size and the central role of defense R&D in a way that made the U.S. national innovation system very different from its counterparts in Europe.

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Indeed, R&D investments grew through the Eisenhower and Kennedy eras as R&D intensity (the ratio of R&D expenditures to GDP) more than doubled from less than 1.40 to 2.88 by 1964. Thereafter, R&D intensity suffered a dramatic decline to 2.12 in the late 1970s. Along with efforts at the "Great Society," the second Johnson Administration saw the rise of social turmoil and the Vietnam War, which led innovation expenditures to stagnate even before the oil crises.

In the Reagan era, R&D expenditures began to increase again, fueled by growing competitiveness challenges particularly with Japan, and increasing focus on national security challenges with the Soviet Union. In the process, R&D intensity climbed to 2.72 in 1985. After the end of the Cold War, and the onset of the Persian Gulf War, increased uncertainty caused R&D intensity to decline again to 2.39 in 1994. It was only with the Clinton years that innovation funding began a renewed march upward, on the back of the technology revolution and increased commitment to health R&D, peaking at 2.72 in 2001.

In the first term of the George W. Bush administration, R&D intensity actually dipped to 2.57 of GDP in 2004. But the attacks of September 11, 2001 fueled R&D expansion for defense and security enhancements. In conjunction with the War on Terror and engagements in Afghanistan and Iraq, the R&D intensity ratio rose to 2.85 in 2008. President Obama arrived in the White House at the height of the global financial crisis. The Administration's stimulus initiatives and recovery packages provided a significant but only temporary growth injection. The nation's business and government R&D intensity rose to 2.90 in 2009, thanks to some funding going to R&D in the American Recovery and Reinvestment Act (ARRA). However, as subsequent years would show, these one-time gains were the exception. Today, the R&D intensity ratio in the United States is back at 2.8. (Figure 7)

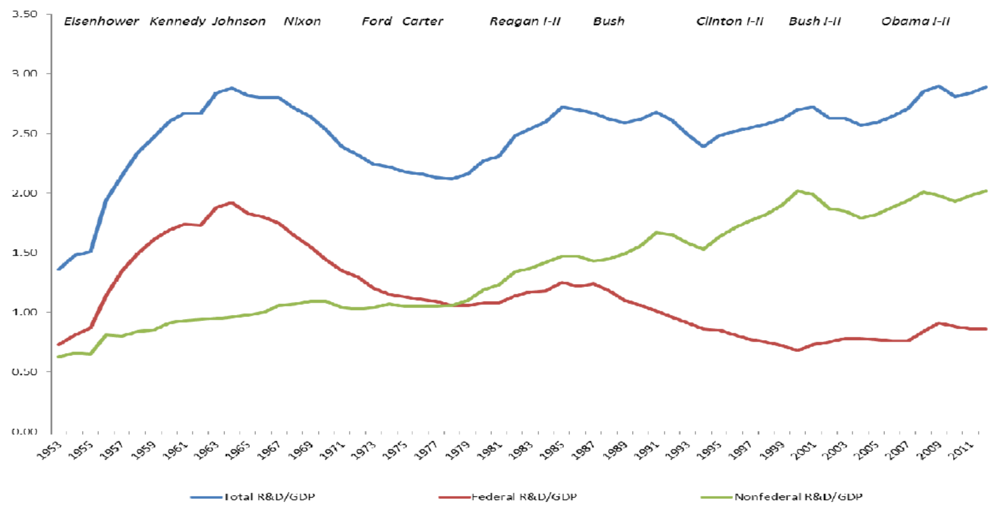

Figure 7: Ratio of U.S. R&D to Gross Domestic Product, Roles of Federal and Nonfederal Funding for R&D: 1953–2012[18]

GOVERNMENT R&D: DECELERATING GROWTH, RELATIVE EROSION

World War II institutionalized the federal role in R&D, leading to significant advances in atomic power, electronics, jet aircraft, and radar. In the postwar era, federal funding played a role in many breakthrough innovations including in IT (Google search engine, GPS, ARPANET, smart phone technologies), energy (shale gas revolution, seismic imaging, visible LED technology), health (advanced prosthetics, human genome project, HIV/AIDS), mathematics (reverse auctions, kidney matching program, fast multipole method), education, transportation (civil aviation), and agriculture (hybrid corn, lactose free milk).[19]

The U.S. government supports and facilitates the national R&D system through various policy avenues. The most direct ones comprise R&D activities conducted by federal organizations (agency intramural laboratories and facilities, or Federally Funded Research and Development Centers [FFRDCs]) and the funding for R&D provided to other performers (e.g., businesses and academic institutions). Federal R&D spans a range of objectives, including defense, health, space, energy, natural resources and environment, general science, and various other categories.

After the global financial crisis, U.S. budget constraints have resulted in a decline of federal R&D expenditures. (Figure 8)

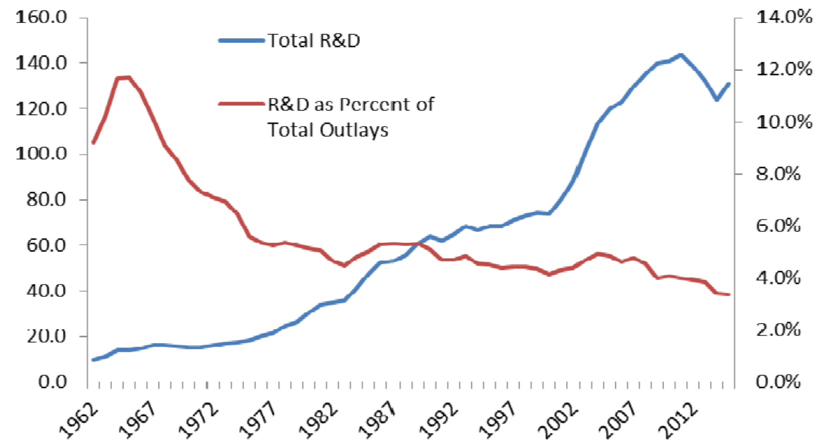

Figure 8: Federal R&D as a Share of Total Budget, 1962 – 2015: Outlays in Billions of Current Dollars[20]

Over the past three decades, most of the rise in the U.S. R&D/GDP ratio has been fueled by business R&D. While national R&D increased in the 1980s, the ratio of federal spending to GDP actually declined from the early 1980s to the late 1990s, particularly due to cuts in defense-related R&D. This trend was reversed only in the early 2000s, thanks to increased federal spending on biomedical R&D, national security R&D and the one-time R&D gains by the ARRA 2009. (Figure 9)

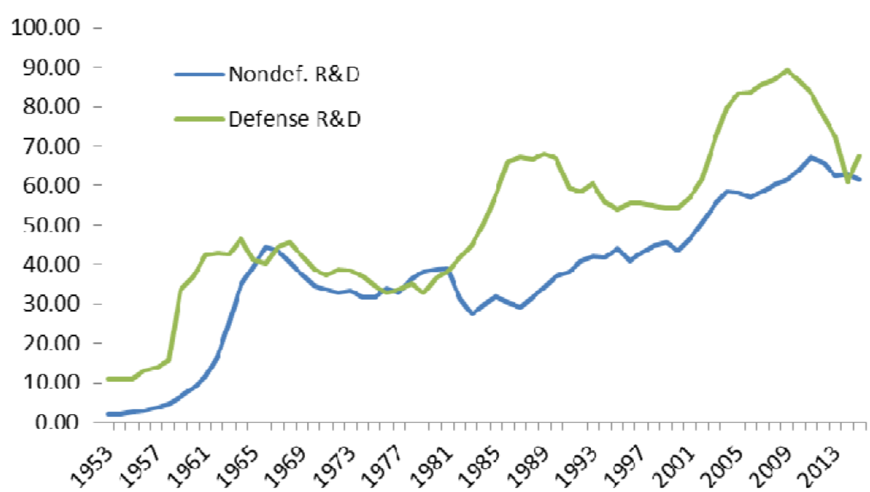

Figure 9: Trends in Federal R&D by Function, FY 1953-2015: Outlays for the Conduct of R&D, Billions of Constant FY 2014 Dollars[21]

While governments fund about one-third of R&D, businesses perform 71 percent of total R&D followed by academia (13 percent), and federal government (8 percent). More than half of government R&D consists of defense R&D. Non-profit R&D and FFRDCs each account for 4 percent of U.S. R&D. (Figure 10) FFRDCs spent $17.4 billion on R&D in 2012.

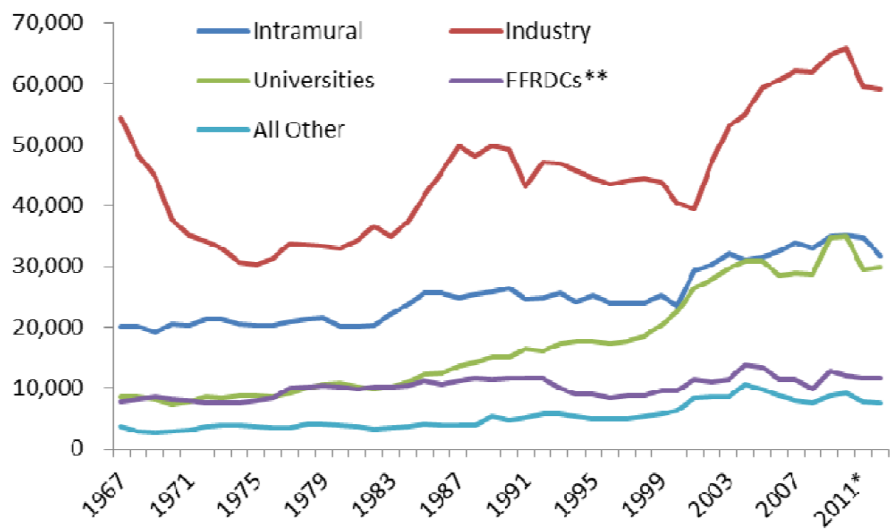

Figure 10: Federal R&D and R&D Plant Funding by Performer, FY 1967-2012 (in Millions of Constant FY 2014 Dollars)[22]

Through federal technology transfer, inventions and other intellectual assets from federally funded R&D are further developed and commercialized. In turn, the Small Business Innovation Research (SBIR) program and Small Business Technology Transfer (STTR) program provide competitively awarded funding to small businesses.[23]

Other federal efforts to promote the transfer and commercialization of federal R&D, though narrower in scope and resources, include the Hollings Manufacturing Extension Partnership (MEP), the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E), and the National Science Foundation (NSF) Cooperative Research Centers (I/UCRC) Program. To the extent that sequester continues, these programs will likely face budget cuts.

DEFENSE R&D: AN ERA OF DIMINISHED PROSPECTS[24]

Since World War II, U.S. defense R&D expenditures have been the highest among the major advanced economies. It was not until the late 1970s that the combined military spending of Germany, France, the UK, and Japan exceeded that of the U.S. (ironically, today their share is smaller than that of the U.S., again). In the U.S., 57 percent of federal R&D support in 2011 went to defense R&D—more than three times the share for defense in South Korea and the UK, and eight times the share for defense in France, Germany, and Japan.[25]

Through the Cold War, defense dominated the federal R&D budget. Its share fell below 50 percent of the total obligations in just three years. In 1960, defense research accounted for 80 percent of federal R&D funds. Its decline converged with the growth of the space program and the social turmoil of the Vietnam and Nixon years. While it was hovering around 50 percent until the early 1980s, it was boosted dramatically by the Reagan era rearmament. (Figure 13)[26]

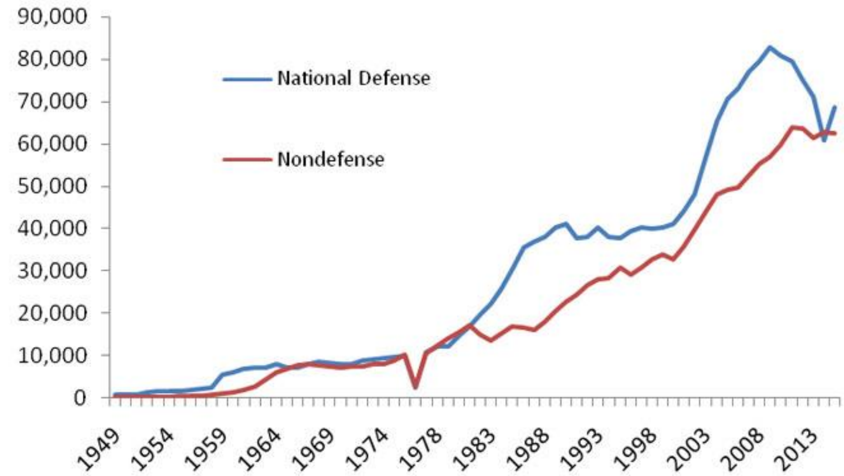

Figure 13: Historical Outlays for R&D in Millions of Current Dollars, 1949–2015

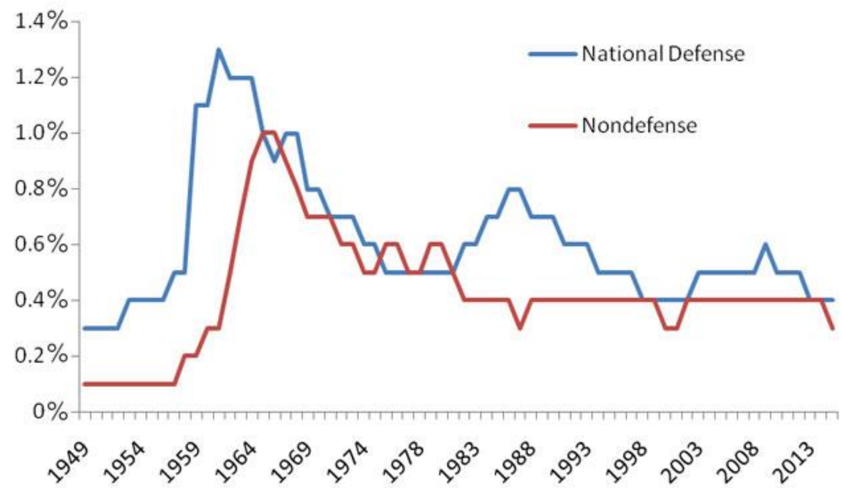

Figure 14: Historical Outlays for R&D as Percentages of GDP, 1949–2015

By the mid-80s, R&D for defense was more than twice the federal investment for non-defense R&D. As the Cold War faded between 1986 and 2001, the share of defense shrank back to just over half of the total. Things changed after September 11, 2001, when national defense R&D expenditures increased again, peaking in 2009. In the context of the global financial crisis, defense R&D plunged, but it is expected to climb again relative to non-defense R&D in 2014.

Currently, the Department of Defense (DOD) plans to keep supporting research, development, test and evaluation (RDT&E) and expects to spend close to $63 billion in these areas in 2014. Under the 2015 Future Years Defense Plan, DOD would halve spending on System Development and Demonstration, from about $20 billion in 2009 to below $10 billion by 2018.[27]

Academic R&D: Most Daunted Budgets in a Generation

Universities have been involved in patenting and licensing intellectual property since the 1920s.[28] After World War II and the increase in federal support for research conducted at universities, technology transfer to the private marketplace was limited by a licensing system in which the federal government held the patent. When the Bayh-Dole Act was passed in 1980, it shifted intellectual property rights to the research institution, and this significantly increased the commercialization of technology developed with federal funding.[29] Today, an increasing share of research at universities and nonprofits is commercialized, benefiting industry and the U.S. economy.

Nevertheless, in the aftermath of the global financial crisis, academic R&D, too, is facing its most daunting budget environment in a generation. In 2012, R&D expenditures at U.S. universities and colleges totaled $66 billion. (Figure 10)

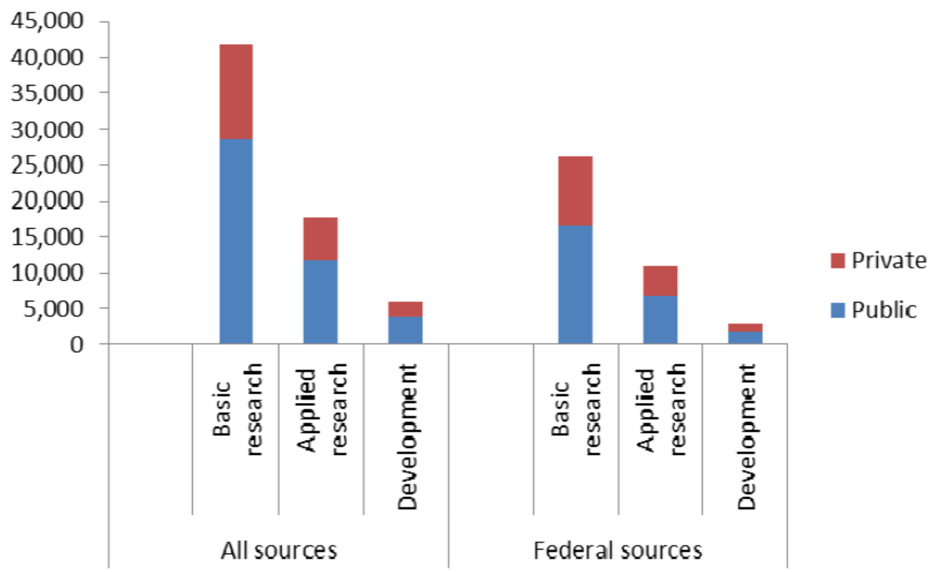

Figure 15: Higher education R&D: Fiscal Years 2010—12 ($ Millions)[30]

Adjusted for inflation, academic R&D actually fell by 1 percent between 2011 and 2013, when the real GDP increased at an average annual rate of 2.0 percent.[31] Some two-thirds of academic R&D was spent on basic research, a third on applied research, and 9 percent on development. Expenditures are concentrated in life sciences, which have received over half of all academic R&D expenditures for more than three decades. (Figure 16)

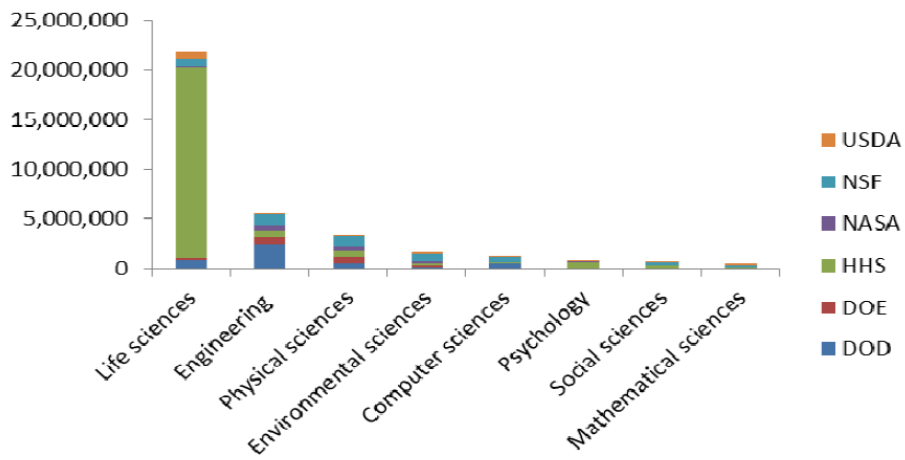

Figure 16: Higher Education R&D: By Agency and S&E Field, 2012($ Millions)[32]*

***DoD = Department of Defense; DoE = Department of Energy; DoHHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; DoA = Department of Agriculture.**

U.S. higher education institutions continue to enjoy leadership in international rankings, but concerns about increasing budget cuts in the research universities continue to grow.[33] As ITIF has shown, America is nowhere near the lead nation in terms of funding university research; "in fact, of 39 nations, the United States ranks just 24th in government funding and 27th in business funding as a share of GDP, and, the leading seven nations invest more than double the U.S. level."[34]

Since U.S. innovation is concentrated geographically; these shifts are reflected in regional evolution as well. A typical example is Silicon Valley, perhaps the most imitated region worldwide.[35] Indeed, local R&D budgets have a minor but vital role in overall innovation. State and local governments provided 5.5 percent ($3.4 billion) of academic science and engineering R&D funding in 2012. Historically, their share has plunged from a peak of 10 percent in the early 1970s to less than 6 percent in recent years because of cuts to higher education funding.[36] While public support for higher education has been under pressure for more than three decades, the cuts escalated after the global financial crisis. Most states have begun to restore some of the cuts they made to higher education funding after the recession hit. Nevertheless, eight states were still cutting expenditures in 2014, and in almost all states higher education funding remains well below pre-recession levels. In fact, all major R&D states, as defined by R&D performed *or* R&D intensity, have suffered from high tuition increases in public colleges.[37]

BUSINESS INNOVATION: RESILIENCE BUT EROSION OF DYNAMISM

Historically, U.S. innovation has been dominated by large corporations, especially in incremental R&D. However, small new ventures often develop new technologies. In turn, established large companies develop and commercialize major new technologies with product and process improvements that refine new technologies to the point at which they become widely used. "In this century, and especially after World War II, the systematization and exploitation of science became a central source of growth in the United States and worldwide," says Alfred D. Chandler, Jr., the pioneer U.S. business historian. "In turn, American big business R&D has been complemented by the federal government and small business."[38] The business sector today remains the largest performer of R&D, conducting more than $294 billion (69 percent) of the total in the United States in the early 2010s. Business has long been dominant in the composition of national R&D. Since the Cold War era, its annual share of national R&D has varied from 68 percent to 74 percent.[39] (Figure 17) The business sector, in turn, is led by multinational companies that can achieve the kind of scale and scope that allows them to compete and innovate globally.

Business has long been dominant in the composition of national R&D.

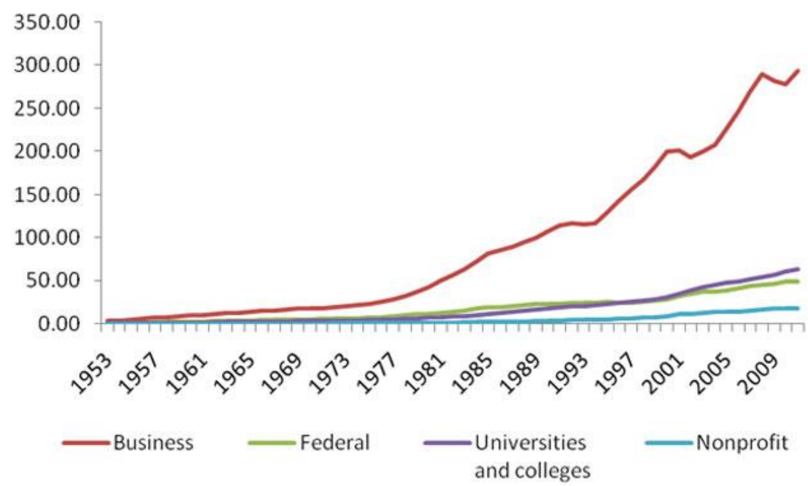

Figure 17: U.S. R&D by Performing Sector in U.S. $ Billions, 1953–2011[40]

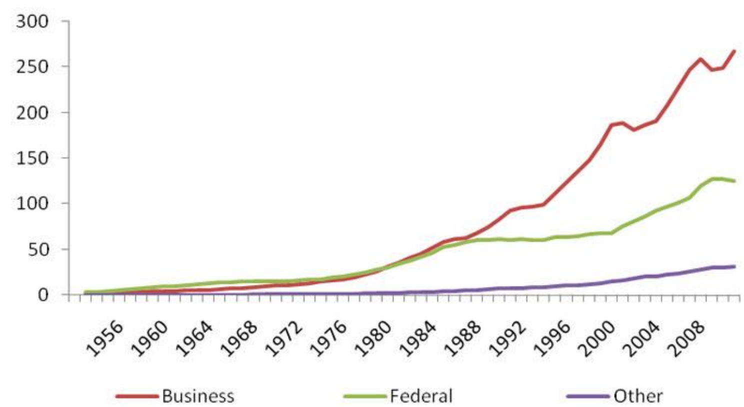

Figure 18: U.S. R&D by Funding Sector in U.S. $ Billions, 1953–2011

Internationally, European companies dominated multinational competition and R&D performance until the interwar period in the early 20th century. After World War II, U.S. companies captured the leadership, typically through technology-driven competitiveness in which R&D, but also managerial and organizational practices played a vital role. Since the late 1970s, U.S. R&D predominance has been challenged by leading European companies, their Japanese counterparts, and most recently by emerging-economy multinationals.

In 2013, U.S. companies accounted for more than 35 percent of R&D investment by the top 2000 companies worldwide.[41] In turn, the U.S. was followed by Europe (33.6 percent)—including Germany (10 percent), France (5 percent), UK (4 percent) and Switzerland (4 percent)—along with Japan (19 percent), China (3 percent) and Taiwan (2 percent). (Figure 19)

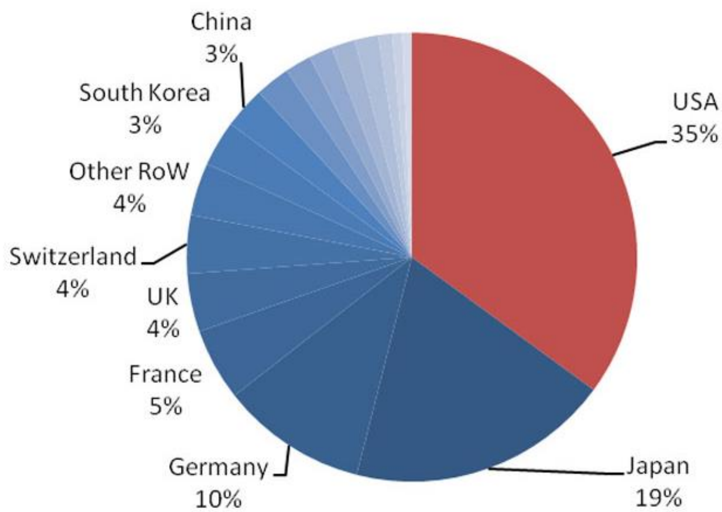

Figure 19: Top-2000 R&D Investment by the Main World Region[42]

Three-fourths of all U.S. R&D expenditures focus on technology, pharmaceuticals, and biotech, software, and automobiles. The U.S. share of the top-2000 R&D companies amounts to 658 companies. The top-20 U.S. R&D investors account for almost half of the total, and include information and communications technology companies (Microsoft, Intel, Google, Cisco, IBM, Oracle, Qualcomm, Hewlett-Packard, Apple, EMC), pharmaceutical companies (Merck, Johnson & Johnson, Pfizer, Eli Lilly, Abbott, Bristol-Myers Squibb, Amgen), automobile manufacturers (General Motors, Ford), and general industrials (General Electric).

Emerging economies have dramatically increased their spending, which has stagnated or actually declined in advanced economies.

Companies headquartered in North America, Europe, and Japan continue to lead in R&D spending, but with smaller shares of the global spending than they had 10 years ago. Meanwhile, over the past decade, China's share of R&D spending has grown by a factor of 15. In the past decade (2005 to 2014), emerging economies have dramatically increased their spending, which has stagnated or actually declined in advanced economies—as evidenced by declines in Europe (-1 percent), North America (-6 percent), and Japan (-25 percent).[43] (Figure 20)

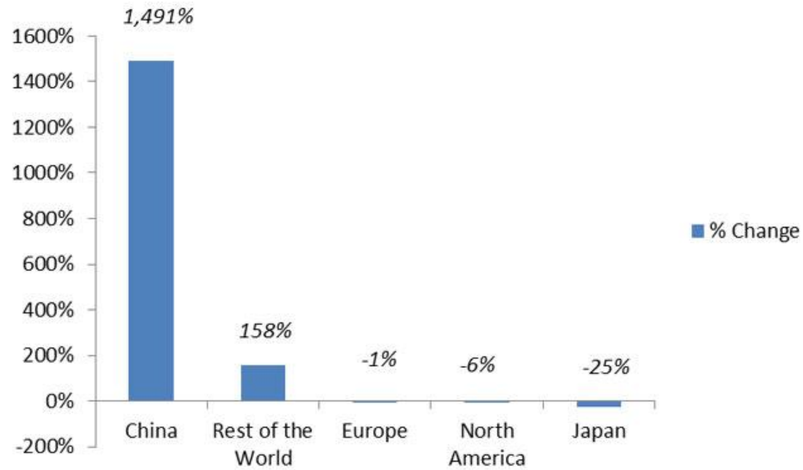

Figure 20: R&D Spending by Region, 2005–2014[44]

Venture Capital

Many large high-technology companies invest in and acquire small businesses as part of their efforts to develop and commercialize new technologies. Conversely, many small businesses hope to establish a role in the ecosystems of these big multinational corporations. According to the *Global Entrepreneurship Monitor*, the U.S. ranks second among all countries and first among all advanced economies in entrepreneurship.[45] (Figure 21)

Indeed, it is this relative dominance in global venture capital that continues to play a vital role in U.S. competitive superiority worldwide.

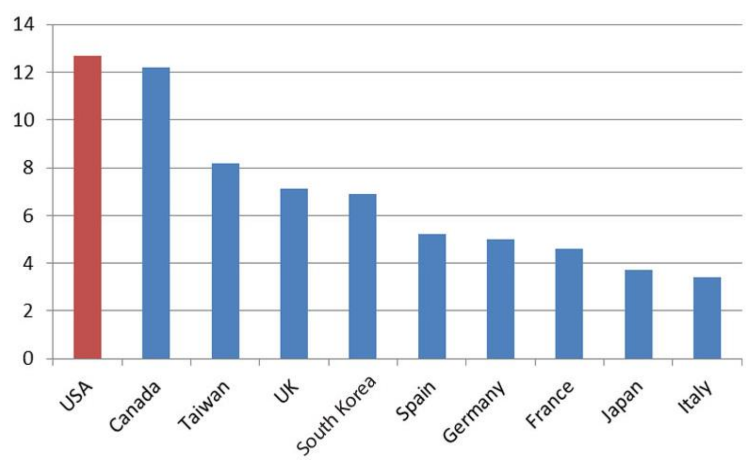

Figure 21: U.S. Leadership in Early-Stage Entrepreneurship in U.S. $ Billions[46]

Risk-taking is often said to be typical to the U.S. business environment, particularly in Silicon Valley. The U.S. continues to account for three-fourths of global venture capital investments, as against Europe (13 percent), China (7 percent), Israel (4 percent), India (2 percent), and Canada (1 percent).[47] (Figure 22) In turn, large emerging economies—China and India—are relatively new in the game. Indeed, it is this relative dominance in global venture capital that continues to play a vital role in U.S. competitive superiority worldwide.

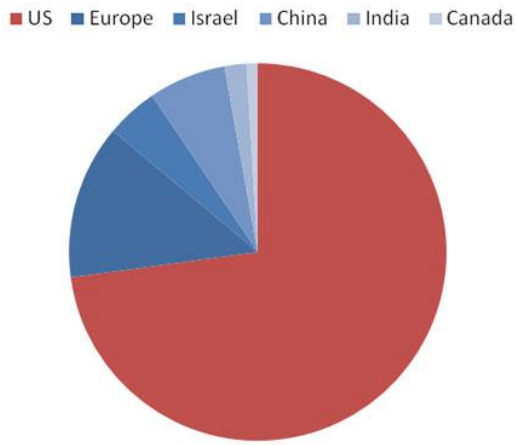

Figure 22: U.S. Leadership in Venture Capital in U.S. $ Billions[48]

Nevertheless, U.S. venture capital (VC) continues to suffer from the adverse repercussions of the Internet era's "irrational exuberance." The overall activity level of the industry is about half of what it was at the year 2000 peak.[49] Due to consolidation, the 10 largest funds represented almost half of the capital raised in 2012.

Measuring industry activity by the total dollars invested in a given year indicates that the industry has remained generally in the $20 billion to $30 billion range since 2002. In 2012, $26.7 billion was invested in 3,143 companies. As the Internet revolution took off, venture capital investments soared and peaked at $105 billion in 2000, but collapsed to $20 billion in 2003. After a rebound to $30 billion in 2008, the global financial crisis caused another contraction to $20 billion.[50] In the process, VC investments have become less venturesome. In 2000, expansion accounted for more than 60 percent of investments, whereas early-stage and later-stage investment accounted for 25 percent and 18 percent, respectively. In 2012, the share of expansion had been halved, whereas later stage had almost doubled.[51] (Figure 23)

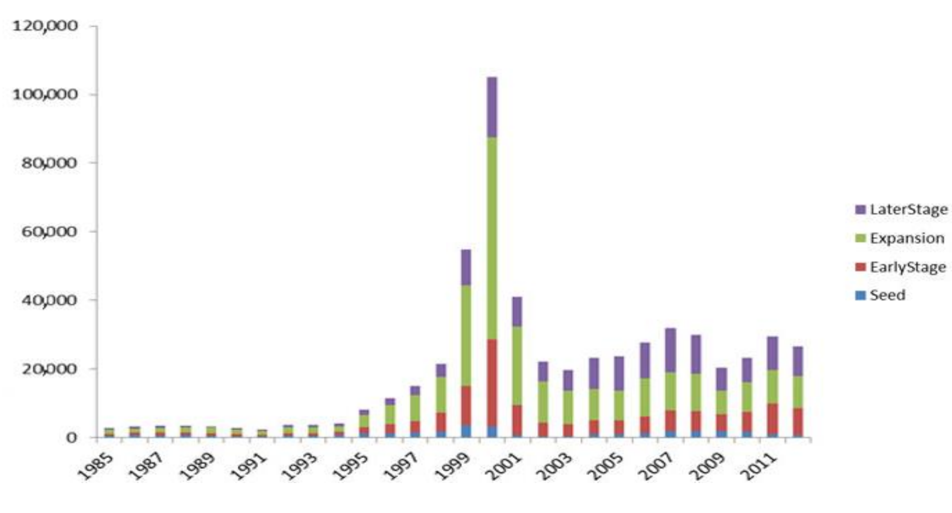

Figure 23: Venture Capital Investments by Stage, 1985–2012, in U.S. $ Millions[52]

Initial public offerings (IPOs) tell the same story. Between 1985 and 2000, venture backed IPOs soared from $51 million to over $27 billion, until collapsing to $2 billion in 2002. During the years preceding the global crisis, IPOs again climbed to $12.4 billion in 2007, plunging to $0.8 billion a year later. In the past few years, the IPOs have grown to $21.5 billion again. In the process, the number of venture –backed companies going public has fallen, while the dollars raised in those IPOs have more than doubled. Further, looking behind the numbers, Facebook itself raised $16 billion of the total $21.5 billion in 2012, with a few other high-profile IPOs looming large in the remainder. In other words, many companies attempting or seeking to go public have not been able to do so.[53] (Figure 24) Furthermore, the largest future IPO prospects are in the large emerging economies, not in the United States. Before its historic $25 billion IPO in September 2014, Alibaba's market was value was estimated at $231 billion.[54]

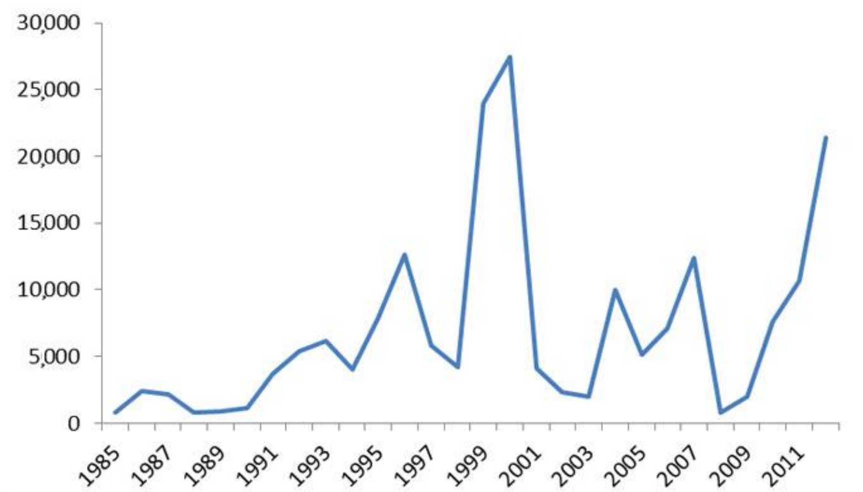

Figure 24: Evolution of Venture-Backed IPOs, 1985-2012 ($ Millions)

The U.S. venture capital industry is highly concentrated, in both geographic and industrial terms. As a result, the vitality of the business is not indicative of the nation as a whole nor is it distributed among multiple industries. Rather it is dominated by three states (California, Massachusetts and New York) that account for almost three fourths of venture capital in the nation and by two industrial groups (information technology and medical/health/life science) which play comparable roles.[55]

In addition to venture capital, entrepreneurs who hope to launch or expand a small firm with a new and unproven technology but do not have easy access to public- or credit-driven institutional funding can turn to SBIR financing. Coordinated by the Small Business Administration, this federal government program provides early stage public financing to help small or start-up companies to commercialize technology derived from federal R&D. In the early 2010s, the Department of Defense awarded $1 billion to small businesses through its SBIR program. Other SBIR agencies contributed another $1 billion to the program's beneficiaries. In the past, companies such as Symantec, Qualcomm, Deviance and iRobot were started with R&D funding from this program. As R&D budgets are cut SBIR financing will also be cut as it is based on a proportionate share of federal spending.

A NEW FUTURE FOR AMERICAN INNOVATION?

Despite the past successes of U.S. innovation, the global environment will be far more challenging in the coming decades. In the absence of significant increases in investment in innovation on both the tax and direct spending sides, the current sequestration is likely to pave the way to structural innovation stagnation in America. What is needed is a national innovation strategy. In the past decade, there has been more talk about one, but little in terms of execution. Unfortunately, time is running out.

The current sequestration is likely to pave the way to structural innovation stagnation in America.

Past and current U.S. advantages in the innovation ecosystem, such as a risk-taking business culture, strong venture capital, and a large domestic market no longer are enough to ensure global leadership.

Over the past decade or two, the dramatic ascent of the emerging nations reflects a broader "new deal" in global innovation as many developing nations are gradually moving away from cost-efficiencies toward innovation. Nevertheless, the problem is not that the developing nations are catching up with advanced economies in global R&D investments. That's the nature of economic development. After all, when the large European economies—the UK, France, Germany and Italy—recovered after World War II and began to compete with the United States and its living standards, this was not seen as a risk to be contained, but as a typical result of catch-up growth. The real challenge is in how some emerging economies are achieving their catch-up growth (through the use of "innovation mercantilism" practices), say the advanced economies. Whereas emerging economies argue that what they are doing today is not that different from what most contemporary advanced economies used to in their early stages of development. However, both agree that America invests too little in R&D, either directly or through incentives like the R&D tax credit, and lacks an overall innovation policy.[56]

Today, most innovation analysts believe that effective innovation policy relies on much more than just science policy and the promotion of high-technology development. As ITIF has noted, the world's leading innovation countries in the advanced world tend to be strong in some half-a-dozen core policy areas, including open and non-discriminatory market access and foreign direct investment (FDI) policies; science and R&D policies that spur innovation; openness to domestic competition and new firm entry; effective intellectual property rights; digital policies; open and transparent government procurement policies; and openness to high-skill immigration.[57]

In one way or another, all these policy components play a central role in the U.S. national innovation system, but not in a consolidated and strategic way. In part this has stemmed from the belief that the United States is the leader and doesn't need an innovation policy, and also from the fact that the nation has historically had an ambivalent relationship with the need for a national innovation policy, which some see as an unwanted government intervention into free markets.

Despite a longstanding public debate since the 1980s, the question is not whether the United States should have an innovation policy. The simple reality is that U.S. policies affect our innovation-based competitiveness.[58] Moreover, in the old national economy, we could afford to be indifferent to what U.S. firms led in innovation–if it wasn't Honeywell, it might be IBM, but in either case it was going to be U.S. firms with U.S. jobs. Now with global markets and global competition, the next leader may very well not be a U.S. firm, or even if it is, it may be a U.S. firm with an increasing share of its value generated in other nations with more robust innovation policy environments.

Before the global financial crisis, there were efforts in the direction of establishing a national innovation strategy. The National Innovation Act was proposed in 2005 by Senators John Ensign (R-NV) and Joseph Lieberman (D-CT). The proposal would have established a President's Council on Innovation as well as an Innovation Acceleration Grants Program. It sought to nearly double the NSF research funding level by 2011 and expand graduate research, fellowship, and trainee programs; to require that the National Institute of Standards and Technology support research for advanced manufacturing systems to enhance productivity and efficiency; and to make permanent the R&D credit for qualified expenses. Furthermore, a goal of the program was to mandate that the Department of Defense allocate at least 3 percent of its budget towards science and technology, with at least 20 percent of that investment going to basic research. This Act was introduced to the House of Representatives in January 2006, but it failed to pass.[59]

What the nation truly needs is an updated and future-driven combination of the National Innovation Act and the American Competitiveness Initiative.

Nevertheless, the quest for a National Innovation Act did lead Congress and President Bush to enact in 2007 the American Competitiveness Initiative, as the America COMPETES Act. The goals of the initiative were to double, over a decade, funding for innovation-enabling research at federal agencies, modernize research and experimentation tax credits, strengthen K-12 math and science education, reform the workforce training system, and reform immigration in order to retain highly skilled foreign workers in the U.S. The legislation retained the significant increase in NSF funding proposed by the National Innovation Act. But again, while the American Competitiveness Initiative authorized these increases, when it came to appropriations it was a different matter. The federal budget that was approved in December 2007—at the onset of the Great Recession—failed to allocate more than a minor fraction of the intended funds for the American Competitiveness Initiative.

As Democrats returned to the White House, expectations went up but the bold initiatives proposed were set aside. Under President Obama, the Department of Commerce created the National Advisory Council on Innovation and Entrepreneurship to help the Obama Administration "develop a broader strategy to spur innovation and enable entrepreneurs to develop breakthrough technologies and dynamic companies and to create jobs all across America."[60] It was followed by President Obama's *A Strategy for Innovation,* which advocated investment in basic research, education and infrastructure. Nevertheless, President Obama's outline remains constrained by the same political pressures that have limited any effort toward U.S. national innovation strategy in the past four decades of debate on U.S. competitiveness and innovation. And while the administration's own budget priorities did not allow cuts in entitlements in order to free up needed innovation investments and/or business tax cuts, Republicans in Congress too often equated productive investment with wasteful spending in their stated goal to bring down the national debt.

What the nation truly needs is an updated and future-driven combination of the National Innovation Act and the American Competitiveness Initiative. Unlike its precursors, however, this new hybrid engine for innovation must have solid bipartisan support in order to be viable.

ENDNOTES

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[6] OECD, *PISA 2012 Results* (OECD, 2014), http://www.oecd.org/pisa/keyfindings/pisa-2012-results.htm. The Program for International Student Assessment (PISA) was initiated in 1997, although the first PISA assessments were started in 2000.
[7] Despite allegation of "cheating" in the West, the PISA results are valid. See: Dan Steinbock, "China is taking the innovation game to the West," *South China Morning Post,* February 6, 2013; David Stout, "China Is Cheating the World Student Rankings System," *Time,* December 4, 2013; Andreas Schleicher, "Are the Chinese cheating in PISA or are we cheating ourselves?," *EducationToday* (blog), OECD, December 10, 2013.
[8] 2012 OECD, PISA (Program for International Student Assessment).
[9] See: World Intellectual Property Organization, *World Intellectual Property Indicators* (WIPO, annual report).
[10] Ibid.
[11] Nevertheless, the current dominance of the advanced economies in triadic patents in no way contradicts the perceived rise of the emerging economies in the global patents rivalries. In the past, most major countries sought patent protection exclusively in the world's largest markets (U.S., EU, Japan). Today, the global share of industries and markets in emerging economies is ascending, whereas that of the advanced economies is in relative decline. Second, current patents are based on past R&D activities that were led by the U.S., EU, and Japan; they often reflect past monopoly positions. Today, those activities and positions are no longer the exclusive monopoly of the advanced West.
[12] OECD Triadic Patent Families Database. See also: Adams Nager, "The United States is Slipping in Triadic Patents," *Innovation Files* (blog), ITIF, August 18, 2014.
[13] OECD Triadic Patent Families Database.
[14] Ibid.
[15] OECD Triadic Patent Families Database.
[16] Here Asia is defined by its 20 major economies. The share of China, Japan, and India alone now amounts to some 32 percent of global R&D.
[17] Battelle, R&D Magazine, International Monetary Fund, World Bank, CIA Fact Book, OECD.
[18] R&D data for 2012 are preliminary and nay later be revised. Federal R&D/GDP ratios represent the federal government as a funder of R&D by all performers; the nonfederal ratios reflect all other sources of R&D funding. See National Science Board, *Science and Engineering Indicators* (NSF / NCSES, 1953-2014).
[19] Peter L. Singer, "Federally Supported Innovations: 22 Examples of Major Technology Advances that Stem from Federal Research Support" (ITIF, February 2014).
[20] AAAS estimates based on Budget of the U.S. Government Historical Tables. FY15 data are the President's request.
[21] AAAS, based on OMB Historical Tables in Budget of the U.S. Government FY 2015. Constant dollar conversions based on GDP deflators.
[22] National Science Foundation, Federal Funds for R&D survey data series, available at http://www.nsf.gov/statistics/fedfunds/. Includes R&D plant.

[23] Federal agencies with extramural R&D budgets exceeding $100 million annually must set aside 2.5 percent for SBIR awards to U.S.-located small businesses.
[24] This section draws from a companion piece: Dan Steinbock, "The Challenges for America's Defense Innovation" (ITIF, November, 2014).
[25] Calculated on the basis of SIPRI Military Expenditure Database, July 2014; see also: Robert D. Atkinson, Stephen J. Ezell, and Luke A. Stewart, *The Global Innovation Policy Index* (ITIF / Kauffman Foundation, March 2012), 43, http://www2.itif.org/2012-global-innovation-policy-index.pdf.
[26] Data from Budget of the US Government; Office of Management and Budget
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[30] National Science Board, *Science and Engineering Indicators 2014* (NSF / NCSES, 2014), Chapter 5.
[31] Ibid.
[32] Ibid.
[33] Committee on Research Universities et al., *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security* (National Academies Press, 2012).
[34] Robert D. Atkinson and Luke A. Stewart, "University Research Funding: The United States is Behind and Falling" (ITIF, May 2011).
[35] Author's interviews with Professor Michael E. Porter, 1990-1997, and Professor AnnaLee Saxenian, May 1999. See also: Michael E. Porter, *The Competitive Advantage of Nations* (New York: The Free Press, 1990). AnnaLee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Boston: Harvard University Press, 1994).
[36] The top 10 states account for two-thirds of all expenditures. California (22 percent of all R&D) alone generates as much R&D as the four next highest states—Massachusetts, Texas, Maryland, and New Jersey—altogether. The list of most R&D intensive states (R&D performed/state GDP) is different. In this ranking, California (4.39 percent) is only fifth, while Massachusetts (5.36 percent) ranks second. The most R&D intensive state is New Mexico (8.01 percent) followed by Maryland (6.23 percent).
[37] Michael Mitchell et al., "States Are Still Funding Higher Education Below Pre-Recession Levels" (Center on Budget and Policy Priorities, May 1, 2014); Michael Mitchell, "Mapping Higher Ed Funding Cuts and Tuition Hikes" (Center on Budget and Policy Priorities, June 4, 2014). Like states, most cities are today better able to meet their financial needs, but continued high levels of unemployment, uncertainty about federal and state actions, and long-term pension and health benefit obligations continue to constrain funding for innovation for many cities. These trends are likely to be reflected in reduced innovation prospects in the foreseeable future. See: City Fiscal Conditions, National League of Cities (annual surveys).
[38] Author's interview with Alfred D. Chandler (1997).
[39] Over the 20-year period of 1991–2011.
[40] Science & Engineering Indicators 2014.
[41] The 2013 EU Industrial R&D Investment Scoreboard contains economic and financial data for the world's top 2000 companies ranked by their investments in research and development (R&D).
[42] The 2013 EU Industrial R&D Investment Scoreboard European Commission, JRC/DG RTD.
[43] Barry Jaruzelski, Volker Staack, and Brad Goehle, "Global Innovation 1000: Proven Paths to Innovation Success" (Strategy & / PWC, October 28, 2014).
[44] Based on data by Strategy & [formerly Booz & Co.] (2014), Global Entrepreneurship Monitor, 2013.
[45] Total Early-Stage Entrepreneurial Activity (TEA), Global Entrepreurship Monitor, 2013.
[46] Advanced countries: Total Early-Stage Entrepreneurial Activity (TEA), Global Entrepreurship Monitor, 2013.
[47] Global quarterly venture capital investments, Dow Jones VentureSource. In 2001, there was still much talk about the Lisbon Strategy and how Europe will catch up to U.S. growth and productivity within a decade. In contrast, as I argued then and today, a deep disconnect has evolved between European policy rhetoric and empirical realities. Dan Steinbock, "Innovation, Technology and Risk Capital," *Enterprise Papers*, no. 5

(European Commission, 2001); Dan Steinbock, "Multipolar Innovation – and Europe," *European Business Review,* July-August, 2014, 54-56.

[48] Global quarterly venture capital investments, Dow Jones VentureSource.

[49] In 2000, 1,053 firms each invested $5 million or more during the year; in 2012, less than half of that at 522. Venture capital under management by the end of 2012 decreased to $199 billion. In effect, the industry continues to contract from the 2000 bubble high of $261.2 billion.

[50] VC investments are typically categorized into four broad stages of financing: seed, which supports the initial development and marketing; first-round, which also supports the initiation of commercial manufacturing; expansion, which ensures working capital for expansion, funds for growth and financing for an initial public offering (IPO); and later stage, which includes acquisition financing and management and leveraged buyouts.

[51] For the data, see The 2013 NVCA Yearbook.

[52] The 2013 NVCA Yearbook.

[53] This, in turn, is reflected in the great gap between median and mean (average) valuation of almost seven times! In other words, the successful very large IPOs have had a huge outlier effect. For the data, see The 2013 NVCA Yearbook.

[54] Moreover, in the IPO, the buyers were not purchasing actual shares in the group, since China forbids foreign ownership, but rather just shares in Alibaba's Cayman Islands shell corporation.

[55] More than 40 percent of the companies and over 50 percent of investments, respectively, are located in California. Measured by investments, it is followed by Massachusetts (12 percent) and New York (7 percent). These four states account for three-fourths of all venture capital in America. The investments are also highly concentrated by industry groups. Today, more than 60 percent of all investments and over 70 percent of initial investments go to information technology (software accounts for about half of the total), while medical/health/life science account for 25 percent of all, and 17 percent of initial investments, respectively. Further, the continued interest in clean technology investing has brought the industrial/energy sector to 10.5 percent of the total.

[56] GBU Reference and Global Mercantilist Index, ITIF 2014

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ABOUT THE AUTHOR

Dr. Dan Steinbock is Research Director of International Business at India China and America Institute (U.S.A.) and Visiting Fellow at Shanghai Institutes for International Studies (China) and the EU Center (Singapore). For more information see: http://www.differencegroup.net.

ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a Washington, D.C.-based think tank at the cutting edge of designing innovation strategies and technology policies to create economic opportunities and improve quality of life in the United States and around the world. Founded in 2006, ITIF is a 501(c) 3 nonprofit, non-partisan organization that documents the beneficial role technology plays in our lives and provides pragmatic ideas for improving technology-driven productivity, boosting competitiveness, and meeting today's global challenges through innovation.

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