How the Shift to IT-Enabled Vehicles Plays to America's Competitive Strengths

BY ROBERT D. ATKINSON AND CALEB FOOTE | OCTOBER 2018

As IT hardware and software become more integral to vehicles, the United States appears to be regaining its competitive advantage.

For several months, President Trump has been threatening to impose tariffs on automotive imports. For instance, he tweeted in June that the administration would place a 20 percent tariff on European cars if the EU didn't make concessions, and he implied in April and again in September that the United States should impose a 25 percent tariff on Chinese cars.[1] The president's concern may be based on the fact that the United States has lost global market share in automobile production. However, this fails to consider the direction that the auto industry is moving and the implications of that trend for U.S. competitiveness. The automobile industry and the tech industry both are increasingly focused on developing connected and autonomous vehicles (CAVs)—trucks and cars that integrate information and communication technologies into their systems to assist drivers, and cars that can operate with little or no driver input, respectively. As IT hardware and software become more integral to vehicles, the United States appears to be regaining competitive advantage after enduring decades of declining global market share in traditional vehicles. Rather than impose tariffs, Congress and the Trump administration should continue strengthening U.S. leadership in CAVs by adopting a more robust set of innovation policies.

INVESTING IN CONNECTED AND AUTONOMOUS VEHICLES WILL CREATE COMPETITIVE ADVANTAGES FOR THE UNITED STATES

Vehicles are becoming increasingly IT-based. Over the last decade, car manufacturers, technology companies, and broadband providers have connected vehicles to networks, automated many of their functions, and brought a wealth of innovative applications to consumers. In the past, cars were primarily mechanical, using some electricity to power certain components, such as lights, radios, and spark plugs. Over the last two decades, cars have incorporated new digital capabilities—and now, just as computers increasingly connected to the Internet in the 1990s, cars too are connecting to networks and devices. This includes not just Internet connectivity, but also connections to digital services that automakers provide, connections to drivers' smartphones, and connections to devices outside the vehicle, such as to traffic lights, parking meters, other vehicles, and smart home equipment. The typical automobile today contains approximately 100 million lines of software code—twice as much as Microsoft's Vista operating system did in 2007.[2]

The typical automobile today contains approximately 100 million lines of software code, twice as much as Microsoft's Vista operating system did in 2007.

Connected cars are becoming more common, with one report estimating that 90 percent of all new cars will have some level of connectivity by 2020.[3] Another report estimates that by 2020, there will be 61 million cars with data connectivity in use globally.[4]

And connected vehicles are a step in the path to partially and ultimately fully autonomous vehicles (AVs). These vehicles will be able to drive without a person actively controlling them—indeed, some may come without steering wheels, accelerators, or brakes. While they are still early in development, AVs are likely the future.

Investment in autonomous vehicles has increased drastically in recent years. According to a report by the Brookings Institution, more than $80 billion was invested in autonomous vehicles between August 2014 and June 2017, of which the largest share went to the United States.[5] This funding also grew significantly over that period, with automakers and tech companies investing $65 billion in the 12 months from July 2016 to June 2017 alone. The scale and explosive growth of these investments in recent years demonstrates the intensity of the industry's focus on AVs and signals that R&D is likely to continue growing rapidly in the coming years.

U.S. Company Investment

The U.S. auto industry holds a strong position in CAVs, and that is expected to continue. One industry analysis suggests that global growth in automated vehicles is likely to be the fastest in North America.[6] Based on interviews with industry executives and experts, Bloomberg reported in May that Alphabet Inc.'s Waymo division and General Motors have the most advanced autonomous vehicle projects, with both having announced plans to release self-driving ride-hailing services in the next year.[7] GM's fleet of self-driving Chevrolet Bolts, which are manufactured in Michigan, has attracted $5 billion since May from SoftBank, a technology fund, and Honda. GM and Lyft plan to deploy thousands of self-driving test cars.

Fiat Chrysler has partnered with Waymo to supply a fleet of self-driving Chrysler Pacificas. In 2017, Ford invested $1 billion in Argo AI to develop a virtual driver system. Indeed, Ford plans to roll out AVs by 2021, as part of its Ford Smart Mobility, LLC, a new subsidiary focused on connectivity, AVs, and ride sharing services.[8] Meanwhile, Delphi Automation spun off a subsidiary, Delphi Technologies, now named Aptiv, focusing on software, electrical components, and other work on AVs.[9] It is launching a fleet of 30 self-driving cars via Lyft in Las Vegas.[10] And Tesla's semi-autonomous Autopilot functionality is already operational in its Model S and X vehicles.[11]

But it is not just U.S. auto companies that are investing in AVs; so too are American technology companies, building on the fact that an increasing share of value-added and innovation in autos is IT-driven. For example, Apple's "Project Titan" is focused on developing AVs, and it reportedly has at least 66 test vehicles on the road and registered with the California DMV.[12] Hardware companies, including Cisco, Intel, and Texas Instruments are also working on autonomous vehicle technologies. In 2016, Intel created its Autonomous Driving Group and committed $250 million to automobile technology investments through its Intel Capital group. Cisco is working to integrate gigabit-speed Ethernet connectivity in cars. Texas Instruments is working on a range of technologies, including advanced radar systems. Other companies are also active in the market. Microsoft is providing advanced technologies such as its Azure cloud services and HoloLens technologies to car companies, and it is working on other CAV technologies. Uber and Lyft are both investing in AV development and testing in partnership with automotive companies.

Foreign Investment in the U.S.

The extent of U.S. leadership in autonomous vehicles is underscored by the degree to which foreign automakers have been investing in U.S.-based R&D:

- Toyota plans to invest $22.3 billion in R&D in the coming year, of which $8 billion is going to AVs through the Toyota Research Institute, which operates exclusively in the United States, with a major facility in California and partnerships with University of Michigan and MIT.[13]
- The Nissan Research Center, which is collaborating with NASA on autonomous vehicles, opened a new office this year in Santa Clara, CA.[14]
- Volkswagen's Silicon Valley Electronics Research Laboratory employs over 160 researchers focusing on sensor and battery technologies.[15]
- BMW plans to expand its fleet of self-driving vehicles in the United States to 40 by the end of 2018, operated out of its research office in Mountain View, the first such office BMW will have established anywhere in the world.[16]
- Daimler operates six R&D facilities in the U.S. through Mercedes-Benz R&D North America; it is opening a facility in Oregon to develop autonomous trucks; and it will release a self-driving taxi program in California in 2019.[17]

Reasons for U.S. Leadership

The fact that cars and trucks are becoming more dependent on IT bodes well for the United States and for the U.S. auto industry. First, the United States has long been the global leader in IT. Beyond having easy access to technology hubs like Silicon Valley, which benefit from the agglomeration effects of high-density skilled labor and large volumes of venture capital, the United States continues to produce more graduates per capita in relevant fields than most of the rest of the developed world (figure 1), and it invests more in software as a share of GDP than major auto competitors—slightly more than Japan and significantly more than Germany (figure 2). As vehicles continue to become even more dependent on IT hardware and software, the U.S. economy stands to benefit because it has long been stronger in electrical engineering and computer science compared to Japan and Europe, which by contrast have had relative advantages in mechanical engineering.

Figure 1: ICT graduates by level of degree per 1,000 workers, 2016[18]

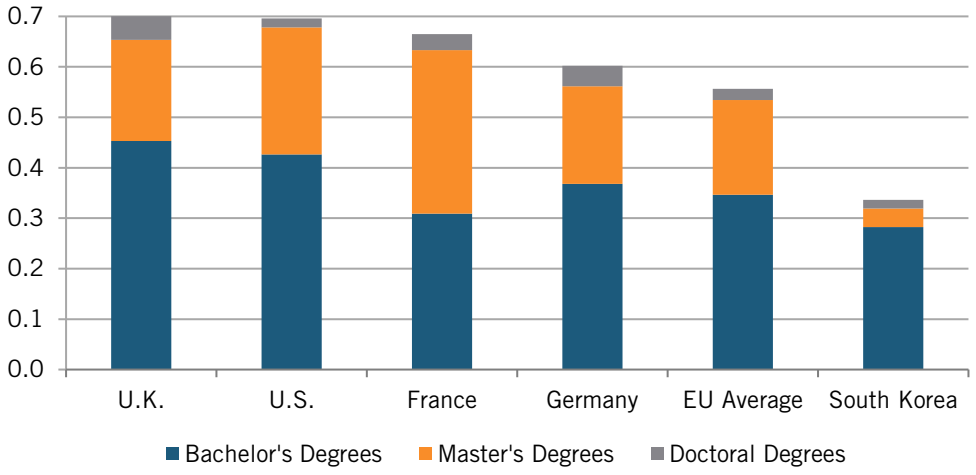
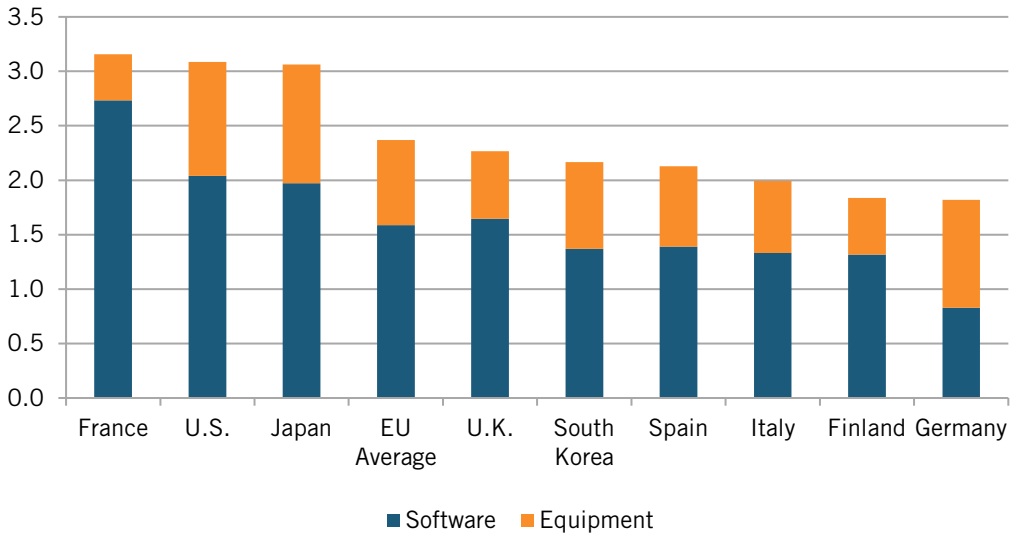


Figure 2: ICT investment by capital asset as a percentage of GDP, 2015[19]



POLICY RECOMMENDATIONS

To ensure America's continuing leadership in connected and autonomous vehicles, the administration should focus not on tariffs, but on ensuring that the country's regulatory and investment climate and innovation policy system related to these new vehicle technologies are the best in the world.

First, the federal government should continue to ensure that the U.S. regulatory system tilts toward experimentation, testing, and deployment of AVs.[20] This can be a real advantage for the United States, because Europe in particular, with its focus on avoiding risk according to the "precautionary principle," is willing to let the United States "go first." This is one reason why so many foreign car companies are doing their AV testing here. Unlike older generations of cars, where being a late adopter was not a major problem, it may be with AVs. That is because AVs are more like traditional IT hardware and software industries, where scale economies and network effects can be key enablers of competitive advantage. To the extent the United States can be the most innovation friendly to AVs, including both cars and trucks, the chances of increasing longer-term competitive advantage will increase.

AVs are more like traditional IT hardware and software industries, where scale economies and network effects can be key enablers of competitive advantage.

Second, the tax code can play a role in enabling AV innovation and competitiveness. In particular, Congress should expand the rate of the Alternative Simplified Credit (ASC) from 14 percent to at least 25 percent. The ASC provides a credit of 14 percent on R&D expenditures above 50 percent of the average of a firm's R&D expenditures over the previous three years. But America's competitors, including China, Japan, and much of Europe, have more generous R&D tax incentives. ITIF has calculated that expanding the R&D tax credit would pay for itself after 15 years by producing additional growth in federal revenue.[21]

Third, the federal government needs to do more to ensure that companies in the United States have access to a world-class engineering and computer science workforce. One reason why so many foreign companies have put their R&D in the United States is because of the talent pools it offers. But absent stronger policies for engineering and computer science education, particularly at the high-school, community college, and university levels, that lead could evaporate. ITIF laid out a comprehensive policy agenda for this in its 2016 report "The Case of Improving U.S. Computer Science Education."[22] A related step would be to expand funding for the National Science Foundation's Advanced Technical Education program to establish additional community and technical college training centers focused on automobile IT-related occupations.

Finally, the federal government should do more to support industry cooperative, pre-competitive R&D. The National Network for Manufacturing Innovation (NNMI), launched under the Obama administration in 2012, and renamed in September 2016 as Manufacturing USA, is a model for this. The Institutes play a pivotal role in revitalizing America's industrial commons and helping ensure U.S. leadership across a range of advanced-manufacturing process and product technologies.[23] The administration should establish a competition to enable any industry, including the auto industry, to propose and

co-fund additional institutes. In this case, the auto and tech industries could support one or more institutes related to CAVs. The administration should also support additional funding for the National Institute of Standards and Technology's Manufacturing Extension Partnership and charge it with establishing a joint-state automobile supply chain initiative to help small auto suppliers become more sophisticated and productive, including by increasing their IT capabilities.

In summary, as vehicles become more like computers and smart phones, the opportunity for reestablishing U.S. leadership in vehicles grows. That leadership will not grow by imposing tariffs, as doing so will likely lead to reciprocal actions that cut off markets for U.S. companies. That leadership can grow if the federal government works to make the United States the most attractive location in the world to develop, test, and produce connected and autonomous vehicles.

ENDNOTES

1. Donald J. Trump, Twitter post, June 22, 2018, 8:34 p.m., https://twitter.com/realDonaldTrump/status/1010320166486454272; Donald J. Trump, Twitter post, April 9, 2018, 6:03 a.m., https://twitter.com/realdonaldtrump/status/983284198046826496; Donald J. Trump, Twitter post, September 9, 2018, 10:01 a.m., https://twitter.com/realDonaldTrump/status/1038789398140084224.
2. Jeff Desjardins, "How Many Millions of Lines of Code Does it Take?" *Visual Capitalist,* February 8, 2017, http://www.visualcapitalist.com/millions-lines-of-code.
3. Henry Bzeih, Greg Ross, Nicolas Nollet, "Connected Car Industry Report 2014" (Telefónica, 2014), https://iot.telefonica.com/multimedia-resources/connected-car-industry-report-2014-english.
4. Gartner, "Gartner Says Connected Car Production to Grow Rapidly Over Next Five Years," news release, September 16, 2016, http://www.gartner.com/newsroom/id/3460018.
5. Cameron F. Kerry and Jack Karsten, "Gauging Investment in Self-driving Cars," Brookings Institute, October 16, 2017, https://www.brookings.edu/research/gauging-investment-in-self-driving-cars.
6. Energias Market Research, "Autonomous Vehicles Market: Restructuring the Urban Transport Network in the Near Future to Witness a CAGR of 62.86% During 2018-2024," *Globe Newswire,* October 5, 2019, https://globenewswire.com/news-release/2018/10/05/1617244/0/en/Autonomous-Vehicles-Market-Restructuring-the-urban-transport-network-in-the-near-future-to-witness-a-CAGR-of-62-86-during-2018-2024.html.
7. David Welch and Elisabeth Behrmann, "Who's Winning the Self-Driving Car Race?" *Bloomberg*, May 7, 2018, accessed October 15, 2018, https://www.bloomberg.com/news/features/2018-05-07/who-s-winning-the-self-driving-car-race.
8. CB Insights, "46 Corporations Working on Autonomous Vehicles," *CB Insights,* September 4, 2018, https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list.
9. Ibid.
10. Andrew Krok, "Aptiv Will Deploy 30 Self-driving BMWs in Las Vegas Via Lyft," *CNET,* May 2, 2018, https://www.cnet.com/roadshow/news/aptiv-self-driving-bmw-las-vegas-lyft.
11. Ibid.
12. Daisuke Wakabayashi, "Apple Targets Electric-Car Shipping Date for 2019," *The Wall Street Journal,* September 21, 2015, https://www.wsj.com/articles/apple-speeds-up-electric-car-work-1442857105.
13. Nikkei Staff Writers "Toyota pours $22bn into R&D as Apple and Google close in," *Nikkei Asian Review*, May 10, 2018, https://asia.nikkei.com/Business/Companies/Toyota-pours-22bn-into-R-D-as-Apple-and-Google-close-in.
14. Peter Lyon, "Self-Driving Robot Car Borne From Nissan-NASA Collaboration," *Forbes*, January 29, 2018, https://www.forbes.com/sites/peterlyon/2018/01/29/self-driving-robot-car-borne-from-nissan-nasa-collaboration/#595c57818c8d; "Nissan to Move, Expand Silicon Valley Research Office to Santa Clara", *Silicon Valley Business Journal*, May 4, 2018, https://www.bizjournals.com/sanjose/news/2018/05/04/nissan-silicon-valley-research-campus-santa-clara.html.
15. "Innovating the Future at VW's Electronics Research Lab," Volkswagen, accessed January 18, 2018, http://newsroom.vw.com/company/innovating-the-future-at-vws-electronics-research-lab.
16. Roberto Baldwin, "BMW's New Research Center is Dedicated to Autonomous Driving," *Engadget,* April 11, 2018, https://www.engadget.com/2018/04/11/bmw-research-center-autonomous-driving.
17. Mercedes-Benz Research & Development North America, accessed October 15, 2018, http://mbrdna.com; Max Bernhard, "Daimler Sets Up U.S. Autonomous Truck R&D Center," *Market Watch,* June 7, 2018, https://www.marketwatch.com/story/daimler-sets-up-us-autonomous-truck-rd-center-2018-06-07; Alexandria Sage, "Daimler, Bosch to Deploy Self-Driving Taxis in California Test

Program," *Reuters*, July 10, 2018, https://www.reuters.com/article/us-daimler-selfdriving-bosch/daimler-bosch-to-deploy-self-driving-taxis-in-california-test-program-idUSKBN1K02ZU.

18. "Graduates by Field," accessed September 12, 2018, OECD Stat, https://stats.oecd.org/; "Total Labor Force," World Bank, accessed September 13, 2018, https://data.worldbank.org/indicator/sl.tlf.totl.in.
19. OECD, *OECD Digital Economy Outlook 2017*, October 2017, https://doi.org/10.1787/9789264276284-en; "GDP (Current US$)," World Bank, accessed September 20, 2018, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.
20. For a discussion of policy recommendations see Alan McQuinn and Daniel Castro, "A Policymaker's Guide to Connected Cars" (Information Technology and Innovation Foundation, January 2018), https://itif.org/publications/2018/01/16/policymakers-guide-connected-cars.
21. Information Technology and Innovation Foundation, "Winning the Race Memo: Corporate Taxes" (September 2012), http://www2.itif.org/2012-wtr-taxes.pdf.
22. Adams Nager and Robert D. Atkinson, "The Case for Improving U.S. Computer Science Education" (Information Technology and Innovation Foundation, May 2016), https://itif.org/publications/2016/05/31/case-improving-us-computer-science-education.
23. David M. Hart, Stephen J. Ezell, and Robert D. Atkinson, "Why America Needs a National Network for Manufacturing Innovation" (Information Technology and Innovation Foundation, December 11, 2012), https://itif.org/publications/2012/12/11/why-america-needs-national-network-manufacturing-innovation.

ABOUT THE AUTHORS

Robert D. Atkinson is the founder and president of ITIF. Atkinson's books include *Big is Beautiful: Debunking the Myth of Small Business* (MIT, 2018), *Innovation Economics: The Race for Global Advantage* (Yale, 2012), and *The Past and Future of America's Economy: Long Waves of Innovation That Power Cycles of Growth* (Edward Elgar, 2005). Atkinson holds a Ph.D. in city and regional planning from the University of North Carolina, Chapel Hill, and a master's degree in urban and regional planning from the University of Oregon.

Caleb Foote is a research assistant at the Information Technology and Innovation Foundation. Prior to joining ITIF, Caleb graduated from Brown University with a concentration in Economics. He previously interned for TechHelp and serves as a trustee of the American Parliamentary Debate Association.

ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized as the world's leading science and technology think tank, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

FOR MORE INFORMATION, VISIT US AT WWW.ITIF.ORG.