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TESTIMONY

THE CONNECTED WORLD: EXAMINING THE INTERNET OF THINGS

BY ADAM D. THIERER
Senior Research Fellow, Mercatus Center at George Mason University

Testimony before the Senate Committee on Commerce, Science, and Transportation

February 11, 2015

Mr. Chairman and members of the Committee, thank you for inviting me here today to comment on the policy implications of the Internet of Things. My name is Adam Thierer, and I am a senior research fellow at the Mercatus Center at George Mason University, where I study technology policy.

My message today is condensed from a recent book[1] and a forthcoming law review article[2] on the Internet of Things, which refers to a world full of "smart" devices equipped with sensing and networking capabilities.

My research focuses primarily on the privacy and security implications of the Internet of Things and wearable technology. The three general conclusions of my work are as follows:

1. First, the Internet of Things offers compelling benefits to consumers, companies, and our country's national competitiveness that will only be achieved by adopting a flexible policy regime for this fast-moving space.
2. Second, while there are formidable privacy and security challenges associated with the Internet of Things, top-down or one-size-fits-all regulation will limit innovative opportunities.
3. Third, with those first two points in mind, we should seek alternative and less costly approaches to protecting privacy and security that rely on education, empowerment, and targeted enforcement of existing legal mechanisms. Long-term privacy and security protection requires a multifaceted approach incorporating many flexible solutions.

I will discuss each point briefly.

1. Adam Thierer, *Permissionless Innovation: The Continuing Case for Comprehensive Technological Freedom* (Arlington, VA: Mercatus Center at George Mason University, 2014).
2. Adam Thierer, "The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, November 2015), which will be published in the *Richmond Journal of Law and Technology* 21, no. 6 (2015), http://mercatus.org/publication/internet-things-and-wearable-technology-addressing-privacy-and-security-concerns-without.

For more information or to meet with the scholars, contact
Outreach Contact: Taylor Barkley, 703-993-8205 (work), 949-632-5064 (mobile), tbarkley@mercatus.gmu.edu
Mercatus Center at George Mason University, 3434 Washington Blvd., 4th Floor, Arlington, Virginia 22201

BENEFITS OF IOT

First, the Internet of Things will benefit the "3-Cs" of consumers, companies, and our country:

- Consumers will benefit from more of their devices being networked, sensing, and communicating. The Internet of Things offers us more choices and convenience, especially for personal health and productivity.

- Companies will benefit from increased efficiencies and the ability to offer a staggering array of new product and service options to their customers.[3]

- And our country will benefit by maintaining our global competitive advantage in the digital economy.

The magnitude of this opportunity is breathtaking.[4] Technology analysts and economic consultancies have predicted economic benefits in the *trillions* of dollars.[5]

The positive effects of the Internet of Things will reverberate throughout every sector of the economy, and as Progressive Policy Institute economist Michael Mandel notes, it "has the potential to help revive the high-growth economy."[6] It we let it, it could revolutionize manufacturing, health care, energy, transportation, retailing, and various government services.

GETTING POLICY RIGHT

If America hopes to be a global leader in the Internet of Things, as it has been for the Internet more generally over the past two decades, then we first have to get public policy right.

America took a commanding lead in the digital economy because, in the mid-1990s, Congress and the Clinton administration crafted a nonpartisan vision for the Internet that protected "permissionless innovation"—the idea that experimentation with new technologies and business models should generally be permitted without prior approval.[7]

Congress embraced permissionless innovation by passing the Telecommunications Act of 1996 and rejecting archaic Analog Era command-and-control regulations for this exciting new medium.[8]

The Clinton administration embraced permissionless innovation with its 1997 "Framework for Global Electronic Commerce," which outlined a clear vision for Internet governance that relied on civil society, voluntary agreements, and ongoing marketplace experimentation.[9]

3. Michael E. Porter and James E. Heppelmann, "How Smart, Connected Products Are Transforming Competition," *Harvard Business Review*, November 2014, https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition.
4. Emily Adler, "The 'Internet of Things' Will Soon Be a Truly Huge Market, Dwarfing All Other Consumer Electronics Categories," *Business Insider*, July 10, 2014, http://www.businessinsider.com/internet-of-things-will-soon-be-a-truly-huge-market-dwarfing-all-other-consumer-electronics-categories-2014-7.
5. Gil Press, "Internet of Things by the Numbers: Market Estimates and Forecasts," *Forbes*, August 22, 2014, http://www.forbes.com/sites/gilpress/2014/08/22/internet-of-things-by-the-numbers-market-estimates-and-forecasts.
6. Michael Mandel, "Can the Internet of Everything Bring Back the High-Growth Economy?" (Policy Memo, Progressive Policy Institute, Washington, DC, September 2013), 9, http://www.progressivepolicy.org/2013/09/can-the-internet-of-everything-bring-back-the-high-growth-economy. ("No one can predict the ultimate course of innovative technologies, but it appears that the Internet of Everything has the potential to help revive the high-growth economy.")
7. Adam Thierer, "Embracing a Culture of Permissionless Innovation" (Cato Online Forum, Cato Institute, Washington, DC, November 2014), http://www.cato.org/publications/cato-online-forum/embracing-culture-permissionless-innovation.
8. Adam Thierer, "The Greatest of All Internet Laws Turns 15," *Forbes*, May 8, 2011, http://www.forbes.com/sites/adamthierer/2011/05/08/the-greatest-of-all-internet-laws-turns-15.
9. Specifically, the Clinton framework stated that "the private sector should lead [and] the Internet should develop as a market driven arena not a regulated industry." It also argued that "governments should encourage industry self-regulation and private sector leadership where possible" and "avoid undue restrictions on electronic commerce." White House, "The Framework for Global Electronic

This nonpartisan blueprint sketched out almost two decades ago for the Internet is every bit as sensible today as we begin crafting a policy paradigm for the Internet of Things.[10]

Again, the first order of business is for policymakers to send a clear green light to entrepreneurs letting them know that our nation's default policy position remains "innovation allowed." Second, we should avoid basing policy interventions on hypothetical worst-case scenarios, or else best-case scenarios will never come about.[11] Our policy regime, therefore, should be responsive, not anticipatory.

FLEXIBLE SOLUTIONS

Of course, privacy- and security-related challenges exist that deserve attention. Data is going to be moving fluidly across so many platforms and devices that it will be difficult to apply traditional Fair Information Practice Principles[12] in a rigid regulatory fashion for every conceivable use of these technologies.[13]

Specifically, it will be challenging to achieve perfect "notice and choice" in a world where so many devices are capturing volumes of data in real time. Moreover, while "data minimization" remains a worthy goal, if it is mandated in a one-size-fits-all fashion, it could limit many life-enriching innovations.

Law will still play a role, but we're going to need new approaches.

- Policymakers can encourage **privacy and security "by design"** for Internet of Things developers, but those best practices should not be mandated as top-down controls. Flexibility is essential.[14]
- More **privacy-enhancing tools**—especially robust encryption technologies—will also help, and government officials would be wise to promote these tools instead of restricting them.
- **Increased education** is also essential, and governments can help get the word out about inappropriate uses of these technologies.
- Existing **privacy torts and existing targeted rules** (such as "Peeping Tom" laws) will also likely evolve to address serious harms as they develop.
- Finally, the Federal Trade Commission will continue to play an important backstop role, using its Section 5 authority to **police "unfair and deceptive" practices**. The commission has already been remarkably active in encouraging companies to live up to the privacy and security promises they make to their consumers, and that will continue.

Commerce" (July 1997), http://clinton4.nara.gov/WH/New/Commerce.

10. Adam Thierer, "15 Years On, President Clinton's 5 Principles for Internet Policy Remain the Perfect Paradigm," *Forbes*, February 12, 2012, http://www.forbes.com/sites/adamthierer/2012/02/12/15-years-on-president-clintons-5-principles-for-internet-policy-remain-the-perfect-paradigm.

11. As analysts at the Center for Data Innovation correctly argue, policymakers should only intervene to address specific, demonstrated harms. "Attempting to erect precautionary regulatory barriers for purely speculative concerns is not only unproductive, but it can discourage future beneficial applications of the Internet of Things," they say. See Daniel Castro and Joshua New, "10 Policy Principles for Unlocking the Potential of the Internet of Things," Center for Data Innovation, December 4, 2014, http://www.datainnovation.org/2014/12/10-policy-principles-for-unlocking-the-potential-of-the-internet-of-things.

12. The Fair Information Practice Principles (FIPPs) traditionally include (1) notice, (2) choice, (3) purpose specification, (4) use limitation, and (5) data minimization.

13. Adam Thierer, "Some Initial Thoughts on the FTC Internet of Things Report," *Technology Liberation Front*, January 28, 2015, http://techliberation.com/2015/01/28/some-initial-thoughts-on-the-ftc-internet-of-things-report.

14. Adam Thierer, "Striking a Sensible Balance on the Internet of Things and Privacy," *Technology Liberation Front*, January 16, 2015, http://techliberation.com/2015/01/16/striking-a-sensible-balance-on-the-internet-of-things-and-privacy. See also Adam Thierer, "Muddling Through: How We Learn to Cope with Technological Change," *Medium*, June 30, 2014, https://medium.com/tech-liberation/muddling-through-how-we-learn-to-cope-with-technological-change-6282d0d342a6.

CONCLUSION: WE CAN ADAPT

In closing, we should also never forget that, no matter how disruptive these new technologies may be in the short term, we humans have an extraordinary ability to adapt to technological change and bounce back from adversity.[15] That same resilience will be true for the Internet of Things.

We should remain patient and continue to embrace permissionless innovation to ensure that the Internet of Things thrives and American consumers and companies continue to be global leaders in the digital economy.

APPENDICES TO TESTIMONY OF ADAM THIERER

15. Adam Thierer, "Muddling Through: How We Learn to Cope with Technological Change," *Medium*, June 30, 2014, https://medium.com/tech-liberation/muddling-through-how-we-learn-to-cope-with-technological-change-6282d0d342a6.

APPENDIX 1: SELECTED READINGS FROM ADAM THIERER ON THE INTERNET OF THINGS

law review article: "The Internet of Things and Wearable Technology Addressing Privacy and Security Concerns without Derailing Innovation," forthcoming, *Richmond Journal of Law & Technology*, Vol. 21, No. 6, (2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2494382.

essay: "A Nonpartisan Policy Vision for the Internet of Things," *Technology Liberation Front,* December 11, 2014, http://techliberation.com/2014/12/11/a-nonpartisan-policy-vision-for-the-internet-of-things.

essay: "Some Initial Thoughts on the FTC Internet of Things Report," *Technology Liberation Front,,* January 28, 2015, http://techliberation.com/2015/01/28/some-initial-thoughts-on-the-ftc-internet-of-things-report.

essay: "Striking a Sensible Balance on the Internet of Things and Privacy," *Technology Liberation Front,,* January 16, 2015, http://techliberation.com/2015/01/16/striking-a-sensible-balance-on-the-internet-of-things-and-privacy.

slide presentation: "Policy Issues Surrounding the Internet of Things & Wearable Technology," September 12, 2014, http://techliberation.com/2014/09/12/slide-presentation-policy-issues-surrounding-the-internet-of-things-wearable-technology.

essay: "CES 2014 Report: The Internet of Things Arrives, but Will Washington Welcome It?" *Technology Liberation Front,,* January 8, 2014, http://techliberation.com/2014/01/08/ces-2014-report-the-internet-of-things-arrives-but-will-washington-welcome-it.

essay: "The Growing Conflict of Visions over the Internet of Things & Privacy," *Technology Liberation Front,,* January 14, 2014, http://techliberation.com/2014/01/14/the-growing-conflict-of-visions-over-the-internet-of-things-privacy.

op-ed: "Can We Adapt to the Internet of Things?" *IAPP Privacy Perspectives*, June 19, 2013, https://privacyassociation.org/news/a/can-we-adapt-to-the-internet-of-things.

agency filing: My Filing to the FTC in its 'Internet of Things' Proceeding, May 31, 2013, http://techliberation.com/2013/05/31/my-filing-to-the-ftc-in-its-internet-of-things-proceeding.

book: *Permissionless Innovation: The Continuing Case for Comprehensive Technological Freedom* (Arlington, VA: Mercatus Center at George Mason University, 2014), http://mercatus.org/permissionless/permissionlessinnovation.html.

essay: "What's at Stake with the FTC's Internet of Things Workshop," *Technology Liberation Front,,* November 18, 2013, http://techliberation.com/2013/11/18/whats-at-stake-with-the-ftcs-internet-of-things-workshop.

law review article: "Removing Roadblocks to Intelligent Vehicles and Driverless Cars," forthcoming, *Wake Forest Journal of Law & Policy* (2015),http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2496929.

APPENDIX 2: WHAT IS THE INTERNET OF THINGS?[16]

Many of the underlying drivers of the Internet and Information Age revolution—massive increases in processing power, exploding storage capacity, steady miniaturization of computing and cameras, ubiquitous wireless communications and networking capabilities, digitization of all data, and massive datasets (or "big data")—are beginning to have a profound influence beyond the confines of cyberspace. It is cheaper than ever, for example, to integrate a microchip, a sensor, a camera, and even an accelerometer into devices today. "Thanks to advances in circuits and software," observe Neil Gershenfeld and J. P. Vasseur, "it is now possible to make a Web server that fits on (or in) a fingertip for $1." As costs continue to fall and these technologies are increasingly embedded into almost all devices that consumers own and come into contact with, a truly "seamless web" of connectivity and "pervasive computing" will exist.

As a result of these factors, mundane appliances and other machines and devices that consumers have long taken for granted—cars, refrigerators, cooking devices, lights, weight scales, watches, jewelry, eyeglasses, and even their clothing—will all soon be networked, sensing, automated, and communicating. In other words, consumers are transitioning to what Alex Hawkinson, CEO and founder of SmartThings, calls a "programmable world" where "things will become intuitive [and] connectivity will extend even further, to the items we hold most dear, to those things that service the everyday needs of the members of the household, and beyond."[17]

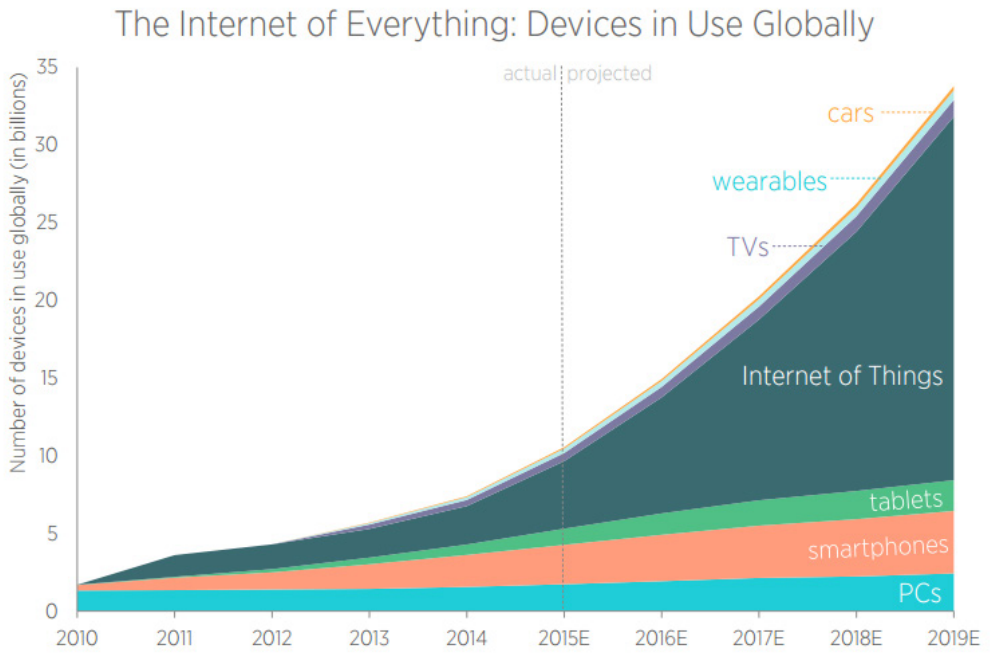
This so-called Internet of Things—or "machine-to-machine" connectivity and communications—promises to usher in "a third computing revolution"[18] and bring about profound changes that will rival the first wave of Internet innovation. The first use of the term Internet of Things is attributed to Kevin Ashton, who used it in the title of a 1999 presentation.[19] A decade later, he reflected on the term and its meaning:

> If we had computers that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss, and cost. We would know when things needed replacing, repairing, or recalling and whether they were fresh or past their best.
>
> We need to empower computers with their own means of gathering information, so they can see, hear, and smell the world for themselves, in all its random glory. RFID [radio-frequency identification] and sensor technology enable computers to observe, identify, and understand the world—without the limitations of human-entered data.[20]

More recently, analysts with Morrison & Foerster have defined IoT as "the network of everyday physical objects which surround us and that are increasingly being embedded with technology to enable those objects to collect and transmit data about their use and surroundings."[21] These low-power devices typically rely on sensor technologies as well as existing wireless networking systems and protocols (Wi-Fi, Bluetooth, near field communication, and GPS) to facilitate those objectives. In turn, this reliance will fuel the creation of even more "big data." Many of these technologies and capabilities will eventually operate in the background of consumers' lives and be almost invisible to them.

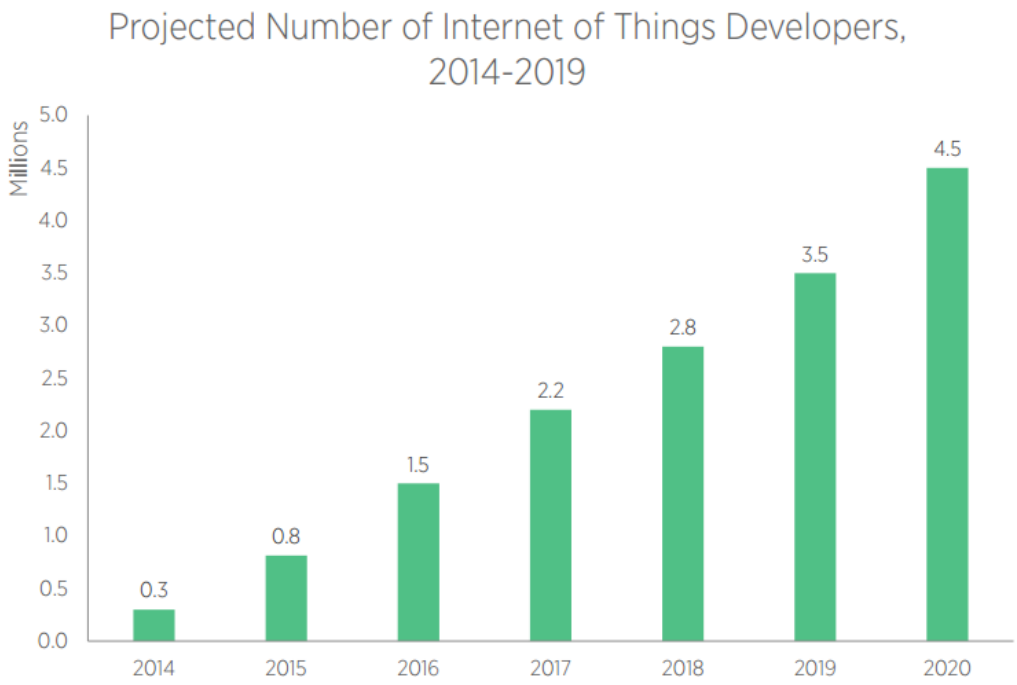
16. This section adapted from Adam Thierer, "The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, November 2015), which will be published in the *Richmond Journal of Law and Technology* 21, no. 6 (2015), http://mercatus.org/publication/internet-things-and-wearable-technology-addressing-privacy-and-security-concerns-without.
17. Alex Hawkinson, "What Happens When the World Wakes Up," *Medium* (Sept. 23, 2014), https://medium.com/@ahawkinson/what-happens-when-the-world-wakes-up-c73a5c931c17.
18. Timothy B. Lee, "Everything's Connected: How Tiny Computers Could Change the Way We Live," *Vox* (Aug. 13, 2014), http://www.vox.com/2014/5/8/5590228/how-tiny-computers-could-change-the-way-we-live.
19. Kevin Ashton, "That "Internet of Things" Thing," *RFID Journal* (June 22, 2009), http://www.rfidjournal.com/articles/view?4986.
20. Ibid.
21. Amy Collins, Adam J. Fleisher, D. Reed Freeman Jr., and Alistair Maughan, "The Internet of Things Part 1: Brave New World," *Client Alert* (Morrison Foerster), March 18, 2014, 1, http://www.jdsupra.com/legalnews/the-internet-of-things-part-1-brave-new-23154.

IoT is sometimes understood as being synonymous with "smart" systems: smart homes, smart buildings, smart appliances, smart health, smart mobility, smart cities, and so on. Smart car technology is also expanding rapidly.[22] The promise of IoT, as described by *New York Times* reporter Steve Lohr, is that "billions of digital devices—from smartphones to sensors in homes, cars, and machines of all kinds—will communicate with each other to automate tasks and make life better."[23] "Consumers and public officials can use the connected world to improve energy conservation, efficiency, productivity, public safety, health, education, and more," predicts CEA.[24] "The connected devices and applications that consumers choose to adopt will make their lives easier, safer, healthier, less expensive, and more productive."[25] In addition to giving consumers more control over their lives, these technologies can also help them free up time by automating routine tasks and chores.



Source: "The Internet of Everthing: 2015," Business Insider Intelligence.
Produced by Adam Thierer and Andrea Castillo, Mercatus Center at George Mason University, 2015.

22. See Patrick Thibodeau, "Explained: The ABCs of the Internet of Things," *Computerworld*, May 6, 2014, http://www.computerworld.com/s/article/9248058/Explained_The_ABCs_of_the_Internet_of_Things_.
23. Steve Lohr, "A Messenger for the Internet of Things," *N.Y. Times Bits*, April 25, 2013, http://bits.blogs.nytimes.com/2013/04/25/a-messenger-for-the-internet-of-things.
24. Consumer Electronics Association, Comment to the Federal Trade Commission on Internet of Things, Project No. P135405 (June 10, 2013), 7.
25. Ibid.



Source: "IoT: Breaking Free From Internet and Things," Vision Mobile, 2014.
Produced by Adam Thierer and Andrea Castillo, Mercatus Center at George Mason University, 2015.

APPENDIX 3: PROJECTED USE AND ECONOMIC IMPACT OF THE INTERNET OF THINGS[26]

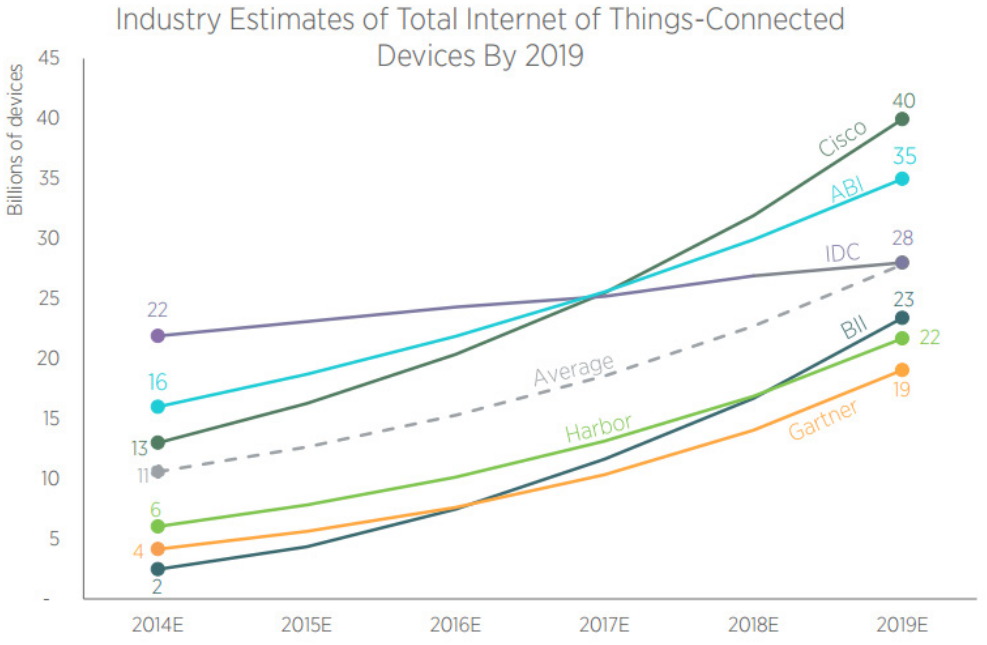
The Internet of Things is already growing at a breakneck pace and is expected to continue to accelerate rapidly. Below is a summary of recent forecasts regarding the growing device connectivity as well as potential economic benefits of the IoT.

A. Connectivity

- **Cisco** projects that 37 billion intelligent things will be connected and communicating by 2020.[27]
- **ABI Research** estimates that there are more than 10 billion wirelessly connected devices in the market today and more than 30 billion devices expected by 2020.[28]
- **IDC** (International Data Corporation) predicts far greater penetration of 212 billion devices installed globally by the end of 2020.[29]
- **Gartner** anticipates that 25 billion Internet of Things devices will be in operation by 2020.[30]
- **VisionMobile** projects that the number of IoT developers will grow from roughly 300,000 in 2014 to more than 4.5 million by 2020.[31]
- **Business Insider** estimates that will be a total of 23.4 billion Internet of Things devices connected by 2019 and that their adoption will be driven by the enterprise and manufacturing sectors.[32]
- **Harbor** projects that 21.7 billion Internet of Things devices will be connected and in use by 2019.[33]
- **Machina Research** reports that roughly 7.2 billion "machine-to-machine connected consumer electronic devices" will be in global use by 2023.[34]
- **Navigant Research** states that more than 1 billion smart meters will be installed globally by 2022, up from 313 million in 2013.[35]

26. This section compiled with the assistance of Andrea Castillo, Program Manager of the Technology Policy Program at the Mercatus Center.
27. Dave Evans, "Thanks to IoE, the Next Decade Looks Positively 'Nutty,'" *Cisco Blog*, February 12, 2013, http://blogs.cisco.com/ioe/thanks-to-ioe-the-next-decade-looks-positively-nutty.
28. "More Than 30 Billion Devices Will Wirelessly Connect to the Internet of Everything in 2020" (Press Release, ABI Research, May 9, 2013), https://www.abiresearch.com/press/more-than-30-billion-devices-will-wirelessly-conne.
29. Antony Savvas, "Internet of Things Market Will Be Worth Almost $9 Trillion," *CNME*, October 6, 2013, http://www.cnmeonline.com/news/internet-of-things-market-will-be-worth-almost-9-trillion.
30. "Gartner Says 4.9 Billion Connected 'Things' Will Be in Use in 2015" (Press Release, Gartner, 2014), http://www.gartner.com/newsroom/id/2905717.
31. Matt Asay, "The Internet of Things Will Need Millions of Developers by 2020," *ReadWrite*, June 27, 2014, http://readwrite.com/2014/06/27/internet-of-things-developers-jobs-opportunity.
32. John Greenough, "The Enterprise Internet of Things Report: Forecasts, Industry Trends, Advantages, and Barriers for the Top IoT Sector," *Business Insider*, 2014, https://intelligence.businessinsider.com/the-enterprise-internet-of-things-report-forecasts-industry-trends-advantages-and-barriers-for-the-top-iot-sector-2014-11.
33. Harbor Research, *Smart Systems and the Internet of Things Forecast* (2013), http://harborresearch.com/wp-content/uploads/2013/08/Harbor-Research_2013-Forecast-Report_Prospectus.pdf.
34. "The Connected Life" (Press Release, Machina Research, 2014), https://machinaresearch.com/static/media/uploads/machina_research_press_release_-_ce_report_-_2014_07_28.pdf.
35. Smart Electric Meters, "Advanced Metering Infrastructure, and Meter Communications: Global Market Analysis and Forecasts," Navigant Research, November 2013, http://www.navigantresearch.com/research/smart-meters.

- **IHS Automotive** anticipates that the number of cars connected to the Internet will grow more than six fold from 2013 to reach 152 million internationally by 2020.[36]
- **ON World** projects that roughly 100 million Internet-connected wireless lights will be in operation by 2020.[37]



Source: "The Internet of Things Is Rising: How the IOT Market Will Grow Across Sectors," *BI Intelligence*, 2014.
Produced by Adam Thierer and Andrea Castillo, Mercatus Center at George Mason University, 2015.

B. Economic Impact

- **McKinsey Global Institute** researchers estimate the potential economic impact of IoT technologies to be from $2.7 to $6.2 trillion per year by 2025.[38]
- **IDC** estimated in 2013 that this market would grow at a compound annual growth rate of 7.9 percent to reach $8.9 trillion by 2020.[39]
- **Cisco** analysts estimate that IoT will create $14.4 trillion in value between 2013 and 2022.[40]
- **Business Insider** estimates that IoT will add approximately $5.6 trillion in value to the global economy in between 2014 and 2019.[41]

36. "Emerging Technologies: Big Data in the Connected Car" (Press Release, IHS Automotive, November 2013), http://press.ihs.com/press-release/country-industry-forecasting/big-data-drivers-seat-connected-car-technological-advance.
37. Mareca Hatler, Darryl Gurganious, and Charlie Chi, "Smart Wireless Lighting," *ON World*, 2013, http://onworld.com/smartlighting.
38. James Manyika, Michael Chui, Jacques Bughin, Richard Dobbs, Peter Bisson, and Alex Marrs, "Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy," McKinsey, May 2013, http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Technology%20and%20Innovation/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx.
39. Antony Savvas, "Internet of Things Market Will Be Worth Almost $9 Trillion," *CNME*, October 6, 2013, http://www.cnmeonline.com/news/internet-of-things-market-will-be-worth-almost-9-trillion.
40. Joseph Bradley, Joel Barbier, and Doug Handler, "Embracing the Internet of Everything to Capture Your Share of $14.4 Trillion," CISCO, 2013, http://www.cisco.com/web/about/ac79/docs/innov/IoE_Economy.pdf.
41. John Greenough, "The Enterprise Internet of Things Report: Forecasts, Industry Trends, Advantages, and Barriers for the Top IoT

- **Accenture** estimates that the industrial IoT could add $14.2 trillion to the global economy by 2030, and that the US economy will gain at least $6.1 trillion in cumulative GDP by that year.[42]
- **General Electric** projects that industrial IoT technologies will add about $15 trillion to global GDP by 2030 (in constant 2005 dollars).[43]
- **Morgan Stanley** forecasts that driverless cars will save the US economy $1.3 trillion per year once autonomous cars fully penetrate the market, while saving the world another $5.6 trillion a year.[44]

Sector," *Business Insider,* 2014, https://intelligence.businessinsider.com/the-enterprise-internet-of-things-report-forecasts-industry-trends-advantages-and-barriers-for-the-top-iot-sector-2014-11.
42. "Winning with the Industrial Internet of Things" (Positioning Paper, Accenture, 2015), http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Industrial-Internet-of-Things-Positioning-Paper-Report-2015.PDF.
43. Peter C. Evans and Marco Annunziata, "Industrial Internet: Pushing the Boundaries of Minds and Machines," General Electric, 2012, http://www.ge.com/docs/chapters/Industrial_Internet.pdf.
44. Ravi Shanker et al., "Driverless Cars: Self-Driving the New Auto Industry Paradigm" (Blue Paper, Morgan Stanley, November 6, 2013), http://www.wisburg.com/wp-content/uploads/2014/09/%ef%bc%88109-pages-2014%ef%bc%89morgan-stanley-blue-paper-autonomous-cars%ef%bc%9a-self-driving-the-new-auto-industry-paradigm.pdf.

APPENDIX 4: A NONPARTISAN POLICY VISION FOR THE INTERNET OF THINGS[45]

What sort of public policy vision should govern the Internet of Things? I recently heard three public policymakers articulate their recommended vision for the Internet of Things (IoT), and I found their approach so inspiring that I wanted to discuss it here in the hopes that it will become the foundation for future policy in this arena.

On December 4, 2015, it was my pleasure to attend a Center for Data Innovation (CDI) event on "How Can Policymakers Help Build the Internet of Things?" As the title implied, the goal of the event was to discuss how to achieve the vision of a more fully connected world and, more specifically, how public policymakers can help facilitate that objective. It was a terrific event with many excellent panel discussions and keynote addresses.

Two of those keynotes were delivered by Senators Deb Fischer (R-Neb.) and Kelly Ayotte (R-N.H.). Below I offer some highlights from their remarks and then relate them to the vision set forth by Federal Trade Commission (FTC) Commissioner Maureen K. Ohlhausen in some of her recent speeches. I will conclude by discussing how the Ayotte-Fischer-Ohlhausen vision can be seen as the logical extension of the Clinton administration's excellent 1997 "Framework for Global Electronic Commerce," which proposed a similar policy paradigm for the Internet more generally. This shows how crafting policy for the IoT can and should be a nonpartisan affair.

A. Sen. Deb Fischer's Remarks

In her opening remarks at the CDI event in December 2014, Sen. Deb Fischer explained how "the Internet of Things can be a game changer for the U.S. economy and for the American consumer." "It gives people more information and better tools to analyze data to make more informed choices," she noted.

After outlining some of the potential benefits associated with the Internet of Things, Sen. Fischer continued on to explain why it is essential we get public policy incentives right first if we hope to unlock the full potential of these new technologies. Specifically, she argued that:

> In order for Americans to receive the maximum benefits from increased connectivity, there are two things the government must avoid. First, policymakers can't bury their heads in the sand and pretend this technological revolution isn't happening, only to wake up years down the road and try to micromanage a fast-changing, dynamic industry.
>
> Second, the federal government must also avoid regulation just for the sake of regulation. We need thoughtful, pragmatic responses and narrow solutions to any policy issues that arise. For too long, the only "strategy" in Washington policy-making has been to react to crisis after crisis. We should dive into what this means for U.S. global competitiveness, consumer welfare, and economic opportunity before the public policy challenges overwhelm us, before legislative and executive branches of government—or foreign governments—react without all the facts.

Fischer concluded by noting, "It's entirely appropriate for the U.S. government to think about how to modernize its regulatory frameworks, consolidate, renovate, and overhaul obsolete rules. We're destined to lose to the Chinese or others if the Internet of Things is governed in the United States by rules that pre-date the VCR."

B. Sen. Kelly Ayotte's Remarks

Like Sen. Fischer, Ayotte similarly stressed the many economic opportunities associated with IoT technologies for both consumers and producers alike. Ayotte also noted that IoT is going to be a major topic for the Senate Commerce Committee. She said that the role of the Committee will be to ensure that the various agencies looking into IoT issues are not issuing "conflicting regulatory directives" and "that what is being done makes sense and allows for future innovation that we can't even anticipate right now." Among the agencies she cited that are currently looking into IoT issues: FTC (privacy and security), FDA (medical device applications), FCC (wireless issues), FAA

45. This section is adapted from Adam Thierer, "A Nonpartisan Policy Vision for the Internet of Things," *Technology Liberation Front*, December 11, 2014, http://techliberation.com/2014/12/11/a-nonpartisan-policy-vision-for-the-internet-of-things.

(commercial drones), NHTSA (intelligent vehicle technology), and NTIA (multi-stakeholder privacy reviews) as well as state lawmakers and regulatory agencies.

Sen. Ayotte then explained what sort of policy framework America needed to adopt to ensure that the full potential of the Internet of Things could be realized. She framed the choice lawmakers are confronted with as follows:

> We as policymakers we can either create an environment that allows that to continue to grow, or one that thwarts that. To stay on the cutting edge, we need to make sure that our regulatory environment is conducive to fostering innovation." [. . .] We're living in the Dark Ages in the ways the some of the regulations have been framed. Companies must be properly incentivized to invest in the future, and government shouldn't be a deterrent to innovation and job-creation.

Ayotte also stressed that "technology continues to evolve so rapidly there is no one-size-fits-all regulatory approach" that can work for a dynamic environment like this. "If legislation drives technology, the technology will be outdated almost instantly," and "that is why humility is so important," she concluded.

The better approach, she argued was to let technology evolve freely in a "permissionless" fashion and then see what problems developed and then address them accordingly. "[A] top-down, preemptive approach is never the best policy" and will only serve to stifle innovation, she argued. "If all regulators looked with some humility at how technology is used and whether we need to regulate or not to regulate, I think innovation would stand to benefit."

C. FTC Commissioner Maureen K. Ohlhausen

Fischer and Ayotte's remarks reflect a vision for the Internet of Things that FTC Commissioner Maureen K. Ohlhausen has articulated in recent months. In fact, Sen. Ayotte specifically cited Ohlhausen in her remarks.

Ohlhausen has actually delivered several excellent speeches on these issues and has become one of the leading public policy thought leaders on the Internet of Things in the United States today. One of her first major speeches on these issues was her October 2013 address entitled, "The Internet of Things and the FTC: Does Innovation Require Intervention?" In that speech, Ohlhausen noted that, "The success of the Internet has in large part been driven by the freedom to experiment with different business models, the best of which have survived and thrived, even in the face of initial unfamiliarity and unease about the impact on consumers and competitors."

She also issued a wise word of caution to her fellow regulators:

> It is . . . vital that government officials, like myself, approach new technologies with a dose of regulatory humility, by working hard to educate ourselves and others about the innovation, understand its effects on consumers and the marketplace, identify benefits and likely harms, and, if harms do arise, consider whether existing laws and regulations are sufficient to address them, before assuming that new rules are required.

In this and other speeches, Ohlhausen has highlighted the various other remedies that already exist when things do go wrong, including FTC enforcement of "unfair and deceptive practices," common law solutions (torts and class actions), private self-regulation and best practices, social pressure, and so on.

D. The Clinton Administration Vision

These three women have articulated what I regard as the ideal vision for fostering the growth of the Internet of Things. It should be noted, however, that their framework is really just an extension of the Clinton administration's outstanding vision for the Internet more generally.

In the 1997 "Framework for Global Electronic Commerce," the Clinton administration outlined its approach toward the Internet and the emerging digital economy. As I've noted many times before, the framework was a succinct and bold market-oriented vision for cyberspace governance that recommended reliance upon civil society, contractual negotiations, voluntary agreements, and ongoing marketplace experiments to solve information-age problems. Specifically, it stated that "the private sector should lead [and] the Internet should develop as a market

driven arena not a regulated industry." "[G]overnments should encourage industry self-regulation and private sector leadership where possible" and "avoid undue restrictions on electronic commerce."

Sen. Ayotte specifically cited those Clinton principles in her speech and said, "I think those words, given twenty years ago at the infancy of the Internet, are today even more relevant as we look at the challenges and the issues that we continue to face as regulators and policymakers."

I completely agree. This is exactly the sort of vision that we need to keep innovation moving forward to benefit consumers and the economy, and this illustrates how IoT policy can be a bipartisan effort.

Why does this matter so much? As I noted in this essay from November 2014, thanks to the Clinton administration's bold vision for the Internet:

> This policy disposition resulted in an unambiguous green light for a rising generation of creative minds who were eager to explore this new frontier for commerce and communications. . . . The result of this freedom to experiment was an outpouring of innovation. America's info-tech sectors thrived thanks to permissionless innovation, and they still do today. An annual Booz & Company report on the world's most innovative companies revealed that 9 of the top 10 most innovative companies are based in the U.S. and that most of them are involved in computing, software, and digital technology.[46]

In other words, America had the policy right before and we can get the policy right again. Patience, flexibility, and forbearance are the key policy virtues that nurture an environment conducive to entrepreneurial creativity, economic progress, and greater consumer choice.

Other policymakers should endorse the vision originally sketched out by the Clinton administration and now so eloquently embraced and extended by Sen. Fischer, Sen. Ayotte, and Commissioner Ohlhausen. This is the path forward if we hope to realize the full potential of the Internet of Things.

46. Adam Thierer, "15 Years On, President Clinton's 5 Principles for Internet Policy Remain the Perfect Paradigm," *Forbes*, February 12, 2012, http://www.forbes.com/sites/adamthierer/2012/02/12/15-years-on-president-clintons-5-principles-for-internet-policy-remain-the-perfect-paradigm.

APPENDIX 5: SOME INITIAL THOUGHTS ON THE FTC INTERNET OF THINGS REPORT[47]

On January 27, 2015, the Federal Trade Commission (FTC) released its long-awaited report on "The Internet of Things: Privacy and Security in a Connected World." The 55-page report is the result of a lengthy staff exploration of the issue, which kicked off with an FTC workshop on the issue that was held on November 19, 2013.

In this essay, I will offer a few general thoughts on the FTC's report and its overall approach to the Internet of Things and then discuss a few specific issues that I believe deserve further attention.

A. Big Picture, Part 1: Should Best Practices Be Voluntary or Mandatory?

Generally speaking, the FTC's report contains a variety of "best practice" recommendations to get Internet of Things innovators to take steps to ensure greater privacy and security "by design" in their products. Most of those recommended best practices are sensible as *general guidelines* for innovators, but the really sticky question here continued to be this: When, if ever, should "best practices" become binding regulatory requirements?

The FTC does a bit of a dance when answering that question. Consider how, in the executive summary of the report, the Commission answers the question regarding the need for additional privacy and security regulation: "Commission staff agrees with those commenters who stated that there is great potential for innovation in this area, and that IoT-specific legislation at this stage would be premature." But, just a few lines later, the agency (1) "reiterates the Commission's previous recommendation for Congress to enact strong, flexible, and technology-neutral federal legislation to strengthen its existing data security enforcement tools and to provide notification to consumers when there is a security breach," and (2) "recommends that Congress enact broad-based (as opposed to IoT-specific) privacy legislation."

Here and elsewhere, the agency repeatedly stresses that it is not seeking IoT-specific regulation, merely "broad-based" digital privacy and security legislation.

The problem is that once you understand what the IoT is all about you come to realize that this largely represents a distinction without a difference. The Internet of Things is simply the extension of the Net into everything we own or come into contact with. Thus, this idea that the agency is not seeking IoT-specific rule sounds terrific until you realize that it is actually seeking something far more sweeping—greater regulation of *all* online and digital interactions. And because "the Internet" and "the Internet of Things" will eventually (if they are not already) be consider synonymous, this notion that the agency is not proposing technology-specific regulation is really quite silly.

Now, it remains unclear whether there exists any appetite on Capitol Hill for "comprehensive" legislation of any variety, although perhaps we'll learn more about that possibility when the Senate Commerce Committee hosts a hearing on these issues on February 11. But at least so far, "comprehensive" or "baseline" digital privacy and security bills have been non-starters.

And that's for good reason in my opinion: Such regulatory proposals could take us down the path that Europe charted in the late 1990s with onerous "data directives" and suffocating regulatory mandates for the IT and computing sector. The results of this experiment have been unambiguous, as I documented in congressional testimony in 2013. I noted there how America's Internet sector came to be the envy of the world while it was hard to name any major Internet company from Europe. Whereas America embraced "permissionless innovation" and let creative minds develop one of the greatest success stories in modern history, the Europeans adopted a "Mother, may I?" regulatory approach for the digital economy. America's more flexible, light-touch regulatory regime leaves more room for competition and innovation compared to Europe's top-down regime. Digital innovation suffered over there while it blossomed here.

That's why we need to be careful about adopting the sort of "broad-based" regulatory regime that the FTC recommends in this and previous reports.

47. This section is adapted from Adam Thierer, "Some Initial Thoughts on the FTC Internet of Things Report," *Technology Liberation Front*, January 28, 2015, http://techliberation.com/2015/01/28/some-initial-thoughts-on-the-ftc-internet-of-things-report.

B. Big Picture, Part 2: Does the FTC Really Need More Authority?

Something else is going on in this report that has also been happening in all the FTC's recent activity on digital privacy and security matters: The agency has been busy laying the groundwork for its own expansion.

In this latest report, for example, the FTC argues that:

> Although the Commission currently has authority to take action against some IoT-related practices, it cannot mandate certain basic privacy protections. . . . The Commission has continued to recommend that Congress enact strong, flexible, and technology-neutral legislation to strengthen the Commission's existing data security enforcement tools and require companies to notify consumers when there is a security breach.

In other words, this agency wants more authority. And we are talking about sweeping authority here that would transcend its *already sweeping* authority to police "unfair and deceptive practices" under Section 5 of the FTC Act. Let's be clear: It would be hard to craft a law that grants an agency more comprehensive and open-ended consumer protection authority than Section 5. The meaning of those terms—"unfairness" and "deception"—has always been a contentious matter, and at times the agency has abused its discretion by exploiting that ambiguity.

Nonetheless, Section 5 remains a powerful enforcement tool for the agency and one that has been wielded aggressively in recently years to police digital economy giants and small operators alike. Generally speaking, I'm alright with *most* Section 5 enforcement, especially since that sort of retrospective policing of unfair and deceptive practices is far less likely to disrupt permissionless innovation in the digital economy. That's because it does not subject digital innovators to the sort of "Mother, may I?" regulatory system that European entrepreneurs face. But an expansion of the FTC's authority via more "comprehensive, baseline" privacy and security regulatory policies threatens to convert America's more sensible bottom-up and responsive regulatory system into the sort of innovation-killing regime we see on the other side of the Atlantic.

Here's the other thing we can't forget when it comes to the question of what additional authority to give the FTC over privacy and security matters: The FTC is not the end of the enforcement story in America. Other enforcement mechanisms exist, including privacy torts, class action litigation, property and contract law, state enforcement agencies, and other targeted privacy statutes. I've summarized all these additional enforcement mechanisms in my 2014 law review article referenced above.

C. FIPPS, Part 1: Notice and Choice vs. Use-Based Restrictions

Let's drill down a bit and examine some of the specific privacy and security best practices that the agency discusses in its new IoT report.

The FTC report highlights how the IoT creates serious tensions for many traditional Fair Information Practice Principles (FIPPs). The FIPPs generally include (1) notice, (2) choice, (3) purpose specification, (4) use limitation, and (5) data minimization. But the report is mostly focused on notice and choice as well as data minimization.

When it comes to notice and choice, the agency wants to keep hope alive that it will still be applicable in an IoT world. I'm sympathetic to this effort because it is quite sensible for *all* digital innovators to do their best to provide consumers with adequate notice about data collection practices and then give them sensible choices about it. Yet, like the agency, I agree that "offering notice and choice is challenging in the IoT because of the ubiquity of data collection and the practical obstacles to providing information without a user interface."

The agency has a nuanced discussion of how context matters in providing notice and choice for IoT, but one can't help but think that even they must realize that the game is over, to some extent. The increasing miniaturization of IoT devices and the ease with which they suck up data means that traditional approaches to notice and choice just aren't going to work all that well going forward. It is almost impossible to envision how a rigid application of traditional notice and choice procedures would work in practice for the IoT.

Relatedly, as I wrote in January 2015, the Future of Privacy Forum (FPF) released a white paper entitled, "A

Practical Privacy Paradigm for Wearables," that notes how FIPPs "are a valuable set of high-level guidelines for promoting privacy, [but] given the nature of the technologies involved, traditional implementations of the FIPPs may not always be practical as the Internet of Things matures." That's particularly true of the notice and choice FIPPS.

But the FTC isn't quite ready to throw in the towel and make the complete move toward "use-based restrictions," as many academics have. Use-based restrictions would focus on specific uses of data that are particularly sensitive and for which there is widespread agreement they should be limited or disallowed altogether. But use-based restrictions are, ironically, controversial from both the perspective of industry and privacy advocates (albeit for different reasons, obviously).

The FTC doesn't really know where to go next with use-based restrictions. The agency says that, on one hand, "has incorporated certain elements of the use-based model into its approach" to enforcement in the past. On the other hand, the agency says it has concerns "about adopting a pure use-based model for the Internet of Things," since it may not go far enough in addressing the growth of more widespread data collection, especially of more sensitive information.

In sum, the agency appears to be keeping the door open on this front and hoping that a best-of-all-worlds solution miraculously emerges that extends *both* notice and choice and use-based limitations as the IoT expands. But the agency's new report doesn't give us any sort of blueprint for how that might work, and that's likely for good reason: because it probably won't work at that well in practice, and there will be serious costs in terms of lost innovation if they try to force unworkable solutions on this rapidly evolving marketplace.

D. FIPPS, Part 2: Data Minimization

The biggest policy fight that is likely to come out of this report involves the agency's push for data minimization. To minimize the risks associated with excessive data collection, the report recommends that:

> Companies should examine their data practices and business needs and develop policies and practices that impose reasonable limits on the collection and retention of consumer data. However, recognizing the need to balance future, beneficial uses of data with privacy protection, staff's recommendation on data minimization is a flexible one that gives companies many options. They can decide not to collect data at all; collect only the fields of data necessary to the product or service being offered; collect data that is less sensitive; or deidentify the data they collect. If a company determines that none of these options will fulfill its business goals, it can seek consumers' consent for collecting additional, unexpected categories of data.

This is an unsurprising recommendation in light of the fact that, in previous major speeches on the issue, FTC Chairwoman Edith Ramirez argued that "information that is not collected in the first place can't be misused" and that:

> The indiscriminate collection of data violates the First Commandment of data hygiene: Thou shall not collect and hold onto personal information unnecessary to an identified purpose. Keeping data on the off chance that it might prove useful is not consistent with privacy best practices. And remember, not all data is created equally. Just as there is low quality iron ore and coal, there is low quality, unreliable data. And old data is of little value.

In my forthcoming law review article, I discussed the problem with such reasoning at length and note:

> If Chairwoman Ramirez's approach to a preemptive data use "commandment" were enshrined into a law that said, "Thou shall not collect and hold onto personal information unnecessary to an identified purpose." Such a precautionary limitation would certainly satisfy her desire to avoid hypothetical worst-case outcomes because, as she noted, "information that is not collected in the first place can't be misused," but it is equally true that information that is never collected may never lead to seren-

> dipitous data discoveries or new products and services that could offer consumers concrete benefits. "The socially beneficial uses of data made possible by data analytics are often not immediately evident to data subjects at the time of data collection," notes Ken Wasch, president of the Software and Information Industry Association. If academics and lawmakers succeed in imposing such precautionary rules on the development of IoT and wearable technologies, many important innovations may never see the light of day.

FTC Commissioner Josh Wright issued a dissenting statement to the report that lambasted the staff for not conducting more robust cost-benefit analysis of the new proposed restrictions and specifically cited how problematic the agency's approach to data minimization was. "[S]taff merely acknowledges it would potentially curtail innovative uses of data . . . [w]ithout providing any sense of the magnitude of the costs to consumers of foregoing this innovation or of the benefits to consumers of data minimization," he says. Similarly, in her separate statement, FTC Commissioner Maureen K. Ohlhausen worried about the report's overly precautionary approach on data minimization when noting that, "without examining costs or benefits, [the staff report] encourages companies to delete valuable data—primarily to avoid hypothetical future harms. Even though the report recognizes the need for flexibility for companies weighing whether and what data to retain, the recommendation remains overly prescriptive," she concludes.

Regardless, the battle lines have been drawn by the FTC staff report as the agency has made it clear that it will be stepping up its efforts to get IoT innovators to significantly slow or scale back their data collection efforts. It will be very interesting to see how the agency enforces that vision going forward and how it impacts innovation in this space. All I know is that the agency has not conducted a serious evaluation here of the trade-offs associated with such restrictions. I penned another law review article in 2014 offering "A Framework for Benefit-Cost Analysis in Digital Privacy Debates" that they could use to begin that process if they wanted to get serious about it.

E. The Problem with the "Regulation Builds Trust" Argument

One of the interesting things about this and previous FTC reports on privacy and security matters is how often the agency premises the case for expanded regulation on "building trust." The argument goes something like this (as found on page 51 of the new IoT report): "Staff believes such legislation will help build trust in new technologies that rely on consumer data, such as the IoT. Consumers are more likely to buy connected devices if they feel that their information is adequately protected."

This is one of those commonly-heard claims that sounds so straight-forward and intuitive that few dare question it. But there are problems with the logic of the we-need-regulation-to-build-trust-and-boost-adoption arguments we often hear in debates over digital privacy.

First, the agency bases its argument mostly on polling data. "Surveys also show that consumers are more likely to trust companies that provide them with transparency and choices," the report says. Well, of course surveys say that! It's only logical that consumers will say this, just as they will always say they value privacy and security more generally when asked. You might as well ask people if they love their mothers!

What consumers claim to care about and what they actually do in the real-world are often two very different things. In the real-world, people balance privacy and security alongside many other values, including choice, convenience, cost, and more. This leads to the so-called "privacy paradox," or the problem of many people saying one thing and doing quite another when it comes to privacy matters. Put simply, people take some risks, including some privacy and security risks, to reap other rewards or benefits. (See this essay for more on the problem with most privacy polls.)

Second, online activity and the Internet of Things are both growing like gangbusters despite the privacy and security concerns that the FTC raises. Virtually every metric I've looked at that track IoT activity show astonishing growth and product adoption, and projections by all the major consultancies that have studied this consistently predict the continued rapid growth of IoT activity. Now, how can this be the case if, as the FTC claims, we'll only see the IoT really take off after we get more regulation aimed at bolstering consumer trust? Of course, the agency

might argue that the IoT will grow *at an even faster clip* than it is right now, but there is no way to prove one way or the other. In any event, the agency cannot possible claim that the IoT isn't already growing at a very healthy clip. Indeed, a lot of the hand-wringing the staff engages in throughout the report is premised precisely on the fact that the IoT is exploding faster that our ability to keep up with it. In reality, it seems far more likely that *cost and complexity* are the bigger impediments to faster IoT adoption, just as cost and complexity have always been the factors weighing most heavily on the adoption of other digital technologies.

Third, let's say that the FTC is correct—and it is—when it says that *a certain amount* of trust is needed in terms of IoT privacy and security before consumers are willing to use more of these devices and services in their everyday lives. Does the agency imagine that IoT innovators don't know that? Are markets and consumers completely irrational?

The FTC says on page 44 of the report that, "If a company decides that a particular data use is beneficial and consumers disagree with that decision, this may erode consumer trust." Well, if such a mismatch does exist, then the assumption should be that consumers can and will push back or seek out new and better options. And other companies should be able to sense the market opportunity here to offer a more privacy-centric offering for those consumers who demand it to win their trust and business.

Finally, and perhaps most obviously, the problem with the argument that increased regulation will help IoT adoption is that it ignores how the regulations put in place to achieve greater "trust" might become so onerous or costly in practice that there won't be as many innovations for us to adopt to begin with! Again, regulation, even very well-intentioned regulation, has costs and trade-offs.

In any event, if the agency is going to premise the case for expanded privacy regulation on this notion, they are going to have to do far more to make their case besides simply asserting it.

F. Once Again, No Appreciation of the Potential for Societal Adaptation

Let's briefly shift to a subject that isn't discussed in the FTC's new IoT report at all.

Major reports and statements by public policymakers about rapidly-evolving emerging technologies are always initially prone to stress panic over patience. Rarely are public officials willing to step-back, take a deep breath, and consider how a resilient citizenry might adapt to new technologies as they gradually assimilate new tools into their lives.

That is really sad, when you think about it, since humans have again and again proven capable of responding to technological change in creative ways by adopting new personal and social norms. I won't belabor the point because I've already written volumes on this issue elsewhere. I tried to condense all my work into a single essay entitled, "Muddling Through: How We Learn to Cope with Technological Change." Here's the key takeaway:

> Humans have exhibited the uncanny ability to adapt to changes in their environment, bounce back from adversity, and learn to be resilient over time. A great deal of wisdom is born of experience, including experiences that involve risk and the possibility of occasional mistakes and failures while both developing new technologies and learning how to live with them. I believe it wise to continue to be open to new forms of innovation and technological change, not only because it provides breathing space for future entrepreneurialism and invention, but also because it provides an opportunity to see how societal attitudes toward new technologies evolve—and to learn from it. More often than not, I argue, citizens have found ways to adapt to technological change by employing a variety of coping mechanisms, new norms, or other creative fixes.

Again, you almost never hear regulators or lawmakers discuss this process of individual and social adaptation even though they must know there is something to it. One explanation is that every generation has their own techno-boogeymen and lose faith in the ability of humanity to adapt to it.

To believe that we humans are resilient, adaptable creatures should not be read as being indifferent to the significant privacy and security challenges associated with any of the new technologies in our lives today, including

IoT technologies. Overly exuberant techno-optimists are often too quick to adopt a "Just get over it!" attitude in response to the privacy and security concerns raised by others. But it is equally unreasonable for those who are worried about those same concerns to utterly ignore the reality of human adaptation to new technologies realities.

G. Why are Educational Approaches Merely an Afterthought?

One final thing that troubled me about the FTC report was the way consumer and business education is mostly an afterthought. This is one of the most important roles that the FTC can and should play in terms of explaining potential privacy and security vulnerabilities to the general public and product developers alike.

Alas, the agency devotes so much ink to the more legalistic questions about how to address these issues, that all we end up with in the report is this one paragraph on consumer and business education:

> Consumers should understand how to get more information about the privacy of their IoT devices, how to secure their home networks that connect to IoT devices, and how to use any available privacy settings. Businesses, and in particular small businesses, would benefit from additional information about how to reasonably secure IoT devices. The Commission staff will develop new consumer and business education materials in this area.

I applaud that language, and I very much hope that the agency is serious about plowing more effort and resources into developing new consumer and business education materials in this area. But I'm a bit surprised that the FTC report didn't even bother mentioning the excellent material already available on the "On Guard Online" website that it helped create with a dozen other federal agencies. Worse yet, the agency failed to highlight the many other privacy education and "digital citizenship" efforts that are underway today to help on this front.

I hope that the agency spends a little more time working on the development of new consumer and business education materials in this area instead of trying to figure out how to craft a quasi-regulatory regime for the Internet of Things. As I noted in 2014 in this *Maine Law Review* article, that would be a far more productive use of the agency's expertise and resources. I argued there that "policymakers can draw important lessons from the debate over how best to protect children from objectionable online content" and apply them to debates about digital privacy. Specifically, after a decade of searching for legalistic solutions to online safety concerns—and convening a half-dozen blue ribbon task forces to study the issue—we finally saw a rough consensus emerge that no single "silver bullet" technological solutions or legal quick-fixes would work and that, ultimately, education and empowerment represented the better use of our time and resources. What was true for child safety is equally true for privacy and security for the Internet of Things.

It is a shame the FTC staff squandered the opportunity it had with this new report to highlight all the good that could be done by getting more serious about focusing first on those alternative, bottom-up, less costly, and less controversial solutions to these challenging problems. One day we'll all wake up and realize that we spent a lost decade debating legalistic solutions that were either technically unworkable or politically impossible. Just imagine if all the smart people who were spending all their time and energy on those approaches right now were instead busy devising and pushing educational and empowerment-based solutions instead!

One day we'll get there. Sadly, if the FTC report is any indication, that day is still a ways off.

APPENDIX 6: WHY "PERMISSIONLESS INNOVATION" MATTERS[48]

A. Innovation Policy: Attitudes Matter

"Why does economic growth . . . occur in some societies and not in others?" asked Joel Mokyr in his 1990 book, *Lever of Riches: Technological Creativity and Economic Progress*.[49] Debate has raged among generations of economists, historians, and business theorists over that question and the specific forces and policies that prompt long-term growth.

As varied as their answers have been, there was at least general agreement that *institutional* factors mattered most: it was really just a question of what mix of them would fuel the most growth. Those institutional factors include: government stability, the enforceability of contracts and property rights, tax and fiscal policies, trade policies, regulatory factors, labor costs, educational policies, research and development expenditures, infrastructure, demographics, and environmental factors.[50]

This leads many scholars and policymakers to speak of innovation policy as if it is simply a Goldilocks-like formula that entails tweaking various policy dials to get innovation *just right*.[51] Such thinking animates the Obama administration's "Strategy for American Innovation," which catalogs "policies to promote critical components of the American innovation ecosystem."[52] The White House claims its strategy plays a "critical role in guiding the development of new policy initiatives that can help unleash the transformative innovation that leads to long-term economic growth."[53]

Unfortunately, far less attention has been paid to the role that *values*—cultural attitudes, social norms, and political pronouncements—play in influencing opportunities for entrepreneurialism, innovation, and long-term growth.[54] Does a socio-political system respect what Deirdre McCloskey refers to as the "bourgeois virtues" that incentivize invention and propel an economy forward?[55] "A big change in the common opinion about markets and innovation," she has argued, "caused the Industrial Revolution, and then the modern world. . . . The result was modern economic growth."[56]

There are limits to how much policymakers can influence these attitudes and values, of course. Nonetheless, to the extent they hope to foster the positive factors that give rise to expanded entrepreneurial opportunities, policymakers should appreciate how growth-oriented innovation *policy* begins with the proper policy *disposition*.[57]

48. This section is adapted from Adam Thierer, "Embracing a Culture of Permissionless Innovation" (Cato Policy Forum, Cato Institute, Washington, DC, November 2014), http://www.cato.org/publications/cato-online-forum/embracing-culture-permissionless-innovation.
49. Joel Mokyr, *Lever of Riches: Technological Creativity and Economic Progress* (New York: Oxford University Press, 1990), 8–9.
50. For a listing and discussion of these and other factors, see Robert D. Atkinson, "Understanding the U.S. National Innovation System," Information Technology and Innovation Foundation, June 2014, http://www.itif.org/publications/understanding-us-national-innovation-system.
51. Michael Nelson, "Six Myths of Innovation Policy," The European Institute, Washington, DC, July 2013, http://www.europeaninstitute.org/EA-July-2013/perspectives-six-myths-of-innovation-policy.html. ("On Capitol Hill and in Brussels, there seems to be a belief that if only governments adopt the right tax policies, adequately fund R&D, enforce patents and copyrights, and support manufacturing, innovative, then start-ups will pop up everywhere and supercharge economic growth. Unfortunately, that misses an underlying problem: In many parts of the U.S. and Europe, innovation is not really welcome. It is misunderstood and even feared.")
52. White House, "Notice of Request for Information: Strategy for American Innovation," *Federal Register*, July 29, 2014, https://www.federalregister.gov/articles/2014/07/29/2014-17761/strategy-for-american-innovation.
53. Ibid.
54. Donald J. Boudreaux, "Deirdre McCloskey and Economists' Ideas about Ideas,'" *Online Library of Liberty*, July 2014, http://oll.libertyfund.org/pages/mccloskey.
55. Deirdre N. McCloskey, *The Bourgeois Virtues: Ethics for an Age of Commerce* (Chicago: University of Chicago Press, 2006).
56. Deirdre McCloskey, "Bourgeois Dignity: A Revolution in Rhetoric" (Cato Unbound, Cato Institute, Washington, DC, October 4, 2010), http://www.cato-unbound.org/2010/10/04/deirdre-mccloskey/bourgeois-dignity-revolution-rhetoric.
57. Randall Holcombe, "Entrepreneurship and Economic Growth," *The Quarterly Journal of Austrian Economics* 1, no. 2 (Summer 1998): 58, http://mises.org/journals/qjae/pdf/qjae1_2_3.pdf, ("When entrepreneurship is seen as the engine of growth, the emphasis

As Mokyr notes, "technological progress requires above all tolerance toward the unfamiliar and the eccentric."[58]

For innovation and growth to blossom, entrepreneurs need a clear green light from policymakers that signals a general acceptance of risk-taking, especially risk-taking that challenges existing business models and traditional ways of doing things.[59] We can think of this disposition as "permissionless innovation." If there was one thing every policymaker could do to help advance long-term growth, it is to first commit themselves to advancing this ethic and making it the lodestar for all their future policy pronouncements and decisions.

B. Permissionless Innovation vs. the Precautionary Principle

While it would seem self-evident that pro-innovation attitudes matter and that a general embrace of risk-taking and commercial pursuits is crucial to unlocking entrepreneurial creativity and opportunities, scholars have typically failed to put a name on this disposition. "Permissionless innovation" is a phrase of recent (but uncertain) origin that nicely summarizes that vision. Permissionless innovation refers to the notion that experimentation with new technologies and business models should generally be permitted by default.[60] Unless a compelling case can be made that a new invention or business model will bring serious harm to individuals, innovation should be allowed to continue unabated, and problems, if they develop at all, can be addressed later.

Permissionless innovation is not an absolutist position that rejects any role for government. Rather, it is an aspirational goal that stresses the benefit of "innovation allowed" as the default position to begin policy debates. It switches the burden of proof to those who favor preemptive regulation and asks them to explain why ongoing trial-and-error experimentation with new technologies or business models should be disallowed.

This disposition stands in stark contrast to the sort of "precautionary principle" thinking that often governs policy toward emerging technologies. The precautionary principle refers to the belief that new innovations should be curtailed or disallowed until their developers can prove that they will not cause any harms to individuals, groups, specific entities, cultural norms, or various existing laws, norms, or traditions.[61]

When the precautionary principle's "better to be safe than sorry"[62] approach is applied through preemptive constraints, opportunities for experimentation and entrepreneurialism are stifled. While some steps to anticipate or to control for unforeseen circumstances are sensible, going overboard with precaution forecloses opportunities and experiences that offer valuable lessons for individuals and society. The result is less economic and social dynamism.

Innovation is more likely in systems that maximize breathing room for ongoing economic and social experimentation, evolution, and adaptation. Societies that appreciate those values—and allow them to influence both social norms and policy decisions—are likely to experience greater economic growth.[63] By contrast, those that deride such values and adopt a more precautionary policy approach are more likely to discourage innovation and languish economically.

shifts toward the creation of an environment within which opportunities for entrepreneurial activity are created, and successful entrepreneurship is rewarded.")

58. Mokyr, *Lever of Riches*, 182.

59. Mokyr, *Lever of Riches*, 12 ("Economic and social institutions have to encourage potential innovators by presenting them with the right incentive structure."); Bret Swanson, "More disruption, please," *TechPolicyDaily*, August 20, 2014, http://www.techpolicydaily.com/technology/disruption-please/#sthash.PVUNga9N.dpuf ("To reignite economic growth, we need a broad commitment to an open economy and robust entrepreneurship.").

60. Thierer, *Permissionless Innovation*.

61. Ibid., vii. See also Adam Thierer, "Technopanics, Threat Inflation, and the Danger of an Information Technology Precautionary Principle," *Minnesota Journal of Law, Science and Technology* 14 (2013): 309–86, http://conservancy.umn.edu/handle/144225.

62. Indur M. Goklany, *The Precautionary Principle: A Critical Appraisal of Environmental Risk Assessment* (Washington, DC: Cato Institute, 2001), 3.

63. Joshua C. Hall, John Pulito, and Benjamin J. VanMetre, "Freedom and Entrepreneurship: New Evidence from the 50 States" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, April 17, 2012), http://mercatus.org/publication/freedom-and-entrepreneurship-new-evidence-50-states ("There is a positive and statistically significant relationship between the level of economic freedom in a country and that country's total entrepreneurial activity.")

Unlocking long-term growth opportunities, therefore, depends upon a rejection of precautionary principle thinking and an embrace of permissionless innovation as the default policy disposition.

C. The Secret Ingredient that Powered the Information Revolution

Consider how permissionless innovation powered the explosive growth of the Internet and America's information technology sectors (computing, software, Internet services, etc.) over the past two decades. Those sectors have ushered in a generation of innovations and innovators that are now the envy of the world.[64] This happened because the default position for the digital economy was permissionless innovation. No one had to ask anyone for the right to develop these new technologies and platforms.[65]

A series of decisions and statements in the mid-1990s paved the way, beginning with the Clinton administration's decision to allow commercialization of what was previously just the domain of government agencies and university researchers. Shortly thereafter, Congress passed, and President Clinton signed, the Telecommunications Act of 1996, which notably avoided regulating the Internet like earlier communications and media technologies. Later, in 1998, the Internet Tax Freedom Act was passed, which blocked governments from imposing discriminatory taxes on the Internet.

Perhaps most important, in 1997, the Clinton administration's released its "Framework for Global Electronic Commerce," outlining its approach toward the Internet and the emerging digital economy.[66] The framework was a succinct and bold market-oriented vision for cyberspace governance that recommended reliance upon civil society, contractual negotiations, voluntary agreements, and ongoing marketplace experiments to solve information age problems.[67] Specifically, it stated that "the private sector should lead [and] the Internet should develop as a market driven arena not a regulated industry."[68] "[G]overnments should encourage industry self-regulation and private sector leadership where possible" and "avoid undue restrictions on electronic commerce."[69]

This policy disposition resulted in an unambiguous green light for a rising generation of creative minds who were eager to explore this new frontier for commerce and communications. As Federal Trade Commission Commissioner Maureen K. Ohlhausen observes, "the success of the Internet has in large part been driven by the freedom to experiment with different business models, the best of which have survived and thrived, even in the face of initial unfamiliarity and unease about the impact on consumers and competitors."[70]

The result of this "freedom to experiment" was an outpouring of innovation. America's info-tech sectors thrived

64. See Bret Swanson, "The Exponential Internet," *Business Horizon Quarterly* (Spring 2014): 40–47, http://www.uschamberfoundation.org/sites/default/files/article/foundation/BHQ-Spring12-Issue3-SwansonTheExponentialInternet.pdf.
65. Ibid., 46. ("The entrepreneurship and investment that has sustained such fast growth for so long is due, in substantial part, to light-touch government policies (at least compared to other industries. . . . There have been mistakes, but for the most part, scientists, entrepreneurs, and big investors have been allowed to build new things, try new products, challenge the status quo, cooperate, and compete. They have also been allowed to fail.") See also Bret Swanson, "Long Live the Risk Takers," *Business Horizon Quarterly* 8 (2013): 30, http://www.uschamberfoundation.org/bhq/long-live-risk-takers ("Failure is a core competency of capitalism and a key component of resilience. Wealth is about creating new ideas. New ideas can only emerge through experiments of science, technology, and enterprise, all of which must be capable of failure in order to generate newness. Failure flushes away bad ideas and points us toward good ones. The failures may at times harm individuals and waste resources—people lose jobs and investments can be lost. The larger effect, however, is to lift the economy to a higher plane of knowledge, efficiency, and resilience.")
66. White House, "The Framework for Global Electronic Commerce," July 1997, http://clinton4.nara.gov/WH/New/Commerce.
67. Adam Thierer, "15 Years On, President Clinton's 5 Principles for Internet Policy Remain the Perfect Paradigm," *Forbes*, February 12, 2012, http://www.forbes.com/sites/adamthierer/2012/02/12/15-years-on-president-clintons-5-principles-for-internet-policy-remain-the-perfect-paradigm.
68. White House, "Framework for Global Electronic Commerce." (The document added that, "parties should be able to enter into legitimate agreements to buy and sell products and services across the Internet with minimal government involvement or intervention. . . . Where governmental involvement is needed, its aim should be to support and enforce a predictable, minimalist, consistent and simple legal environment for commerce.")
69. Ibid.
70. Maureen K. Ohlhausen, "The Internet of Things and the FTC: Does Innovation Require Intervention?" Remarks before the US Chamber of Commerce, Washington, DC, October 18, 2013, http://www.ftc.gov/speeches/ohlhausen/131008internetthingsremarks.pdf.

thanks to permissionless innovation, and they still do today. A 2013 Booz & Company report on the world's most innovative companies revealed that 9 of the top 10 most innovative companies are based in the United States and that most of them are involved in computing, software, and digital technology.

2013: 10 Most Innovative Companies

2013 Rank		2012 Rank	Company	Geography	Industry	R&D Spend ($Bn)*
1	▶	1	Apple	United States	Computing & Electronics	3.4
2	▶	2	Google	United States	Software & Internet	6.8
3	▲	4	Samsung	South Korea	Computing & Electronics	10.4
4	▲	10	Amazon	United States	Software & Internet	4.6
5	▼	3	3M	United States	Industrials	1.6
6	▼	5	General Electric	United States	Industrials	4.5
7	▼	6	Microsoft	United States	Software & Internet	9.8
8	▲	9	IBM	United States	Software & Internet	6.3
9	New	-	Tesla Motors	United States	Automotive	0.3
10	New	-	Facebook	United States	Software & Internet	1.4

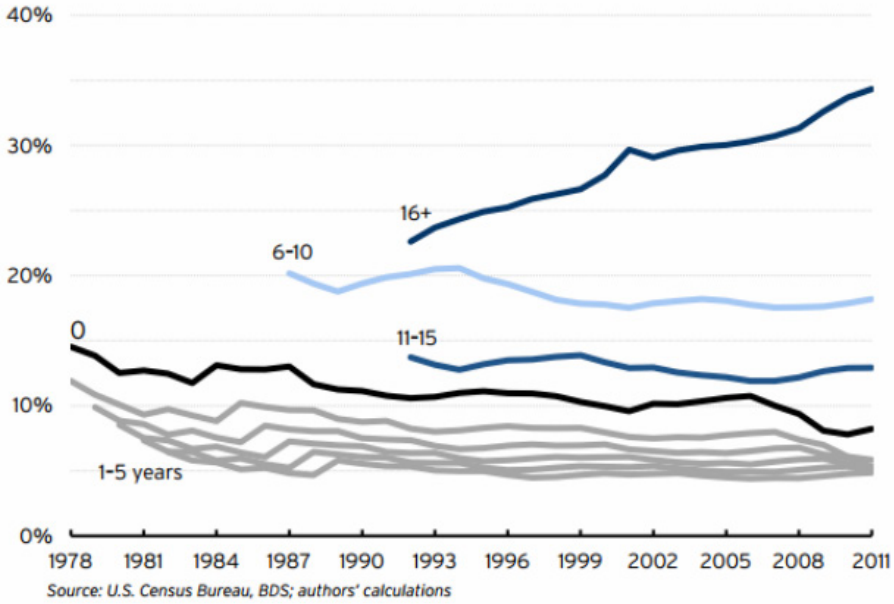
D. And What's Good for the Goose . . .

What's even more powerful about this story is how the information technology and "data-driven innovation" became the goose that laid the golden eggs for the broader US economy.[71] Brink Linsdey has noted that "economists generally agree that information technology (IT) was behind the decade of high TFP [total factor productivity] growth that ran from the mid-1990s to the mid-2000s."[72] It also boosted overall economic growth during that period.[73]

If an embrace of permissionless innovation can unlock this sort of entrepreneurial energy within the information technology sectors, it can also provide a shot in the arm to other sectors. The rest of the economy could certainly use such a boost since "the evidence of a real decline in business dynamism keeps stacking up."[74]

71. A study commissioned by the Direct Marketing Association, John Deighton of Harvard Business School and Peter Johnson of Columbia University found that data-driven marketing added $156 billion in revenue to the US economy and fueled more than 675,000 jobs in 2012. See also John Deighton and Peter A. Johnson, "The Value of Data: Consequences for Insight, Innovation & Efficiency in the U.S. Economy," Data-Driven Marketing Institute, New York, NY, 2013, http://ddminstitute.thedma.org/#valueofdata. Major reports from economic consultancies Gartner and McKinsey Global Institute have also documented significant consumer benefits from "big data" across multiple sectors. See Gartner, "Gartner Says Big Data Will Drive $28 Billion of IT Spending in 2012," October 17, 2012, http://www.gartner.com/newsroom/id/2200815; James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, and Angela Hung Byers, "Big Data: The Next Frontier for Innovation, Competition, and Productivity," McKinsey, May 2011, 97-106, http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation.
72. Lindsey, "Why Growth Is Getting Harder," 14.
73. Harold Furchtgott-Roth and Jeffrey Li, "The Contribution of the Information, Communications, and Technology Sector to the Growth of U.S. Economy: 1997–2007" (Research Paper, Center for the Economics of the Internet, Hudson Institute, Washington, DC, August 2014), http://hudson.org/content/researchattachments/attachment/1425/m0810_2.pdf ("For the years 1997–2002, we find the sector contributed 19% of measurable economic gross output growth, or more than 582 billion 2013 dollars. For the period 2002-2007, we find the sector contributed 9.3% of gross output growth, or more than 340 billion 2013 dollars.")
74. Richard Florida, "The Troubling Decline of American Business Dynamism," *The Atlantic City Lab*, July 31, 2014, http://www.citylab.com/work/2014/07/the-troubling-decline-of-american-business-dynamism/375353.

Figure 1.
Distribution of Total Firms by Firm Age in Years (1978-2011)



Source: U.S. Census Bureau, BDS; authors' calculations

Recent studies "suggest that incentives for entrepreneurs to start new firms in the United States have diminished over time"[75] and that this is hurting job creation and productivity.[76] Two recent Brookings Institution studies by Ian Hathaway and Robert E. Litan also documented a decline in business dynamism in the American economy across a broad range of sectors—including a "precipitous drop since 2006 [that] is both noteworthy and disturbing"[77]—as well as the increased "aging" of businesses, with the share of older firms in the US economy increasing by 50 percent over the past two decades.[78]

Many different institutional factors affect business dynamism, especially the regulatory environment that new startups face. "If you look over time, the number of rules has just proliferated," says Litan. "The cumulative weight of regulation—federal, state and local—is probably the most important impediment to starting a business."[79] Unfortunately, many current public policies "are rife with barriers to entrepreneurship, competition, innovation, and growth," notes Lindsey.[80]

As a result, "the regulatory environment in the United States has become less favorable to private-sector activity in recent years compared to other countries," a Mercatus Center report concluded.[81] This is especially true for

75. Ryan Decker, John Haltiwanger, Ron Jarmin, and Javier Miranda, "The Role of Entrepreneurship in US Job Creation and Economic Dynamism," *Journal of Economic Perspectives* 28, no. 3 (Summer 2014): 4, http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.28.3.3.
76. Robert J. Samuelson, "Where have all the entrepreneurs gone?" *Washington Post*, August 6, 2014, http://www.washingtonpost.com/opinions/robert-samuelson-where-have-all-the-entrepreneurs-gone/2014/08/06/e01e7246-1d7c-11e4-82f9-2cd6fa8da5c4_story.html.
77. Ian Hathaway and Robert E. Litan, "Declining Business Dynamism in the United States: A Look at States and Metros" (Economic Studies at Brookings, Brookings Institution, Washington, DC, May 2014), http://www.brookings.edu/research/papers/2014/05/declining-business-dynamism-litan.
78. Ian Hathaway and Robert E. Litan, "The Other Aging of America: The Increasing Dominance of Older Firms" (Economic Studies at Brookings, Brookings Institution, Washington, DC, July 2014), http://www.brookings.edu/research/papers/2014/07/aging-america-increasing-dominance-older-firms-litan.
79. Quoted in Rick Newman, "What Obama Gets Wrong about Corporate America," *Yahoo Finance*, August 4, 2014, http://finance.yahoo.com/news/what-obama-gets-wrong-about-corporate-america-200338595.html.
80. Lindsey, "Why Growth Is Getting Harder," 18.
81. See also Steven Globerman and George Georgopoulos, "Regulation and the International Competiveness of the U.S. Economy" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, September 18, 2012), 4, http://mercatus.org/

new start-ups.[82] Even if it is the case that "established firms that have the experience and resources to deal with [regulatory burdens]," Litan notes, the cumulative effect of regulations ends up hampering innovation by new, smaller firms. [83]

The reason this is important is not just because "business dynamism is inherently disruptive," as Hathaway and Litan note, "but [that] it is also critical to long-run economic growth" since "a dynamic economy constantly forces labor and capital to be put to better uses."[84] Thus, because economists widely acknowledge that "young firms are known to play a central role in job creation,"[85] it is especially important that policymakers get their signals right.

Again, an embrace of permissionless innovation is the way out of this conundrum.

E. Operationalizing the Vision

Patience, flexibility, and forbearance are the key policy virtues that nurture an environment conducive to entrepreneurial creativity. As the FTC's Ohlhausen argues, it is "vital that government officials . . . approach new technologies with a dose of regulatory humility, by working hard to educate ourselves and others about the innovation, understand its effects on consumers and the marketplace, identify benefits and likely harms, and, if harms do arise, consider whether existing laws and regulations are sufficient to address them, before assuming that new rules are required."[86]

Beyond its importance as an aspirational vision, permissionless innovation can guide policy in concrete ways, especially regulatory policies. Possible reforms include regulatory streamlining[87] and flexibility requirements[88], "sunsetting" provisions,[89] better benefit-cost analysis,[90] and a greater reliance on potential non-regulatory remedies—education, empowerment, transparency, industry self-regulation, etc.—before resorting to preemptive controls on new forms of innovation. Relying on common law solutions is also preferable to top-down administrative controls.[91]

publication/regulation-and-international-competitiveness-us-economy.

82. Jason J. Fichtner and Jakina R. Debnam, "Reducing Debt and Other Measures for Improving U.S. Competitiveness" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, November 13, 2012), http://mercatus.org/publication/reducing-debt-and-other-measures-improving-us-competitiveness ("Regulations have been historically biased toward existing technologies and increasing regulatory burdens on new entrants to a sector. This negatively impacts growth, and increases prices for consumers.")

83. Quoted in Robert J. Samuelson, "Where Have All the Entrepreneurs Gone?" *Washington Post*, August 6, 2014, http://www.washingtonpost.com/opinions/robert-samuelson-where-have-all-the-entrepreneurs-gone/2014/08/06/e01e7246-1d7c-11e4-82f9-2cd6fa8da5c4_story.html.

84. Hathaway and Litan, "Declining Business Dynamism," 1.

85. Chiara Criscuolo, Peter N. Gal, and Carlo Menon, "DynEmp: New Cross-Country Evidence on the Role of Young Firms in Job Creation, Growth, and Innovation," *Vox*, May 26, 2014, http://www.voxeu.org/article/dynemp-new-evidence-young-firms-role-economy.

86. Maureen K. Ohlhausen, "The Internet of Things and the FTC: Does Innovation Require Intervention?," Remarks before the US Chamber of Commerce, Washington, DC, October 18, 2013, http://www.ftc.gov/speeches/ohlhausen/131008internetthingsremarks.pdf.

87. Sherzod Abdukadirov, "Evaluating Regulatory Reforms: Lessons for Future Reforms" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, May 29, 2014), http://mercatus.org/publication/evaluating-regulatory-reforms-lessons-future-reforms; Joshua C. Hall and Michael Williams, "A Process for Cleaning Up Federal Regulations" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, December 20, 2012), http://mercatus.org/publication/process-cleaning-federal-regulations.

88. Richard Epstein, "Can Technological Innovation Survive Government Regulation?" *Harvard Journal of Law and Public Policy* 36, no. 1 (Winter 2013), http://www.harvard-jlpp.com/wp-content/uploads/2013/01/36_1_087_Epstein_Tech.pdf ("What is at stake in this area is nothing less than the question of how to preserve technical innovation in the face of wall-to-wall regulation. The prognosis is grim. Unless we reform agencies like the FDA and their procedures and operations, this country will suffer from a long-term drag on innovation that could, if the trend is not abated, lead to long-term mediocrity, as inventors and scientists flee our shores for friendlier environments. The pace of regulation is one of the central issues of our time.")

89. Adam Thierer, "Sunsetting Technology Regulation: Applying Moore's Law to Washington," *Forbes*, March 25, 2012, http://www.forbes.com/sites/adamthierer/2012/03/25/sunsetting-technology-regulation-applying-moores-law-to-washington; Patrick McLaughlin, "A Solution to the Old Rules vs. New Tech Problem," The Hill, July 8, 2014, http://mercatus.org/expert_commentary/solution-old-rules-vs-new-tech-problem.

90. See Susan E. Dudley and Jerry Brito, *Regulation: A Primer*, 2nd ed. (Arlington, VA: Mercatus Center at George Mason University, 2012).

91. See Thierer, *Permissionless Innovation*, 74-78.

F. Conclusion: Reasons for Optimism

In sum, attitudes matter as much as institutional factors in understanding what drives innovation and long-term growth, and there are reasons for optimism if policymakers embrace permissionless innovation as their default policy disposition.

Pessimists who predict permanent productivity and growth slowdown shouldn't forget that "the rate of growth of productivity at the frontiers of knowledge is especially difficult to predict; and it is unwise to underestimate human ingenuity," as Federal Reserve Vice Chairman Stanley Fischer noted in a 2014 speech.[92] While "it is difficult to know exactly in which direction technological change will move and how significant it will be," Joel Mokyr reminds us that, "something can be learned from the past, and it tells us that such pessimism is mistaken. The future of technology is likely to be bright."[93] Contrary to the belief that all the "low-hanging fruit" has already been picked, Mokyr notes that "we can also plant new trees that will grow fruits that no one today can imagine."[94]

Getting the disposition right will be more important than ever with so many exciting—but potentially highly disruptive—technologies starting to emerge, including the "sharing economy;"[95] 3D printing; the "Internet of Things" and wearable technology;[96] digital medicine; virtual reality and augmented reality technologies; commercial drone services;[97] autonomous vehicles;[98] and various robotic technologies.[99]

Permissionless innovation can help spur the next great industrial revolution by unlocking amazing opportunities in these and other arenas, boosting long-term growth in the process.

92. Stanley Fischer, "The Great Recession—Moving Ahead," a Conference Sponsored by the Swedish Ministry of Finance, Stockholm, Sweden, August 11, 2014, http://www.federalreserve.gov/newsevents/speech/fischer20140811a.htm.
93. Joel Mokyr, "The Next Age of Invention," *City Journal*, Winter 2014, http://www.city-journal.org/2014/24_1_invention.html.
94. Ibid.
95. Adam Thierer, "The Debate over the Sharing Economy: Talking Points & Recommended Reading," *Technology Liberation Front,* September 26, 2014, http://techliberation.com/2014/09/26/the-debate-over-the-sharing-economy-talking-points-recommended-reading.
96. Adam Thierer, "Slide Presentation: Policy Issues Surrounding the Internet of Things & Wearable Technology," *Technology Liberation Front*, September 12, 2014, http://techliberation.com/2014/09/12/slide-presentation-policy-issues-surrounding-the-internet-of-things-wearable-technology.
97. Jerry Brito, Eli Dourado, and Adam Thierer, "Federal Aviation Administration: Unmanned Aircraft System Test Site Program Docket No: FAA-2013-0061" (Public Interest Comment, Mercatus Center at George Mason University, Arlington, VA, April 23, 2013), http://mercatus.org/publication/federal-aviation-administration-unmanned-aircraft-system-test-site-program; Eli Dourado, "The Next Internet-Like Platform for Innovation? Airspace. (Think Drones)," *Wired*, April 23, 2013, http://www.wired.com/opinion/2013/04/then-internet-now-airspace-dont-stifle-innovation-on-the-next-great-platform; Adam Thierer, "Filing to FAA on Drones & 'Model Aircraft'," *Technology Liberation Front*, September 23, 2014, http://techliberation.com/2014/09/23/filing-to-faa-on-drones-model-aircraft.
98. Adam Thierer and Ryan Hagemann, "Removing Roadblocks to Intelligent Vehicles and Driverless Cars" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, September 17, 2014), http://mercatus.org/publication/removing-roadblocks-intelligent-vehicles-and-driverless-cars.
99. Adam Thierer, "Problems with Precautionary Principle-Minded Tech Regulation & a Federal Robotics Commission," *Medium*, September 22, 2014, https://medium.com/@AdamThierer/problems-with-precautionary-principle-minded-tech-regulation-a-federal-robotics-commission-c71f6f20d8bd.

APPENDIX 7: HOW WE ADAPT TO TECHNOLOGICAL CHANGE[100]

A.From Resistance to Resiliency

Citizen attitudes about these technologies will likely follow a cycle that has played out in countless other contexts. That cycle typically witnesses initial *resistance*, gradual *adaptation*, and then eventual *assimilation* of a new technology into society.[101] Some citizens will begin their relationship with these new technologies in a defensive crouch. In the extreme, if there is enough of a backlash, the initial resistance to these technologies might take the form of a full-blown "technopanic."[102]

Over time, however, citizens tend to learn how to adapt to new technologies or at least become more resilient in the face of new challenges posed by modern technological advances. Andrew Zolli and Ann Marie Healy, authors of *Resilience: Why Things Bounce Back*, define *resilience* as "the capacity of a system, enterprise, or a person to maintain its core purpose and integrity in the face of dramatically changed circumstances."[103] They continue:

> To improve your resilience is to enhance your ability to resist being pushed from your preferred valley, while expanding the range of alternatives that you can embrace if you need to. This is what researchers call *preserving adaptive capacity*—the ability to adapt to changed circumstances while fulfilling one's core purpose—and it's an essential skill in an age of unforeseeable disruption and volatility.[104]

Consequently, they note, "by encouraging adaptation, agility, cooperation, connectivity, and diversity, resilience-thinking can bring us to a different way of being in the world, and to a deeper engagement with it."[105]

Those who propose more precautionary solutions to challenging social problems often ignore this uncanny ability of individuals and institutions to "bounce back" from technological disruptions and become more resilient in the process. Part of the reason precautionary thinking sometimes dominates discussions about emerging technologies is that many people hold a deep-seated pessimism about future developments and a belief that, with enough preemptive planning, they can anticipate and overcome any number of hypothetical worst-case scenarios. Consequently, their innate tendency not only to be pessimistic but also to want greater certainty about the future means that "the gloom-mongers have it easy," notes author Dan Gardner.[106] "Their predictions are supported by our intuitive pessimism, so they *feel* right to us. And that conclusion is bolstered by our attraction to certainty."[107] Clive Thompson, a contributor to *Wired* and the *New York Times Magazine*, also notes that "dystopian predictions are easy to generate" and "doomsaying is emotionally self-protective: if you complain that today's technology is wrecking the culture, you can tell yourself you're a gimlet-eyed critic who isn't hoodwinked by high-tech trends and silly, popular activities like social networking. You seem like someone who has a richer, deeper appreciation for the past and who stands above the triviality of today's life."[108]

100. This section adapted from Adam Thierer, "The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation" (Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, November 2015), which will be published in the *Richmond Journal of Law and Technology* 21, no. 6 (2015), http://mercatus.org/publication/internet-things-and-wearable-technology-addressing-privacy-and-security-concerns-without.
101. See Adam Thierer, "Technopanics, Threat Inflation, and the Danger of an Information Technology Precautionary Principle," *Minn. J. L. Sci. & Tech*. 14 (2013): 309.
102. Ibid., 53–60.
103. Andrew Zolli and Ann Marie Healy, *Resilience: Why Things Bounce Back* (New York: Simon & Schuster, 2012).
104. Ibid., 7–8.
105. Ibid., 16.
106. Dan Gardner, *Future Babble: Why Pundits Are Hedgehogs and Foxes Know Best* (New York: Plume, 2012), 140–1.
107. John Seely Brown and Paul Duguid, "Response to Bill Joy and the Doom-and-Gloom Technofuturists," in Albert H. Teich, Stephen D. Nelson, Celia McEnaney, and Stephen J. Lita, editors, *AAAS Science and Technology Policy Yearbook* (Washington, DC: American Association for the Advancement of Science, 2001), 79.
108. Clive Thompson, *Smarter Than You Think: How Technology Is Changing Our Minds for the Better* (New York: Penguin, 2014), 283.

Luckily, as science reporter Joel Garreau reminds readers, "the good news is that end-of-the-world predictions have been around for a very long time, and none of them has yet borne fruit."[109] Doomsayers have a bad track record because they typically ignore how "humans shape and adapt [technology] in entirely new directions."[110] "Just because the problems are increasing doesn't mean solutions might not also be increasing to match them," Garreau correctly notes.[111]

In their 2001 "Response to Doom-and-Gloom Technofuturists," John Seely Brown and Paul Duguid note that "technological and social systems shape each other. . . . [They] are constantly forming and reforming new dynamic equilibriums with far-reaching implications." "Social and technological systems do not develop independently," they continue. Rather, "the two evolve together in complex feedback loops, wherein each drives, restrains, and accelerates change in the other."[112]

This is how humans become more resilient and prosper, even in the face of sweeping technological change. Wisdom is born of experience, including experiences that involve risk and the possibility of occasional mistakes and failures while both developing new technologies and learning how to live with them.[113] Citizens should remain open to new forms of technological change not only because doing so provides breathing space for future entrepreneurialism and invention, but also because it provides an opportunity to see how societal attitudes toward new technologies evolve—and to learn from that change. More often than not, citizens find creative ways to adapt to technological change by using a variety of coping mechanisms, new norms, or other creative fixes. Although some things are lost in the process, something more is typically gained, including lessons about how to deal with subsequent disruptions.

Case Study: The Rise of Public Photography

Consider the jarring impact that the rise of the camera and public photography had on American society in the late 1800s.[114] This case study has implications for the debate over wearable technologies. Plenty of critics existed, and many average citizens were probably outraged by the spread of cameras[115] because "for the first time photographs of people could be taken without their permission—perhaps even without their knowledge," notes Lawrence M. Friedman in his 2007 book, *Guarding Life's Dark Secrets: Legal and Social Controls over Reputation, Propriety, and Privacy*.[116]

In fact, the most important essay ever written on privacy law, Samuel D. Warren and Louis D. Brandeis's famous 1890 *Harvard Law Review* essay "The Right to Privacy," decries the spread of public photography. The authors lament that "instantaneous photographs and newspaper enterprise have invaded the sacred precincts of private and domestic life" and claim that "numerous mechanical devices threaten to make good the prediction that 'what is whispered in the closet shall be proclaimed from the house-tops.'"[117]

Despite the profound disruption caused by cameras and public photography, personal norms and cultural attitudes evolved quite rapidly as cameras became a central part of the human experience. In fact, instead of shunning cameras, most people quickly looked to buy one. At the same time, social norms and etiquette evolved to address

109. Joel Garreau, *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies—and What It Means to Be Human* (New York: Broadway Books, 2006), 148.
110. Ibid., 95.
111. Ibid., 154.
112. Brown and Duguid, *supra* note 106, 79, 82, 83.
113. Thierer, *Permissionless Innovation*, viii.
114. This section was condensed from Thierer, "Technopanics."
115. For a discussion of the anxieties caused by photography during this time, see Robert E. Mensel, *Kodakers Lying in Wait: Amateur Photography and the Right of Privacy in New York*, 1885–1915, Amer. Quar. 43 (March 1991): 24.
116. Lawrence M. Friedman, *Guarding Life's Dark Secrets: Legal and Social Controls over Reputation, Propriety, and Privacy* (Palo Alto, CA: Stanford University Press, 2007), 214.
117. Samuel D. Warren and Louis D. Brandeis, "The Right to Privacy," *Harv. L. Rev.* 4 (1890): 193, 195.

those who would use cameras in inappropriate or privacy-invasive ways. In other words, citizens bounced back and became more resilient in the face of technological adversity.

Although some limited legal responses were needed to address the most egregious misuses of cameras, for the most part the gradual evolution of social norms, public pressure, and other coping mechanisms combined to solve the "problem" of public photography. In much the same way IoT and wearable technology will likely see a similar combination of factors at work as individuals and society slowly adjust to the new technological realities of the time. The public will likely develop coping mechanisms to deal with the new realities of a world of wearable technologies and become more resilient in the process.

That being said, resiliency should not be equated with complacency or a "Just get over it!" attitude toward privacy and security issues. With time, it may very well be the case that people "get over" *some* of the anxieties they might hold today concerning these new technologies, but in the short run, IoT and wearable technologies will create serious social tensions that deserve serious responses.[118]

118. Adam Thierer, "Can We Adapt to the Internet of Things?," *Privacy Perspectives*, June 19, 2013, https://www.privacyassociation.org/privacy_perspectives/post/can_we_adapt_to_the_internet_of_things.