Why Tariffs on Chinese ICT Imports Threaten U.S. Cloud-Computing Leadership

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The practical effect of tariffs on key components used in cloud computing would be to advantage foreign technology competitors, thereby threatening U.S. leadership in both the adoption and provision of cloud computing services, and stunting U.S. growth.

Cloud computing—a technology model that enables on-demand delivery of information technology (IT) services such as applications, processing, and storage—has become a key enabler of the global digital economy. U.S. businesses, large and small alike, have pioneered both the development of cloud-computing services and the adoption of cloud computing to increase productivity, cut costs, and foster innovation—spending $70 billion on public cloud-computing services in 2017.[1] Unfortunately, the Trump administration's proposed tariffs of up to 25 percent on $200 billion of Chinese imports would target many key components that make cloud computing possible.[2] In theory, these tariffs have been undertaken to counteract unfair Chinese trade practices and improve U.S. competitiveness. But their practical effect would be to advantage foreign technology competitors, thereby threatening U.S. leadership in both the adoption and provision of cloud computing, and stunting U.S. economic growth. While contesting Chinese innovation mercantilism remains a laudable and necessary mission, the Trump administration should seek alternative policy measures that do not raise the cost of key productivity- and innovation-enhancing capital goods and services such as information technology and cloud computing.[3]

INTRODUCTION

Cloud computing has quickly become instrumental to the U.S. economy, as 93 percent of U.S. businesses rely on cloud computing to conduct business every day.[4] To deliver these services, more than 3 million data centers have been built across the nation, supporting jobs in all 50 states.[5] There are two kinds of cloud computing: public and private. U.S. companies have long led in the innovation and provision of public cloud-computing services, with Amazon, Microsoft, Google, IBM, and Oracle earning two-thirds of the share of the global market by the first quarter of 2018.[6] (Private clouds are similar in the sense they provide remote and shared computing services, but they are owned and operated by a particular organization for its own needs.) Yet U.S. leadership in cloud computing is by no means guaranteed to last, particularly as firms throughout the world invest heavily in cloud computing. Leading the pack is the Chinese tech giant Alibaba, which has vowed to match Amazon's cloud capabilities by 2019 and enjoys the extensive backing of the Chinese government in its quest to do so.[7]

The Information Technology and Innovation Foundation (ITIF) has long argued that contesting China's innovation mercantilism is a necessary endeavor.[8] However, the Trump administration's proposed tariffs would jeopardize the substantial benefits cloud computing can provide to the U.S. economy. As this report elaborates, the contemplated tariffs that would hit the U.S. cloud-computing industry would have at least four main consequences, none of which would bode well for the economy.

First, prices would rise, both for businesses and consumers. For instance, the Consumer Technology Association (CTA) estimates that a 25 percent tariff on printed circuit board assemblies, which are crucial components of the servers that power data centers, would increase prices by more than 6 percent and reduce consumption by nearly 12 percent in 2019. Similar figures hold for connected devices, covering everything from routers and modems (which enable cloud services) to smart watches and Internet of Things (IoT)-based products (which rely on cloud services for content delivery).[9] To the extent these increased costs are passed along as increased prices, consumers and businesses would be forced to choose between forgoing the technology purchases they were planning on making and cutting back elsewhere, such as on new jobs or expansion.

Second, cloud-services providers would have to cut costs. Companies that rely on cloud-related imports from China would have to find ways to absorb some of the cost increases. Lowering profit margins may force some businesses with less-flexible budgets—especially small businesses—to lay off workers.[10] But even the companies that do not have to cut jobs would have less funding to invest in building new data centers or to conduct the research and development needed to stay ahead of international competitors.

Third, cloud providers may be forced to invest elsewhere to remain competitive. U.S. cloud providers are already facing pressure to build more data centers in places like Europe—in light of new privacy laws—and if doing so means avoiding steep American tariffs, they may be more likely to accede because the physical proximity of a data center is not important

for many cloud users.[11] This is particularly concerning given an analysis by the Chamber of Commerce found that establishing a typical new data center creates 1,688 local jobs during construction, and 157 local jobs through normal operations going forward.[12]

Fourth, the tariffs threaten to disrupt finely crafted global supply chains for the manufacture of information-technology products—supply chains that cannot easily be reinvented in the short term without significant detriment to, and dislocation of, U.S industry. This is exemplified by the fact that Intel has estimated it would cost nearly a billion dollars to move one of their semiconductor chip packaging plants from China to an alternate location.[13] Moreover, in many cases, it may not even be feasible for U.S. tech companies to readily find suppliers for key components that can meet companies' needs for capacity, quality, and price.

U.S. enterprises increasingly depend on cloud computing as an essential business application.

Cloud computing has become an integral part of the global economy, with a global market of $260 billion last year, which is projected to grow by approximately $50 billion in each of the next three years.[14] Every American would feel the impacts of tariffs on goods that constitute key inputs to cloud computing and data services, through increased prices, jobs lost as companies make cuts or go out of business, and fewer data centers that would otherwise have brought jobs to communities across the nation. This report proceeds by outlining how cloud computing has become essential to the digital economy and then documenting how the Trump administration's proposed tariffs would inflict damage on cloud users, cloud providers, U.S. communities, and the overall U.S. economy.

CLOUD COMPUTING HAS BECOME AN INDISPENSABLE TECHNOLOGY PLATFORM

Cloud computing is the dominant computing paradigm of the modern global economy, reflected in part by analysts' expectation that the global market for cloud-computing services will grow to over $400 billion by 2020.[15] (To illustrate cloud computing's rapid growth, consider that in 2010 the worldwide market for cloud-computing services was just $68 billion.)[16] Public cloud computing allows businesses to access computing resources—such as databases, software applications, storage capacity, and computing power—on a pay-for-use basis over the Internet without having to incur the costs involved in building and maintaining the necessary IT infrastructure.[17] Cloud-based solutions, both public and private, offer users a wide range of benefits, among the most significant of which include scalability; operational efficiency; application and partner integration; data storage, management, and analytics; and enhanced security. For example, in manufacturing, cloud computing plays a key role in facilitating the research, design, and development of new products, which powers innovation, reduces product development costs, and speeds companies' time to market for new products and services.[18]

Cloud computing is typically delivered according to one of three service models, namely Software as a Service (SAAS), wherein the consumer uses a provider's application running on cloud infrastructure; Platform as a Service (PAAS), wherein consumers can use cloud infrastructure to deploy applications; and Infrastructure as a Service (IAAS), wherein users

can provision IT resources and run their own systems and applications on infrastructure offered by a cloud provider. Additionally, cloud computing is usually deployed in one of four different configurations: public cloud, hybrid cloud, community cloud, or private cloud.[19] A private cloud is used exclusively by one organization with multiple business units, and may be deployed either onsite or off-site. A community cloud is used exclusively by a specific group of organizations, often those sharing similar business interests or goals. For example, a community cloud may be provisioned for a group of federal agencies. In contrast to a private or community cloud, a public cloud is available for use by the general public. Lastly, a hybrid cloud refers to deploying an application or service across cloud computing infrastructure spanning two or more configurations (private, community, and public).[20]

U.S. enterprises increasingly depend on cloud computing as an essential business application. At least 93 percent of U.S. businesses use cloud technology in some form or another.[21] And according to the "2018 State of the Cloud Survey," which in January 2018 surveyed 997 IT professionals, 96 percent of respondents reported their enterprises depended on cloud computing.[22] That study further found that most enterprises use as many as five distinct cloud services.[23] Analysts estimate that in 2018, at least half of all U.S. information technology investment will be cloud-based, and will grow to 60 percent of all IT infrastructure and 60 to 70 percent of all software, services, and technology investment, by 2020.[24]

Yet cloud computing is not just for large enterprises. In fact, by offering small businesses an infinitely scalable, no-fixed-cost option to adjust their computer processing and data-storage needs, cloud computing has considerably leveled the playing field compared with larger competitors. The cloud-computing option lessens small businesses' need to invest in expensive, fixed-information technology equipment, enabling them to instead consume information technology as an on-demand service and scale consumption as their businesses grow. That is why small businesses use cloud computing at almost the same rate as large businesses.[25]

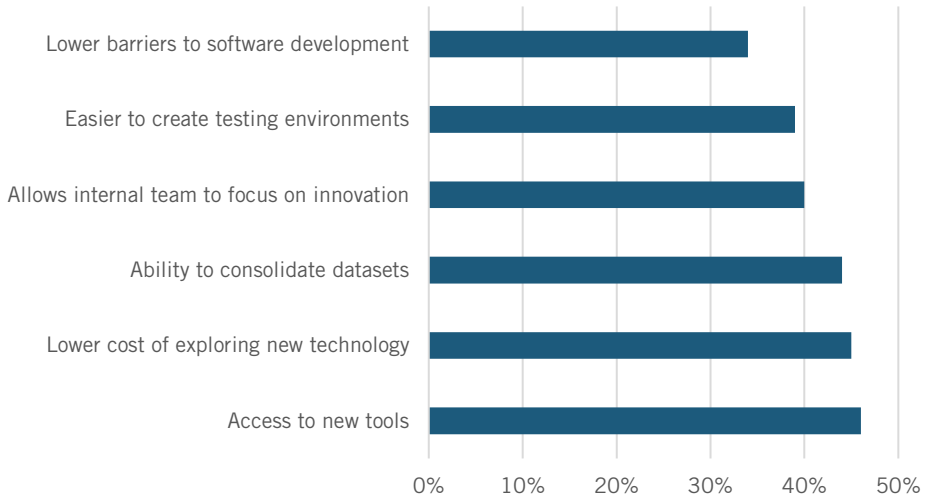
Small businesses use cloud computing services because they offer financial and operational benefits. For instance, a survey of 500 executives at young U.S. businesses found 69 percent of respondents' recent revenue growth had come, in part, from using cloud-based productivity technologies.[26] And because cloud-computing services are often provided by best-of-breed providers, they also enhance security—which explains why a survey of small business owners found 62 percent preferred cloud-based services because they were more secure and reliable.[27] Small businesses view cloud computing as an impetus for innovation, with 41 percent of the small business owners in a February 2017 survey reporting plans to increase their cloud-based technology investments, with a specific concentration on IoT and mobile-payment systems.[28]

This points to how cloud computing bolsters U.S. innovation and productivity growth, as it allows more rapid deployment and adoption of emerging technologies. For instance,

CompTIA's 2018 "Cloud Computing and IT Operations" report found that cloud computing acts an enabler to deploy emerging technologies, with 22 percent of surveyed companies already deploying cloud-based IoT implementations.[29] As Figure 1 shows, almost one-half of all businesses (502 across a range of sizes) surveyed in April 2018 reported that cloud computing played an important role in lowering the costs of exploring new technologies, accessing new tools, and consolidating datasets. Forty-one percent of respondents in the survey reported that cloud computing greatly enhanced their automation initiatives, while 40 percent stated cloud computing moderately enhanced them.[30] Cloud computing will also be the delivery mode for next-generation quantum computing, a new computing architecture that leverages principles of quantum mechanics to enable computing processes potentially tens of thousands of times faster than can be achieved today.[31]

In 2018, at least half of all U.S. information technology investment will be cloud-based, and will grow to at least 60 percent by 2020.

Figure 1: How Cloud Computing Enables Emerging Technology Initiatives[32]



Case Studies Demonstrating Cloud Computing's Importance to Businesses

Cloud computing has become an indispensable enabling technology for businesses across a wide range of industries, from agriculture and manufacturing to health care and education. The following five case studies profile how several companies in these sectors are leveraging cloud-computing applications as core enablers of their business.

SmartFarm

The future of agriculture increasingly lies in the cloud, with farmers leveraging cloud computing to aggregate and analyze data generated and transmitted from instruments such as sensors, satellite images, and weather stations to help them make better decisions about how best to manage their crops.[33] For instance, Chandra Krintz, a professor at UC Santa Barbara, has developed an application called SmartFarm that combines low-cost sensors, self-managing cloud systems, and data analytics to help farmers gather detailed data about their crops.[34] SmartFarm uses sensors to monitor soil conditions and moisture levels, combines them in the cloud with external data such as weather information and satellite images, and delivers customized analyses to farmers through a smartphone application that

also assists them in making optimal planting and yield-management decisions.[35] Similarly, Nicholasville, Kentucky-based SmartFarm Systems, Inc. delivers a cloud-supported, wireless monitoring and control system for remotely located irrigation pumps and environmental, soil moisture, and water-level monitoring devices.[36] The system helps farmers optimize irrigation of their crops.

Numerate

Numerate is a San Francisco, California-based technology platform company leveraging proprietary algorithms alongside the power of cloud computing to transform the drug-design process, with the aim of generating novel small-molecule drug leads for cardiovascular-disease targets.[37] Numerate's algorithms provide predictive models for molecular properties with accuracies comparable to laboratory testing, enabling scientists to search through billions of compounds to rapidly and efficiently identify those with the highest probability of activity against a specific disease target.[38] Numerate's application of computational bioscience combines knowledge of the biocode with exploding amounts of empirical data to clear the way for scientists to design new therapies in the cloud. Such approaches could dramatically reduce the cost of pharmaceutical development and expand the number of therapies that can be created and tested by moving medical research away from a "hit-and-hope" world of trial-and-error guesswork.[39]

Accuride

Accuride, based in Evansville, Indiana, is a leading manufacturer and supplier of wheels and wheel-end components to the North American and European commercial vehicle markets. It has leveraged cloud computing-based solutions to streamline its manufacturing operations.[40] As Paul Wright, Accuride's IT director, explains, before the advent of cloud computing, "At each plant, people on our lines were writing down things like how many parts they made, how many were scrap, what problems they had with the machines, etc." [41] Those pieces of paper were then used to write numbers onto a board every hour, and then entered once a day into an Excel spreadsheet, which was used on a daily basis to create reports for management, and transposed on a monthly basis into PowerPoint.[42]

To overhaul such an inefficient process, Accuride consolidated seven separate systems running more than 200 applications into a single, cloud-based, SAAS-delivered enterprise resource planning system, enabling Accuride to centralize shared information, standardize its systems and processes, enable secure remote access, and utilize robust data collection, reporting, and other tools.[43] As Wright explains, "Using web-based tools, we are able to understand manufacturing performance in real time, directly connected to the machines…. The level of visibility we have is almost like being on the factory floor." He continues, "Every time one of our machines cycles to produce a part, that signals across our ERP system that raw material has been consumed, and sends that signal through the cloud. We have full visibility, so we can measure operational performance based on that data."[44] The system also extends to Accuride's supply chain, with online portals the company's suppliers can use to see and fulfill their material orders.[45] As Accuride President and CEO Rick Dauch concludes, cloud computing has "essentially replaced the central nervous systems of

our company… positively impact[ing] nearly every aspect of our operations, from the shop floor to the top floor, while dramatically enhancing our ability to proactively address customer needs and swiftly respond to market and industry shifts."[46]

MakeTime

MakeTime, based in Lexington, Kentucky, simplifies the production of computer numerically controlled (CNC) parts. (CNC refers to the automation of machine tools by means of computers executing preprogrammed sequences of machine-control commands.) Specifically, MakeTime brokers machine-time capacity, collecting unused CNC machine time from qualified machine shops across the United States and managing the entire production process online.[47] (MakeTime has been dubbed "The Airbnb of CNC.") MakeTime's cloud-based software helps manufacturers overcome capacity shortages, streamline procurement and operational processes, and gain insight and transparency to what has traditionally been a complicated process. MakeTime keeps all its data in the cloud and runs all its algorithms and analytics related to understanding machine utilization availability and matches it to requested demand in real time from the cloud.

For businesses large and small alike, in industries ranging from agriculture and manufacturing to health care and transportation, cloud computing has become an indispensable platform technology critical to their success.

As Tim Shinbara, vice president of The Association for Manufacturing Technology explains, companies such as MakeTime provide a path to production for small and medium-sized enterprises (SMEs) that does not involve waiting on requests for proposals or vetting suppliers, while helping them innovate more effectively, get to market faster, and operate more efficiently.[48] MakeTime and firms like it significantly reduce information and expertise costs and burdens for SMEs. Shinbara notes that the MakeTime model can help strengthen or restore SMEs' supply chains without increasing capital requirements or operational expenditures.[49]

Vocareum

U.S. education is increasingly being delivered through the cloud. In fact, it is estimated that at least 50 percent of U.S. higher-education institutions have adopted cloud-based collaboration systems to improve information sharing across campuses.[50] Vocareum provides cloud-based learning and assessment labs for computer and data science classes, dramatically streamlining and improving the process of teaching students how to code. Vocareum's language-agnostic, enterprise-grade, cloud-based system automates tasks such as provisioning exams online, grading, and providing students immediate feedback on their work, by running tests on their code.[51] Vocareum supports over 10 million auto-graded homework submissions from over 100,000 students on its platform annually.[52]

Cloud Computing Generates Local and National Employment and Economic Growth

Beyond the benefits cloud computing generates for businesses consuming cloud-delivered services, the data centers through which tech companies deliver those services represent a source of economic and employment growth. One study estimates that the construction of a typical data center employs 1,688 local workers, provides $77.7 million in wages for those workers, produces $243.5 million in output along the local economy's supply chain, and generates $9.9 million in revenue for state and local governments.[53] Each year subsequently, that same data center supports 157 local jobs, paying $7.8 million in wages,

contributing $32.5 million to the local economy, and generating $1.1 million in revenue to state and local governments.[54]

It should also be noted that many of these data centers are located in smaller cities. For instance, a survey of some of the largest data centers that have just opened or are expected to open in the United States over the next several years includes facilities in Reno, Nevada; West Des Moines and Waukee, Iowa; Pryor, Oklahoma; and New Albany, Ohio.[55] The over three million data centers in the United States today support U.S. jobs across all 50 states.[56] Moreover, investments continue to grow. According to industry analysts at Data Frontier LLC, capex investments by "hyperscale Internet companies"—by which they predominantly mean cloud-computing service providers—reached $74 billion in 2017, and the industry has already invested one-third that amount ($27 billion) in the first quarter of 2018 alone.[57]

Of course, cloud computing creates jobs both in data centers that physically provide cloud-computing services as well as at large and small companies alike that develop cloud-based applications or provide cloud-delivered services. That is why, overall, Robert Cohen, in a report for the Economic Strategy Institute, estimates that "virtualized infrastructure"—including substantially cloud computing—will generate as many as 25 million new jobs over the next 15 years in the U.S. economy.[58]

TARIFFS WOULD HARM U.S. CLOUD COMPUTING USERS AND PROVIDERS

The third list of tariffs on imported Chinese goods proposed by the Trump administration—the so-called "list three" or "$200 billion list"—includes a number of goods that represent key inputs or components to cloud-computing hardware (i.e., computers and servers) or cloud-computing data centers (i.e., cabling and metal fittings) that would raise costs or disrupt supply chains for these goods, thus harming both U.S. providers and consumers of cloud-computing services. Indeed, the list contains a range of routers, switches, and servers that process data, as well as components such as motherboards and memory modules that fundamentally comprise computing equipment.[59] Final tariff rates have yet to be determined but could range from 10 to 25 percent. Specific examples of components affected include, among others:

- 8471.50 and 8471.60 items. Parts of automatic data processing machines
- 8473.30.11 Printed circuit assemblies (especially for the machines listed in 8471)
- 8517.62.00 Machines for the reception, conversion, and transmission or regeneration of voice, images, or other data, including switching and routing apparatus[60]
- 8517.69.00 Other apparatus for transmission or reception of voice, images, or other data, including for communication in a wired or wireless network
- 8534.00.00 Printed circuits
- 8537.10.91 Power supply, connectors, and distribution units
- 8544.20.00 Power and coaxial cables[61]

Cloud Users

While U.S.-based cloud-computing providers would bear some of the increased costs engendered by tariffs, a considerable share of the costs would likely get passed onto cloud users. Indeed, the biggest negative effect of the proposed tariffs would be on the wide array of businesses, nonprofits, and government organizations that rely on cloud computing as an essential part of their business. As prices for goods representing key components and inputs into the computers, servers, and data centers that fundamentally enable the delivery of cloud computing increase, the cost of delivering cloud-computing services in the United States will inevitably rise. When that happens, organizations and individuals will be able to invest less in cloud-computing services—just as they would be able to invest less in ICT-based capital goods when tariffs are applied directly on them—which would lower the rate of productivity growth, and thus economic growth, in the United States.[62]

This is likely to particularly impact small businesses. Lacking the financial reserves of larger enterprises and often being strapped for cash themselves, small businesses and start-ups are less able to absorb such price increases. (For instance, a recent study of small manufacturing enterprises in the U.S. mid-Atlantic region found that 40 percent could not even cover their working-capital costs.)[63] For small businesses, the added costs to cloud computing the tariffs would cause draws resources away from investments they could otherwise be making, including increased investment in research and development, new hires, new machinery, and expanded facilities.

More generally, tariffs compel companies to invest less into new systems, like cloud computing, that could substantially increase their efficiency and productivity. Lower rates of productivity growth harm everyone, because when workers cannot leverage cloud technology to be more efficient, they get less done on any given day, providing less value to their employer and thus lessening their ability to command a higher wage. Similarly, this inefficiency drives prices to increase even further, because companies cannot afford the investments that would allow them to produce goods more quickly and cheaply. This puts a strain on consumers' wallets, first on products directly related to cloud services, and then on nearly everything they buy, as the economy suffers from the high prices caused by a less-productive society.

Cloud Providers

The tariffs proposed by the Trump administration come at a time when U.S. leadership in cloud computing is being fiercely challenged by firms from around the world, including competitors from China and Europe. As noted, U.S. leadership in advanced technologies like cloud-computing is by no means assured. China in particular has made leadership in cloud computing a core objective of its "Made In China 2025" strategy.[64] This is underscored by Simon Hu, president of Alibaba Cloud, who in 2015 "[vowed] to match or surpass Amazon in four years in terms of customers, technology and worldwide scale."[65] Unnecessarily raising costs for cloud-computing providers in the United States makes their services more expensive to provide and thus risks reducing revenues that could be reinvested in R&D and new facilities.[66] Moreover, as the cost of providing cloud services in

the United States artificially rises due to the tariffs, other countries and regions are made relatively more cost-competitive, which may unintentionally induce the shift of some new data centers to other countries. With Europe introducing restrictive data-privacy regulations as part of its General Data Protection Regulations (GDPR), which European countries are already using a lever to try to get more U.S. cloud providers to open up additional data centers in Europe, the last thing U.S. companies need is new tariffs that raise their operational costs. These additional costs could be a deciding factor in making at-the-margin investments in data centers outside the United States (such as in Europe) more attractive.

Assessing the Costs

More than 80 percent of the benefits generated by information technology—of any type, be it cloud computing or the use of smartphones—stems from its adoption and use, not its production.[67] This is why tariffs on productivity- and innovation-enhancing intermediate goods like ICTs hurt economic growth so substantially.

The Trump administration contends tariffs on Chinese products will help U.S. tech industries; the reality is they would have the exact opposite effect.

In March 2018, ITIF modeled the impact of tariffs broadly applied to U.S. imports of ICT products from China. ITIF found that that a 10 percent tariff levied on Chinese ICT imports would slow the growth of U.S. output by $163 billion over the next 10 years, while a 25 percent tariff would slow output by $332 billion. For the average American household, this slower economic growth would mean $150 to $306 less income in the 10th year after tariffs were applied.[68]

Others have since analyzed the impact of tariffs on products identified specifically on the $200 billion list. For instance, CTA estimates that tariffs on printed circuit assemblies (8473.30.11) would mean companies that depend on these assemblies—virtually every electronics manufacturer and users thereof, including data centers—would face greater costs, with a reduction in their purchaser spending power on the order of $900 million (10 percent tariff case) to $1.8 billion (25 percent tariff case).[69] CTA estimates that the net impact to the U.S. economy of 10 percent tariffs on printed circuit assemblies would be a loss of $110 million, rising to $612 million if 25 percent tariffs were applied. Similarly, CTA estimates that the tariffs on the consumer-facing connected devices under 8517.62, including wireless networking products, would decrease their consumption by 6 to 12 percent, and that Americans would have to pay higher prices on the order of $1.6 billion (10 percent tariff case) to $3.2 billion (25 percent tariff case). CTA estimates the overall impact on the U.S. economy from tariffs on products contained in the 8517.62.00 line alone would range from $411 million (10 percent tariffs) to $1.8 billion (25 percent tariffs) in 2019.[70]

While these are estimates, they firmly reinforce the point that artificially raising the cost of productivity- and innovation-enhancing capital goods such as IT products by levying tariffs on imports from China will raise costs, decrease funds available for IT investment, lower productivity growth, and thus stifle U.S. economic growth. Moreover, American cloud leadership is also instrumental to overall American technological competitiveness, not to

mention economic and national security. U.S.-provided cloud-computing services can also bolster data security. For instance, the U.S. Central Intelligence Agency (CIA) will be one of 17 intelligence-related agencies using a customized, secure, cloud-based solution that will replace a broad range of legacy systems. Jason Hess, cloud security manager for the National Geospatial-Intelligence Agency, explains that use of a single set of infrastructure versus multiple, older data centers actually boosts security, because consolidation means less complexity, and less complex infrastructure is easier to lock down.[71] That's just one example of how cloud computing constitutes a key pillar of America's information technology infrastructure that represents a core source of U.S. national and economic security.

CONCLUSION

As ITIF has written, the Trump administration is to be commended for forcefully contesting China's innovation mercantilist practices. However, imposing tariffs on capital goods imports, especially IT imports, will hurt U.S. economic growth. These tariffs are poised to harm both U.S. cloud-computing users and providers and undermine U.S. cloud-computing leadership. Prevailing upon China to rescind its rampant innovation mercantilist practices is needed, but in doing so the Trump administration should not be compromising the competitiveness and productivity of America's information technology industries and the many sectors and consumers who rely on them.

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ACKNOWLEDGMENTS

The authors wish to thank Robert Atkinson and Nigel Cory for providing input to this report. Any errors or omissions are the authors' alone.

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