CHAPTER 1.2

Cross-Border Data Flows, Digital Innovation, and Economic Growth

Robert Pepper
John Garrity
Connie LaSalle
CISCO SYSTEMS

Forty years ago, the queen of England became one of the first individuals, and the first head of state, to transmit real-time electronic data over national borders.[1] In 1976, just three years after the United States connected ARPANET to London's University College and the Royal Radar Establishment in Norway, Her Majesty Queen Elizabeth II sent an email under the username "HME2."[2] Today over 3.2 billion people across the world have access to and use the Internet, and the flow of digital communication between countries, companies, and citizens, as a component of the "knowledge economy," has been recognized for years as a critical driver of economic growth and productivity.[3] Countries adept at fostering digital activity have witnessed the emergence of new industries as well as the accelerated development of traditional sectors.[4] However, despite the intensive and extensive growth of the global Internet, concerns over growing barriers to digital flows are mounting.

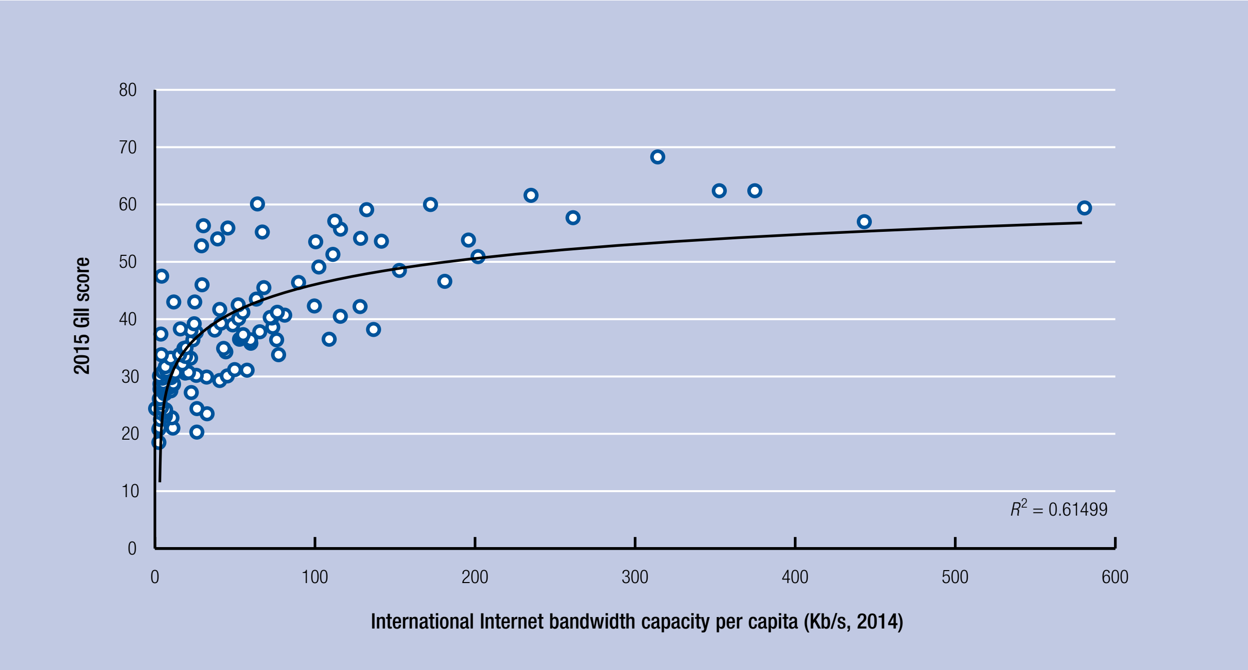
This chapter explores the impact of the free flow of data across national borders on innovation and growth. First reviewed is the literature on the impact of cross-border data flows on countries, companies, and individuals. The chapter then presents an original analysis of the growth of new services built on the free flow of trade through global digitization, and concludes by discussing policy guidelines that mitigate national concerns over data transmission while simultaneously maximizing the benefits of cross-border data flows.

THE GROWTH OF GLOBAL DIGITAL INDUSTRIES AND THEIR NATIONAL ECONOMIC IMPACTS

The development of the commercial Internet has occurred concurrently with a massive expansion of the global economy, which has experienced 6.6-fold growth in nominal terms—from US$11.1 trillion to US$73.5 trillion since 1980.[5] Internet protocol (IP) traffic continues to advance rapidly, with 2019 traffic projected to be 64 times its 2005 volume.[6] Global Internet bandwidth accounts for much of this growth, more than quadrupling between 2010 (<50 terabytes per second) and 2014 (>200 terabytes per second).[7] More importantly, total cross-border Internet traffic increased 18-fold from 2005 to 2012.[8]

This cumulative growth impacts all facets of national economies, not just their budding technology sectors—in fact, an estimated 75 percent of the Internet's benefit is captured by companies in traditional industries.[9] A wide range of positive economic impacts stems from the flow of digital data across borders. For example, 61 percent (US$383.7 billion) of total US service exports were digitally delivered in 2012, and 53 percent of total US imports were digitally delivered.[10] In absolute terms, the amount of digitally delivered exports and imports is even larger in the European Union, which digitally delivered US$465 billion in exports in 2012 and spent US$297 billion on imports. Digital trade is credited with

Figure 1: Cross-border data traffic and national innovation, by country



Sources: Cornell University, INSEAD, and WIPO 2015; ITU 2015b.
Note: The Global Innovation Index (GII) scores range from 0 to 100 (best). Kb/s = kilobits per second.

an estimated increase in US gross domestic product (GDP) of 3.4 percent to 4.8 percent in 2011 and with the creation of up to 2.4 million jobs, according to the United States International Trade Commission (US ITC).[11] The United Nations Conference on Trade and Development (UNCTAD) also estimates that about 50 percent of all traded services is enabled by innovation stemming from the technology sector, which includes the facilitation of cross-border data flows.[12] According to a newly released report by McKinsey & Company, data flows account for US$2.8 trillion of global GDP in 2014 and “cross-border data flows now generate more economic value than traditional flows of traded goods.”[13]

Beyond this economic impact, the free flow of data is, itself, a significant driver of innovation. It allows the sharing of ideas and information and the dissemination of knowledge as well as collaboration and cross-pollination among individuals and companies. Internet-enabled innovation requires an environment that encourages individuals to experiment with new uses of the Internet. In places with severe restrictions that inhibit digital collaboration, people are less likely to experiment and, as a result, innovation is less likely to emerge. Countries with an open Internet tend to be more innovative, as demonstrated in Figure 1, which illustrates the relationship between a country’s ability to share information and its capacity for innovation. The figure demonstrates that countries with a higher capacity to share data internationally (as reflected by a high international Internet bandwidth capacity per capita) tend to have a greater degree of national innovation as well, quantified in the figure by each country’s score on the 2015 Global Innovation Index, a leading measure of innovation capacity at the country level, which is calculated according to 79 different indicators.[14]

Additionally, a high degree of correlation is observed between various measures of potential data flow at the country level and outcome measures. One measure of potential data flow is Freedom House’s 2015 Freedom on the Net indicator, which measures 65 countries

Table 1: Correlation coefficients

Country correlation coefficients		Measures of potential data flows	
		International Internet bandwidth	Freedom on the Net (inverse scale; high to low)
Outcome measures	Global Innovation Index score	0.72	–0.49
	2015 NRI Economic impacts pillar	0.71	–0.49

Sources: Cornell University, INSEAD, and WIPO 2015; Freedom House 2015; ITU 2015b; World Economic Forum 2015.
Note: The Freedom on the Net scores range from 0 to 100, where 0 = most free and 100 = least free. Thus a lower score (greater freedom) for a given country is correlated with higher innovation and better economic outcomes.899

on the basis of obstacles to Internet access, limits on content, and violations of user rights. When correlated with the Economic impacts pillar of the 2015 Networked Readiness Index's Impact subindex (Table 1), which serves as an outcome measure, a clear relationship is demonstrated.

THE IMPACT OF CROSS-BORDER DATA FLOWS: FIRMS AND THE ENGINE OF ECONOMIC ACTIVITY

Cross-border data flows acutely impact the ability of firms to conduct business internationally.

In a recent report, Business Roundtable identifies at least six different areas of activity whereby firms may transmit data across national borders to support business operations. These include interconnected machinery, big data analytics, back-office consolidation, supply-chain automation, digital collaboration, and cloud scalability.[15] See Box 1.

Cross-border flows (data and voice, in particular) reduce costs related to both trade and transactions. This includes customer engagement (finding and fulfilling orders) as well as other operational costs associated with doing business. One recent report by the US ITC estimates that the Internet reduces trade costs by 26 percent on average.[16] Additionally, small- and medium-sized enterprises that utilize the Internet to trade on global platforms have a survival rate of 54 percent, which is 30 percent higher than that of offline businesses. Furthermore, those small- and medium-sized firms that are online are almost as likely to export as large businesses.[17]

At the firm level, a multitude of specific examples illustrate how the ability to transmit data internationally improves firm operations and performance. For example, Unilever, the consumer goods company with over 174,000 employees and operations across 190 countries, has developed a global enterprise data warehouse wherein it collects information from all of its operations to deliver full visibility into the entire system. The primary objective of this effort was to compile a comprehensive consumer database, enabling analysis at the most granular level possible. Additionally, aggregating information on the firm's operations helps identify areas where lowering costs and improving business performance can drive more affordable products for consumers.[18]

Similarly, Rio Tinto, the mining company with operations in over 40 countries across six continents, collects real-time data from its trucks and drills, which are then transmitted to its Processing Excellence Center (PEC) in Brisbane, Australia. Active monitoring and real-time adjustment of Rio Tinto's operations have already driven significant savings from operational efficiencies, with more savings certain to follow on the heels of new and emerging process innovation.[19]

At Cisco, the ability to transfer data across borders optimizes the company's operations. For example, the Research Triangle Park facility in Raleigh, North Carolina (Cisco's largest technical assistance center, which has more than 4,500 employees) provides around-the-clock tech support to customers 24 hours a day, 7 days a week, anywhere in the world. When customers and Cisco employees confront challenging hardware or software problems, technical experts are able to log in remotely, run diagnostic tools, and exchange data to and from one another seamlessly. This type of business activity fundamentally relies upon the free flow of data.[20] As the appendix to this chapter further illustrates, firms around the world innovate and optimize business outcomes by transferring data across borders. Moreover, when trade flows between businesses are curtailed, innovation may decelerate through the interruption of technology transfer or through the reduction of competition-driven development, which is why the uninhibited exchange of data is increasingly critical to productivity and growth.

Box 1: Firms' uses of cross-border data flows

In a 2015 report, Business Roundtable—an industry group representing companies with $7.2 trillion in annual revenues and 16 million employees—identified the following six mechanisms by which cross-border data flows drive business benefits to firms.

Interconnected machinery. Companies improve processes and optimize efficiency by interconnecting elements of the production chain, such as real-time monitoring of capital equipment to reduce downtime or to be able to prepare for immediate service replacements.

Big data analytics. Companies collect data gathered from various, or all, aspects of their operations across regions and apply advanced statistical analysis to be able to make better decisions, both for the business and for customer satisfaction.

Back-office consolidation. Companies centralize standard business operations to take advantage of economies of scale (e.g., human resources, accounting, payroll, support call centers, marketing, etc.) by improving buying power and eliminating overlap.

Supply-chain automation. Companies track inventory levels, process reordering automatically, and match supply and demand.

Digital collaboration. Companies increase communication and collaboration between teams.

Cloud scalability. Companies lower capital expenditure and cost structure of information technology (IT) hardware, infrastructure, software, and applications, all provided as a service, and they reduce capital investment in idle capacity, thus lowering the total cost of ownership and increasing business agility and resilience to failures.

Source: Business Roundtable 2015.

Figure 2: Freedom on the Net as a driver of innovation, by country

Sources: Authors' calculation; Barbier et al. 2016; Freedom House 2015; IMF 2015.
Note: Freedom on the Net scores range from 0 to 100, where 0 = most free, 100 = least free.

THE IMPACT OF CROSS-BORDER DATA FLOWS: INDIVIDUALS AND ENTREPRENEURS

At the individual level, the ability to access cloud-based information provides significant benefit. Individuals are increasingly storing more of their personal information online. Cisco's Global Cloud Index estimates that, by 2019, 2 billion Internet users (or 55 percent of all consumer Internet users) will use personal cloud storage, up from 1.1 billion users in 2014. Globally, consumer cloud storage traffic per user will be 1.6 gigabytes per month by 2019, compared to 992 megabytes per month in 2014.[21] Cloud-based services may be hosted in the domestic market or in other countries.

New entrepreneurs also benefit from access to infrastructure, platforms, and software from cloud-based services, which may reside in other countries. These include applications, data, middleware, operating systems, virtualization, servers, storage, and networking capabilities or equipment. Because of the ability to access these services on a pay-as-you-go model rather than committing to a large initial capital investment, the financial barriers to new business entry have fallen significantly. By one estimate, the cost for an entrepreneur to establish a business with a working prototype has fallen from around US$2 million in the 1990s down to less than US$50,000 and approximately six weeks of work.[22] Furthermore, depending on the business model, in some cases startup costs—when supported by the affordability of cloud-based infrastructure—can be as low as US$3,000.[23]

THE FREE FLOW OF DATA AND THE DIGITAL ECONOMY VALUE AT STAKE

Cisco's data analysis demonstrates that the free flow of data enables people and things to connect, which can improve processes and add tremendous value to any given economy. The potential bottom-line *value at stake* (defined as the combination of increased revenues and lower costs that is created or will migrate among companies and industries as a result of increasing the adoption of Internet technologies) is estimated to be US$29.7 trillion over the 2015–24 period.[24] This includes up to US$23.8 trillion in the private sector, where up to one-third of corporate profits may be at stake and where telecommunications service providers have an opportunity to capture US$1.8 trillion in new economic value. Up to US$5.9 trillion may be generated in the public sector as well. These improvements to the overall digital economy represent a potential annual GDP upside of 0.43 percent and potential employment creation of 2.7 million jobs worldwide.

Figure 2 highlights the relationship between the value at stake that can be generated by the digital economy and the Freedom on the Net score. The figure suggests that countries with higher Freedom on the Net scores are better poised to benefit from potential value at stake from digitization.

In other words, those countries and companies that have not positioned themselves in an environment that fosters open Internet practices may find innovation and economic growth hampered. Risks related to

Table 2: Examples of cross-border data flow restrictions

Restriction type	Restriction description
Local data storage	Restricts data flows by requiring specified data—often but not always personal information—to be stored on local servers. May also require specific applications or services to operate in-country, processing data locally to avoid offshore transfer.
Data protection	Restricts data flows through the application of data privacy laws with adequacy and/or consent requirements that cannot reasonably be met without local data storage.
Geolocation data privacy	Restricts data flows by preventing the collection, disclosure, transfer, or storage of geolocation data without an individual's consent.
Traffic routing	Affects data flows by requiring communications providers to route Internet traffic in a specific way.

Source: Business Roundtable 2015.

cybersecurity also slow innovation, as demonstrated by new Cisco survey research, wherein senior executives have determined that cybersecurity concerns have forced their companies to drop some mission-critical projects. Specifically, 39 percent of the 1,014 executives surveyed state that their organization has "halted a mission-critical initiative due to cybersecurity concerns." In Cisco's survey, 71 percent of all respondents somewhat or strongly agree that cybersecurity threats—both potential and actual—hinder innovation. Furthermore, 60 percent somewhat or strongly agree that cybersecurity risk dampens smart and connected product development, a critical element on the path to digitization.[25]

RESTRICTIONS ON CROSS-BORDER DATA FLOWS

The Internet was architected with protocols to identify the fastest possible route to transmit packets of data between any two points. However, increasing concerns of national governments around privacy, security, and local competition have resulted in some policy and regulatory impediments. Difficulties arise when overly restrictive regulations on cross-border data flows create trade barriers and impact business models. Overly burdensome regulations can slow or prevent business transactions, which increases costs and obstructs the delivery of products to the market. Examples of these restrictions, as noted by Business Roundtable, are included in Table 2.

The number and impact of restrictions that are implemented around the world appear to be increasing. The US ITC identifies localization requirements as a barrier for 82 percent of large firms and 52 percent of small- and medium-sized enterprises in the digital communications sector. Localization mandates are the most frequently identified digital trade barrier.[26]

These restrictions impose significant business costs. The burden of compliance related to both cost and logistics can slow or stop business activity and limit innovation. For example, one analysis estimates that disruptions to cross-border data flows and services trade could result in a negative impact on the European Union of up to 1.3 percent of GDP as well as a potential drop in EU manufacturing exports to the United States of up to 11 percent.[27] In seven different countries and regions of the world studied in one analysis, data localization requirements would also result in lower GDP.[28] Conversely, efforts to decrease barriers to cross-border data traffic have been shown to drive growth and, based on 2014 estimates, the removal of obstacles to the flow of data could increase GDP by 0.1 percent to 0.3 percent in the United States.[29]

THE PATH FORWARD: BALANCING GROWTH, DATA FLOWS, AND NATIONAL CONCERNS

As demonstrated above, the benefits of cross-border data flows are significant. Additional empirical work needs to be done, however.[30] And there are still cases where national concerns over privacy, security, and local economic activity may prompt regulations to curb some flows. In those instances, we propose the following guidelines (see Box 2 for examples):

- Minimize fragmentation by ensuring that any policy actions are least-trade-restrictive to achieve legitimate public policy objectives.
- Carefully craft regulations that are as narrow in scope as possible, with clearly articulated goals.
- Coordinate globally to minimize conflicts in regulations between different jurisdictions.
- Evaluate the full costs of any proposed regulation and ensure that costs of compliance do not outweigh the quantifiable benefits.
- Adhere to trade obligations.

In sum, any limitations on cross-border data flows should address specific concrete—not merely

Box 2: Country examples: Singapore and the Netherlands

Steps taken in several economies embody the spirit of the proposed guidelines, illustrating the feasibility of their implementation across national boundaries. For example, the government of Singapore has promoted data centers in an effort to attract their establishment by private or third party entities within its borders.[1] Additionally, Singapore's Personal Data Protection Commission (PDPC) has actively engaged industry in the development of good practices in data management, including those that regard the transfer of data.[2] Furthermore, guidelines for industry compliance with the Personal Data Protection Act (2014) developed by the PDPC have been narrow in scope and organized by sector, and developed in consultation with industry.

While Singapore has enhanced its presence as a global leader in digital transfer by emerging as a major hub for finance and services, the Netherlands has done so by serving as a major port for traded goods as well as a hub for European data traffic. Despite taking different routes to become more connected, both economies have recognized the importance of digital flows, including those both internally and externally facing. Supporting this notion, in the March 2016 report on digital globalization, the McKinsey Global Institute (MGI) finds that global flows of goods, foreign direct investment, people, and data contribute structurally to economic growth by increasing productivity.[3] Assessing MGI's two most highly ranked economies in country connectedness, Singapore (1st) and the Netherlands (2nd) both also rank in the top 10 for data flow, underscoring the crucial significance of open borders for data transfer and, subsequently, global competitiveness and innovation.

Notes

1 See the Singapore, Ministry of Communications and Information website at http://www.mci.gov.sg/web/content/infocomm-media-masterplan/preliminary-ideas/establish-agile-pervasive-and-trusted-icm-infrastructure/digital-harbour.

2 See PDPC Singapore 2016.

3 Manyika et al. 2016.

theoretical—problems, be least intrusive, be minimally restrictive, and, if possible, be time-bound. In cases where market-driven forces justify fragmentation because of business-enhancing reasons, such as when intellectual property may be affected, segmentation should be driven by the market rather than by government requirements.

These actions would minimize any collateral damage done to the economy imposing restrictions, and they would ensure that the Internet continues to serve as a driver of innovation, economic growth, and social development.

NOTES

1 Wired.com 2012.

2 History.com Staff 2010.

3 Katz 2012; ITU 2015a.

4 Pélissié du Rausas 2011.

5 IMF 2015.

6 Cisco VNI 2015.

7 TeleGeography, available at https://www.telegeography.com/research-services/global-bandwidth-research-service/.

8 Manyika et al. 2014.

9 Pélissié du Rausas 2011.

10 Meltzer 2014. Note that a major challenge for understanding just how potent this impact is, however, is the lack of data available.

11 US ITC 2014.

12 Lee-Makiyama 2015; UNCTAD 2009.

13 Manyika et al. 2016, p. 2.

14 Cornell University, INSEAD, and WIPO 2015.

15 Business Roundtable 2015.

16 US ITC 2014, p. 65.

17 Austin and Olarreaga 2012.

18 Castro and McQuinn 2015.

19 Castro and McQuinn 2015.

20 Moore 2015.

21 Cisco 2015.

22 Center for an Urban Future 2012; Mulas, Minges, and Applebaum 2015.

23 Mulas, Minges, and Applebaum 2015; Mytton 2010.

24 Barbier et al. 2016.

25 Barbier et al. 2016.

26 US ITC 2014.

27 Bauer et al. 2013, p. 3; Castro and McQuinn 2015.

28 Bauer et al. 2014.

29 Castro and McQuinn 2015; US ITC 2014.

30 For example, quantifying firm-level impact of new or existing processes enabled by cross-border data flows.

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Appendix:
Examples of firm-level cross-border data flows

Alliance Medical

Alliance Medical has been a pioneer in the trend of remote interpretation and diagnosis of medical images—such as x-rays, ultrasounds, and magnetic resonance imaging (MRI) images. This service reduces wait times and improves the expediency of diagnoses. In addition to the efficiency cost savings, offloading these tasks also allows doctors to spend more time with patients.

Caterpillar

Caterpillar is a global leader in the manufacture of heavy machinery and engines for use in industries from construction and mining to heavy-duty transportation. Real-time sensors in their products monitor performance data and transmit via cellular and satellite connectivity, allowing users to remotely analyze and monitor assets. This allows customers to identify underutilized machines, thus maximizing efficiency, and to make better equipment placement decisions, thus creating substantial cost savings for customers. Cross-border data flow restrictions, such as constraints on the movement of Global Positioning System (GPS) data, may limit Caterpillar's ability to offer such advanced services in certain markets.

Boeing

Boeing has developed a real-time information tool, the Airplane Health Management (AHM), that gathers and transmits data in real time to maintenance crews on the ground. The data are sent across borders (while aircraft are in the air) and helps to reduce delays, midflight turn-backs, and cancellations. A single Boeing 737 engine produces up to 20 terabytes of data every hour in flight. Data are analyzed in real time, even mid-flight, to find and diagnose problems. Any issues are relayed to waiting airline maintenance personnel at the aircraft's next airport destination. The crews can then meet the aircraft with the appropriate airplane parts to make necessary repairs. This sort of intelligence aids operators in spotting trends, eliminating inefficiencies, saving money, and reducing wait times.

General Electric (GE)

GE has embedded advanced sensors in a wide array of machinery to improve the performance of industrial equipment and machines purchased by its customers. The sensors remotely capture performance data from around the globe; these data are used to improve product reliability, safety, and efficiency. For example, in aviation, GE monitors sensor data from aircraft engines around the globe, thus optimizing engines, to help airlines anticipate maintenance issues and address them before aircraft need to be grounded, saving time and money for airlines and travelers. This sensor system saves airlines more than US$2 billion per year worldwide because the sensor technology reduces delays and cancellations caused by aircraft maintenance needs—a capability predicated on the ability to aggregate and analyze sensor data supplied from locations to generate savings for individuals, governments, and businesses across the globe.

MasterCard

As a global payments industry leader, MasterCard connects consumers, financial institutions, merchants, governments, and businesses through electronic payments. The company processes payment transactions initiated in more than 40 million locations in more than 210 countries and territories. Global payment services are inherently dependent on cross-border data flows because each payment transaction requires transfers of payment transaction data between the merchant, the merchant's bank, MasterCard, and the consumer's bank. MasterCard enables merchants to engage in international trade and sell goods and services to foreign travelers. Even when the merchant, the consumer, and their banks are all based in the same country, MasterCard may leverage its global operations hub to add value to the transaction and facilitate safe, efficient, and cost-effective transactions. However, some countries impose restrictions that require local processing of all electronic payment transactions. In doing so, restrictions can force the building or replication of costly infrastructure domestically; this cost may then be passed onto consumers.

Royal Dutch Shell

Royal Dutch Shell has over 150,000 employees across 90 countries and is headquartered in the Netherlands. As one of the world's largest oil and gas companies, it also has a global computing footprint with three main global data centers. Shell uses these computing resources to manage and analyze the data generated by sensors in its wells, particularly from sensitive, low-power sensors that generate high-resolution seismic data. Transmitting data to the global data centers, these sensors are able to detect resources in wells thought to have run dry.

Tesco

Tesco is a global retailer with stores in 12 countries in Asia, Europe, and North America. The consumer goods giant processes real-time data from its electronic shelves to make national pricing changes instantly as well as to predict when products on its shelves need to be reordered, thus preventing understocking and lost revenue. These benefits are passed on to customers in the form of better service, fresher ingredients, lower prices, boosted convenience, and fully stocked shelves. Tesco also combines weather forecasts for each location, updated several times a day, to adjust deliveries and refrigeration needs to prevent food spoilage.

Volvo

Volvo is a Swedish vehicle manufacturer employing over 115,000 people, with operations in over 190 countries. The company embeds real-time vehicle location data and diagnostic information and transmission capabilities into its vehicles and allows for their systems to alert drivers to needed repairs or software upgrades, as well as locating lost or stolen vehicles during emergencies. The company enables customers to gather data on all of their trucks for real-time monitoring, optimizing vehicle and fleet fuel efficiency.

Walmart

Walmart is the world's largest retailer, with over 11,000 stores in 27 countries employing over 2.2 million people worldwide; it maintains e-commerce websites in 10 countries. The company tracks its performance and global operations by collecting data on all aspects of its business, centralizing data, and deploying shared services (such as human resources support with cloud-based platforms). Virtualizing support operations and back-office consolidation helps to reduce the duplication of hardware and software and to increase operating efficiency through economies of scale. Data flow restrictions can prevent such efficiency-enhancing innovations and in the long run discourage larger job-creating investments in other areas of the business.

Sources: Business Roundtable 2015; Castro and McQuinn 2015.