Embracing the Self-Service Economy

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Executive Summary

We estimate that if self-service technology were more widely deployed, the U.S. economy would be approximately $130 billion larger annually, the equivalent of an additional $1,100 in annual income for every household.

The past decade has witnessed a rapid growth in self service that allows consumers to take on the traditional role of a service worker in the provision of a service. Self service has long existed—think of placing a call by dialing a telephone instead of using a telephone operator or pressing a button in an elevator instead of using an elevator operator—but its importance has grown as advances in information technology (IT) have created many opportunities to leverage self-service technology for large gains in efficiency and convenience. Using computer kiosks, airline travelers check in to their flights; on the Internet, consumers purchase products without ever speaking to a sales agent; and, using a mobile phone, customers check their bank balances and transfer funds. Self-service technology continues to become more efficient and more convenient, and, as a result, increasingly organizations, including businesses, non-profits and governments, are using self-service technology to operate more productively and to better serve their customers.

Self-service technology has already transformed entire industries, from ATMs in banking to e-commerce in the travel industry, resulting in significant savings for businesses which are passed on to consumers in the form of lower prices and better service. However, even though self-service technology has generated a wide range of benefits and savings for consumers, businesses, and government, it is only the beginning. Over at least the next decade, self-service technology has the potential to be a major force for growth in productivity and improvements in quality of life. We estimate that if self-service technology were more widely deployed, the U.S. economy would be approximately $130 billion larger annually, the equivalent of an additional $1,100 in annual income for every household.

These savings could not be coming at a more crucial time. Most national economies will need the power of self-service technologies if they are to avoid serious

economic problems stemming from significant growth in the number of retirees, a situation that will be particularly acute in Europe, Japan, and the United States. In the United States, for example, the number of retirees for every 1,000 working age adults is projected to grow from 213 today to 346 by 2030. For Social Security recipients in 2030 to not see a decline in their inflation-adjusted payments without workers seeing a decline in their after-tax incomes, economic productivity will have to increase by 62 percent. Unfortunately, the Social Security Administration estimates productivity will grow just 40 percent. As a result, in 2030, either worker incomes after Social Security taxes are deducted will be significantly lower, or Social Security benefits will be lower, or both. Self-service technologies promise to be a major source of needed productivity growth, enabling the United States, Japan, Europe, and other nations facing demographic challenges to realize such growth without reductions in wages or benefits.

But these benefits will not automatically occur unless the right policies are in place and the wrong ones are avoided. First, governments should avoid putting in place restrictions on self-service business models and processes. This means that policymakers must resist the efforts of special interest groups that press for restrictions in technology to protect their economic or social interests at the expense of the average citizen. Second, where appropriate, governments should proactively promote self-service delivery of government ser-

vices. For example, governments should pass along to citizens the savings from using lower-cost self-service options. Governments should also help create a climate conducive to expansion of self-service technologies. This means that government should support the development and deployment of technologies that enable self-service, like broadband, electronic IDs, and mobile payment systems. In the United States in particular, Congress should increase the minimum wage thereby providing firms with more incentive to invest in self-service technology, while at the same time helping to boost the incomes of low income Americans. In addition, Congress should establish an academic Center of Excellence to develop best practices for accessible design for self-service technology. Finally, we recommend that policymakers establish stronger safety nets for workers adversely affected by technological change so that the workforce can more easily adapt to a rapidly changing economy.

Self-service technology offers a broad set of benefits to consumers and businesses and has the potential to contribute even more to our national prosperity and quality of life. While self-service technology is widespread, it is still relatively new and will only continue to improve in quality over time. However, policymakers must avoid enacting policies to restrict self-service while at the same time putting in place appropriate policies to stimulate the self-service economy to realize these benefits.

Embracing the Self-Service Economy

Over at least the next decade, self-service technology has the potential to be a major force for growth in productivity and improvements in quality of life. However, policy-makers must avoid enacting policies to restrict self-service while at the same time putting in place appropriate policies to stimulate the self-service economy to realize these benefits.

O ver the past decade a confluence of factors—including technological advances and the emergence of new business models—have contributed to a rapid growth in information technology (IT)-enabled self service that allows consumers to take on new roles in the provision of services. Using computer kiosks, airline travelers check in to their flights; on the Internet, consumers purchase products without ever speaking to a sales agent; and, using a mobile phone, customers check their bank balances and transfer funds. Self-service technology continues to become more efficient and more convenient, and, as a result, increasingly organizations, including businesses, non-profits and governments, are using self-service technology to operate more productively and to better serve their customers. Today, self-service technology has become a fixture in most Americans' lives to the point that the technology is often taken for granted.

However, even though self-service technology has generated a wide range of benefits and savings for consumers, businesses, and government, it is only the beginning. Over at least the next decade, self-service technology has the potential to be a major force for growth in productivity and improvements in quality of life. Most national economies will need the power of self-service technologies if they are to avoid serious economic problems stemming from significant growth in the number of retirees, a situation that will be particularly acute in Europe, Japan, and the United States. In the United States, for example, the number of retirees for every 1,000 working age adults is projected to grow from 213 today to 346 by 2030. For Social Security recipients in 2030 to not see a decline in their inflation-adjusted payments without workers seeing a decline in their after-tax incomes, economic productivity will have to increase by 62 percent. Unfortunately, the Social Security Administration estimates productivity will grow just 40 percent. As a result, in 2030, either worker incomes after Social Security

taxes are deducted will be significantly lower, or Social Security benefits will be lower, or both.[1] Self-service technologies promise to be a major source of needed productivity growth, enabling the United States, Japan, Europe, and other nations facing demographic challenges to realize such growth without reductions in wages or benefits.

Unfortunately policymakers and government leaders do not always recognize the value of the self-service economy nor appreciate its importance to increasing standards of living. If self-service technology were more widely deployed, the U.S. economy would be approximately $130 billion larger annually, the equivalent of an additional $1,100 in annual income for every household.

But these benefits will not automatically occur unless the right policies are in place and the wrong ones are avoided. This report provides an overview of the benefits of self-service technology and the current trends in the field. It also discusses the policy implications of the self-service economy and recommends, for policymakers and government leaders, the following:

- Resist and overturn policies that restrict business use of self-service technologies

- Support "prosumer" technologies like broadband, electronic IDs, and mobile payment systems

- Encourage greater government use of self-service technology

- Support creation of a "Center of Excellence for Accessible Design in IT-enabled Self Service"

- Increase the minimum wage in order to boost self-service technology adoption

- Provide stronger safety nets for workers adversely affected by technological change

The self-service economy is a vital component of the IT revolution—the principal driver of the economy— and success with self-service technology is critical to creating a more intelligent and connected world.

What is self service?

Self service is the process by which consumers engage in all or a portion of the provision of a service or product. Self service has long existed—think of do-it-yourself homeowners doing the work of professional contractors, or self-help books substituting for therapists—but its importance has grown as IT has created many opportunities to leverage technology for large gains in efficiency and convenience. Many of these changes have become ingrained into Americans' way of life. Telephone operators have been replaced by automatic telephone switching that lets individual dial a phone number directly. Elevator operators have been replaced by electronic control systems that let people operate elevators directly. At bowling alleys, players can simply push a button to activate automatic pinsetters and reset the bowling pins, rather than using pinboys for this function. At grocery stores, shoppers pick out their own items rather than taking a list to a central counter and having a clerk get their goods for them.

With self service, the consumer fills a specific service role, such as bagging her own groceries, which a service employee would otherwise have to complete. Self service is different from automation, although there are similarities in that they both involve making a service more efficient. Automation is used to limit the tasks a service employee must complete, such as a retailer having a cashier use a bar code scanner to automatically identify and price an item rather than having to enter the price manually. Gas stations provide a good example of the distinction between self service and automation: self service allows a consumer pump to her own gas in lieu of an attendant, whereas automation allows an automatic car wash to replace a crew that washes cars by hand.

BENEFITS OF SELF SERVICE

The self-service economy has grown because self service provides benefits to consumers, organizations, and the economy as a whole.

Benefits for consumers

Consumers often have the option of choosing to use self-service technology: at a bank, a customer may choose between using a teller and using an automated teller machine (ATM); at a hotel, a traveler may choose between using a vending machine and using room service; and, at a gas station, a customer can choose between pumping her own gas and having an attendant do it. Consumers continue to choose self-service technology for a variety of reasons including faster service, more convenience, and ease of use. Price can

also be a factor when there are monetary savings associated with using the self-service option. For example, in most states, a driver pays a premium at a gas station for an attendant to provide the service, which is another way of saying that a driver receives a discount for pumping her own gas. In other cases, such as with banks, there is typically no extra fee associated with using the human teller versus using the ATM (although some banks have experimented with teller fees).[2]

Self-service technology can provide consumers greater convenience, accessibility, and ease of use. Convenience is a big factor: self-service technologies often make a business available 24 hours a day, seven days a week, rather than being limited to traditional working hours. Consumers often find self-service technology empowering; using the technology, the customer can control the service encounter and not feel rushed or pressured. While some businesses may think their customers prefer face-to-face encounters, this is not always true.[3] In a 2009 consumer survey, 44 percent of respondents indicated that they would prefer to use a hotel kiosk so that they would have no interaction with the clerk.[4] And often, when there are long lines at check in, even more guests prefer kiosk check-in. Some consumers also prefer to use self-service technology to protect their privacy. For example, patients at a hospital may prefer the anonymity of registering with a kiosk rather than a receptionist. Similarly, consumers may prefer to buy certain personal goods online rather than in-person at a retail store.

Self-service technology can also make service encounters more accessible for individuals with disabilities. For example, individuals with mobility disabilities may find online shopping more accessible than shopping in brick-and-mortar stores. Individuals can take advantage of accessibility options in Web browsers to access online applications and services. Kiosks can also offer features to make them accessible to individuals with disabilities, such as ATMs that have a headphone jack so that users can opt to use an audio interface to complete a banking transaction. Kiosks and Internet-based applications can also offer features such as multilingual interfaces to make services more user-friendly. For example, a car rental company may use a multilingual kiosk at an international airport to serve its foreign customers, thereby offering service in more languages than any single employee could possibly provide.

Benefits for businesses

Businesses must utilize IT to be competitive in the service economy. The IT revolution has led to a significant growth in productivity, and the firms with the highest level of IT investments show the highest levels of productivity per worker.[5] While most industries have successfully used IT to increase productivity of their back office workers and frontline service employees, there remains significant opportunity to have customers use technology to make the delivery of a good or service more efficient. By deploying self-service technology, companies can further apply the productivity benefits of IT to their business.

In banks, the average cost for an online transaction is only $0.20, a fraction of $4.25, the average cost of a transaction at a branch location.

For many types of services, the customer has always been a part of the production and delivery process.[6] For example, tax accountants have always relied on their customers to provide them with the information they need to complete the tax forms. From a business point of view, these customers are "partial employees" or "co-producers" because they make up an integral part of the service delivery process.[7] Self-service technology is one way for companies to manage these customers to help facilitate the service delivery.

Businesses invest in self-service technology because it reduces their costs and helps them provide a better quality product or service. Using self-service technology frees up workers that can either be reassigned to more profitable jobs or eliminated to reduce payroll costs. For example, a retailer that introduces self-checkout can reassign cashiers to sales or customer service jobs to increase sales and customer satisfaction or cut these jobs to save on overhead. Many organizations use self-service technology to free up workers from routine transactions so that they can focus on higher value work. For example, in hospitals, medical staff that previously focused on clerical work can instead focus on the health care needs of their patients. In banks, ATMs now handle most routine banking transactions thereby allowing tellers to focus on providing additional financial services and customer support. The

end result for the consumer is more efficiency, more convenience and better service. Self-service technology can also standardize the customer experience and allow companies to better target customers for up-selling. For example, a check-in kiosk at an airport can be programmed to try to sell travelers upgrades to their flights.

Using self-service technology can also help a company increase operational efficiency. For example, e-commerce can cut costs dramatically for a business and it can also cut inventory by 20 to 25 percent because it allows firms to respond more rapidly to orders. In addition, e-commerce can reduce incorrect orders and other inaccuracies and save companies billions. The savings from self-service technology can be seen at banks. As shown in Figure 1, the average estimated cost for an online transaction is only $0.20, a fraction of $4.25, the estimated cost of a transaction at a branch location.[8]

Benefits for the economy

The economy also benefits from self-service technology. Per-capita income growth is the single most important indicator of a nation's economic well being. And the growth in per-capita income is largely a function of the growth of productivity (the amount of output per hour of work). Higher productivity growth goes a long way in solving pressing societal problems, including Social Security shortfalls, lagging income growth, the national debt, and the ability of society to spend in key areas (e.g., transportation, environmental protection,

Figure 1: Estimated average bank transaction costs, by technology[9]
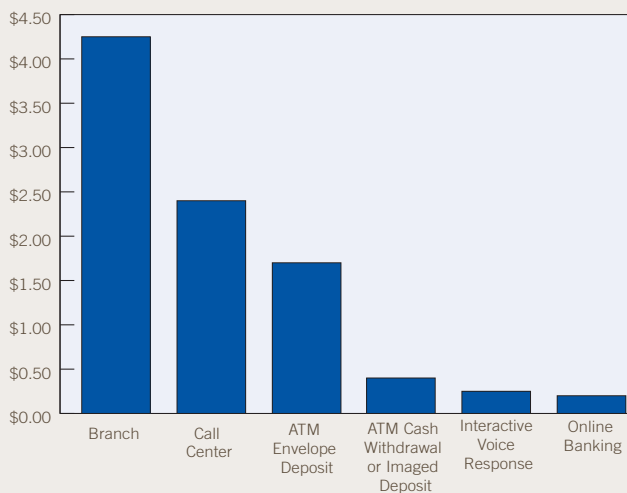
and health coverage). In addition, if advanced nations sustain or even increase their productivity growth, within a decade workers could have not only higher incomes, but also reduced overall work time and an overall increase in the time they can spend with their families and on leisure. The importance of embracing self service technology applies to not only the United States but also Europe, Japan, and other nations facing economic challenges from aging populations. Self-service technology is a labor-saving device and these savings translate into more efficient output. Embracing productivity-enhancing self-service technologies is necessary to maintain the current standard of living for their workers and retirees in these countries.

In most advanced economies, the most substantial gains in per-capita income and productivity growth until around the 1970s came from improving productivity in goods production (e.g., farming, mining, manufacturing, etc.). Companies used technology to automate processes and because these sectors were such a major part of economies, improvements in productivity had large effects on overall per-capita income. As efficiency gains were achieved in the goods sector, however, if economies wanted to grow, they had to find ways to boost efficiencies in the service sector. For the last 40 or so years companies have used technology to streamline many service processes, particularly what are called "back-office" processes, such as accounting, logistics and ordering, information processing and others. As a result, many of the opportunities for productivity gains have already been achieved there. The next big frontier for productivity is on what is called the "front office", aspects of business and government that deal with the customer in functions that largely entail an exchange of information (e.g., a ticket, for example, is simply a form of information, letting someone board a bus or enter a theatre). Self-service technology is critical because it enables improvement in the efficiency of a large array of processes in the economy, which in turn enables lower prices and higher wages.

The potential economic benefits of more use of self-service technology are substantial. We estimate that if self-service technology was more widely deployed, it would contribute an additional $130 billion to the U.S. economy annually. Put differently, this means that the self-service economy would create $1,100 in additional income per U.S. household.[10]

TYPES OF SELF-SERVICE TECHNOLOGY

Self-service technology allows a consumer to take on a role in the delivery of a service or product. In some instances, self-service technology is not necessary for self service. For example, both a hotel guest and a maid could clean a room—the decision as to whether the customer or the business provides the service is more a question of luxury than of capability. But self service is on the rise today because of the advances enabled by the IT revolution such as the Internet and mobile phones. In addition, self service is the natural outcome of technology that has reached maturity. When technology was new, it was often difficult to use and it required workers with specialized skills for operation. However, over time, self-service technologies have become more user-friendly to the point that the average person no longer requires a specialist to operate the technology.

Currently, most self-service technology uses one of four channels: electronic kiosks, the Internet, mobile devices, and the telephone. Some, but not all, of the applications delivered over these channels exclusively use self service. However, some services offer both pure self-service options as well as hybrid solutions that combine self-service technology with personal service. For example, at the airport travelers may use a kiosk to check in, but interaction with airline staff is necessary at the baggage drop. Similarly, a taxpayer using an online tax preparation service like Intuit's TurboTax may still talk by phone to one of its tax professionals for personal tax advice.

Electronic kiosks

Kiosks provide stand-alone solutions to provide users access to information or a service, such as checking an account balance at an ATM or checking in for a flight at an airport kiosk. Many of these kiosks replace small booths or workstations that previously required an attendant to complete a routine task. Today's technology makes kiosks more affordable and convenient. Advances in technology like touch screen displays, card readers, scanners, thermal printing, Power over Ethernet (PoE+), wireless networks, and the availability of broadband Internet access have made deploying consumer-friendly computer kiosks a cost-effective option for many services. As a result kiosk implementations have flourished: in 2008, self-service kiosk transactions in North America totaled $607 billion and will

likely reach $1.7 trillion by 2012.[11] Today, approximately 47 percent of kiosks solutions are being deployed in the retail sector, 41 percent in the hospitality and commercial services sector, and the remainder divided between health care, government, and other sectors.[12]

Advances in technology like touch screen displays, card readers, scanners, thermal printing, Power over Ethernet (PoE+), wireless networks, and the availability of broadband Internet access have made deploying consumer-friendly computer kiosks a cost-effective option for many services.

BANKING

Many banks and financial services providers offer self-service options. Automated teller machines (ATMs) are one of the earliest examples of self-service technology. First introduced in the 1970s, the technology has flourished. Today over 1.8 million ATMs are in operation in virtually every country, and globally consumers conduct over 44 billion transactions annually on ATMs.[13] With one ATM for every 284 households, the United States accounts for 14 billion ATM transactions annually, and over 90 percent of consumers use ATMs.[14]

As shown in Figure 2, the number of ATMs deployed in the United States increased sharply after 1996 when Visa and MasterCard began allowing surcharges on ATM transactions. Unlike other transactional fees, which are divided between the bank, the network operator and the ATM owner, ATM operators could collect the new surcharge fees. As a result, the business case for deploying ATMs became more appealing for both financial institutions and others. In recent years the number of transactions at ATMs has slowed or declined, in part due to the growth in point-of-sale (POS) cash-back options at retailers.[15]

The first ATMs were located at bank branches, but banks (and their customers) quickly saw the value of providing additional machines in convenient locations like shopping malls, grocery stores, and airports. The technology replaced the bank's need for tellers and also offered convenience to banking customers previously restricted to limited banking hours by giving them 24-hour access to their bank accounts seven days a week.
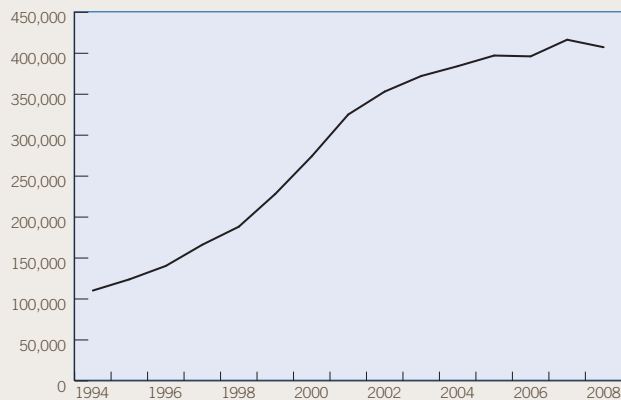
As technology has changed, ATMs have evolved to handle increasingly more complicated transactions and to provide customers greater convenience. Today's ATMs not only allow a bank's customers to make withdrawals, deposits, check balances, and make transfers, but ATMs may offer additional services, such as selling postage or concert tickets. Most ATMs also offer accessibility features such as voice prompts to aid visually impaired customers and multilingual options to better serve their customers.

With today's digital image processing technology, ATMs can also process deposits more efficiently through an ATM. Previously to make a deposit, a customer would have to place the cash or checks to be deposited in an envelope, place this envelope inside the ATM, and then a bank employee would have to come to the ATM daily to collect the deposits, open the envelopes, and process the transactions. Because the bank often could not verify the contents of the deposit, banks often imposed restrictions on the availability of funds deposited by ATMs. Consumer confidence with ATM deposits also suffered because without a detailed receipt, consumers had little evidence to back up their claims in the event of a dispute.

Today's ATMs are more advanced and can better handle check and cash deposits. Newer ATMs can automatically scan checks, use optical character recognition (OCR) technology to process the deposits in real time, and allow customers to instantly receive credit for the deposit. Consumers can also receive a receipt with a printed image of their check deposit, which provides them evidence of their deposit in the event of a dispute. In addition, by eliminating the envelope for

deposits, banks can eliminate up to 75 percent of the transaction cost. In the United States, this change was enabled by the Check Clearing for the 21st Century (the Check 21 Act) that gave digital images of checks the same legal status as the original paper check.[17] This legislation went into effect on October 28, 2004. Newer ATMs can also implement cash recycling and allow cash that is deposited into the ATM to be automatically processed so that the same cash can also be used for withdrawals. Cash recycling can thus reduce the cost of operating ATMs.

The low cost of self-service technology is also making it possible to extend financial services to the more than 10 million Americans who are "unbanked." Financial institutions can offer self-service options at kiosks like check cashing and bill pay, even to individuals who are not formally customers of the institution. For example, 7-Eleven has installed over two thousand kiosks in its stores that allow customers to cash checks, sell money orders, transfer money abroad, and pay bills.[18] In addition, consumers can use self-service kiosks to buy prepaid debit cards and reload value.

SELF-SERVICE GASOLINE STATIONS
Self-service gasoline stations are one of the most prevalent self-service technologies. Instead of having an attendant pump gas, self-service gas stations allow customers to pump their own gas, and in most cases, use a self-pay option to pay for the gas at the pump. Although full-service gas stations provide additional services—the attendant wipes windshields, checks tire pressure, and checks the oil level—they have largely been replaced by more cost-effective self-service stations. Where full-service stations do operate, they usually charge a premium for this service.

However, in the United States, two states—New Jersey and Oregon—have resisted self-service gas stations. Originally, the New Jersey Legislature created the ban in 1949 because of safety concerns that have become obsolete with today's equipment. Today these states continue to resist repealing these bans because of the impact it would have on jobs. In New Jersey, for example, gas stations employ 36,000 individuals.[19] These bans, however, translate into higher prices for consumers. The Federal Trade Commission notes that consumers pay between 2 and 5 cents more per gallon in states with a ban on self service than in those without it.20 This means that the average Oregon or New Jersey driver

pays almost $30 more per year just so several thousand people can be employed pumping gas. Additionally, gas station attendants may face health risks from prolonged exposure to the chemical compounds in gasoline.[21] The latest effort to lift the ban in New Jersey recently failed, as the state gas station trade association mobilized opposition.[22]

SELF-PAY PARKING, TOLLS, AND TRANSIT

Parking lots, garages, toll bridges, and toll roads used to require attendants to collect payments. Today, automated payment systems allow motorists to pay for parking without the use of an attendant. For example, a driver may use a payment kiosk to pay the parking fee using a credit card, debit card, smart card, or cash. Other systems automatically identify drivers that swipe their credit card or smart card upon entering and exiting the car park, eliminating the need for a paper ticket. Cities like Philadelphia are deploying hundreds of self-service parking kiosks that replace traditional coin-operated parking meters. Using these parking kiosks, drivers pay for a fixed amount of time and then place their receipt, which shows an expiration time, on their dashboard. These systems eliminate the expensive process of needing meter coin collectors to regularly visit each parking meter to collect coins, as well as the process of then sorting and depositing the coins.

Similarly, drivers on toll roads increasingly use automated lanes that allow drivers to pay a toll without stopping at a toll booth station. Toll roads using the E-ZPass systems, for example, use wireless transponders in vehicles that automatically debit the customer's account. Transit systems, such as the Metro system in Washington, D.C., have also upgraded their payment systems to make it more efficient. Bus riders can simply pass a contactless smart card over a reader to pay their fare and board the bus, reducing the need for drivers to collect fares. These automated systems are also used by riders to enter the subway platform. This not only saves transit districts money, it reduces the amount of time it takes to board or enter. In some nations, rather than using a smartcard, travelers can user their cell phones as the payment device by simply waving their cell phone over the reader.

FOOD-ORDERING KIOSKS

Self-service in the food industry is not new; coin operated cafeterias like the Automat first opened in the United States in 1902.[23] Today, quick serve restaurants,

including major fast food chains and convenience stores such as Sheetz and Wawa, have begun implementing self-service kiosks to improve business and provide better service to their customers. For example, Subway is piloting 70 self-service kiosks in its sandwich shops for customers to place their order and pay for their meal. The kiosks can be installed at the restaurant or in a satellite location so that customers can place an order for pickup or delivery.

Eliminating language barriers is important to getting a customer's order correct, which boosts customer satisfaction and leads to less waste.

Using kiosks to take orders means fewer employees need to work at the counter and more employees can work on food preparation. Restaurants that implement self-service kiosks can see a 10 to 20 percent increase in throughput (the rate at which customers are served).[24] In addition, kiosk sales generally are higher, as kiosks are able to up-sell more effectively than a typical employee. Kiosks also can offer multilingual service. This not only allows the customers to choose the language they want to use to place an order, it also allows the employees to choose the language in which they want to receive the order. This feature is especially useful when the primary language of the customer is not the same as that of the employee receiving the order. Eliminating language barriers is important to getting a customer's order correct, which boosts customer satisfaction and leads to less waste. Finally, self-service food-ordering kiosks can also be used to satisfy regulations enacted in various jurisdictions that require restaurants to make available nutritional information about their products easily available to their customers.

Similar electronic ordering systems have been deployed at the delis of grocery stores. For example, the Stop & Shop grocery chain in the northeastern United States offers a touch screen kiosks where customers can place their deli orders. At the kiosk, customers can swipe their grocery store loyalty card so that they can see their previous orders or enter a new one. After placing his order, the customer receives an order number and can wait for their order, or enter a cell phone number and receive a text message when the order is ready.[25] Electronic order systems are also being deployed at

drive-through restaurants to make placing orders faster and more accurate. Drivers can now more easily place orders from their car with recent improvements in touch-screen technology, such as touch screens that respond to both gloved and bare fingers, and graphic interfaces that automatically adjust to the height of the driver's car.[26]

The cost of checking in a passenger with an airline agent is approximately $3 versus only $0.14 with a kiosk.[27]

AIRPORT AND TRAVEL KIOSKS
Airlines have invested heavily in airport kiosks to allow customers to manage their reservations. Airport kiosks with touch screen displays, magnetic stripe card readers, and bar code scanners are now common in airports around the world. Using these kiosks, customers have the opportunity to check in for their flight, change or upgrade their seats, modify their reservation, and even purchase a ticket. Travelers without baggage can check in and then proceed directly to the gate; travelers with baggage can check in and then take their luggage to the baggage drop.

Check-in kiosks, combined with online check in, have enabled airlines to generate substantial gains in productivity as processing a passenger with a kiosk is more efficient than processing a passenger using only airline agents. The cost of checking in a passenger with an airline agent is approximately $3 versus only $0.14 with a kiosk.[27] Alaska Airlines, for example, has found that with 84 percent of customers using self-service check in, they have boosted the number of passengers processed per agent from 21 to 55 per hour.[28] Some airports, such as Newark Liberty International Airport, have invested in common-use check-in kiosks that serve all of the airlines in a particular terminal rather than dedicated kiosks for each airline, allowing each kiosk to serve more customers, with less idle time.

The International Air Transport Association (IATA) has launched a "Fast Travel" initiative designed to bring more self-service options to air travelers. In part this is to address customer demand—according to a 2009 survey, over half of all passengers worldwide want more self-service options, in large part to have more control and reduce length of time waiting in lines.[30]

By providing more self-service options, airlines will give passengers more control over the departure and arrival process, reduce passenger wait time in lines, and save the airlines money. For example, airlines have introduced kiosks that allow passengers to tag their checked baggage themselves rather than requiring an agent to handle this transaction. Airlines are also upgrading their kiosks to scan and forward documents to government officials, so that travelers can submit their travel documents from a kiosk, rather than going to a check-in counter to show their identification. On some airlines, passengers that miss a flight or encounter a cancelled flight can use kiosks to rebook a flight, rather than having to wait to speak to an agent. Similarly, if passengers are missing luggage, they can use a kiosk to report the issue rather than having to locate an agent. Finally, some airlines, such as Air France, are introducing self boarding, an automated boarding gate that allows passengers to board through an automated turnstile. IATA estimates that once fully implemented all of these initiatives will save $1.6 billion annually across the entire industry.[31]

Governments are also using self-service technology, combined with biometric-enhanced passports, to improve the accuracy and speed with which travelers can pass through customs and immigration. For example, the Australian government has established SmartGate kiosks at its international airports to allow travelers with Australian or New Zealand e-passport holders to self-process through the passport control area.[32] The SmartGate system uses data in the e-passport and

Figure 3: Self-boarding gate at the Paris-Charles de Gaulle Airport[29]
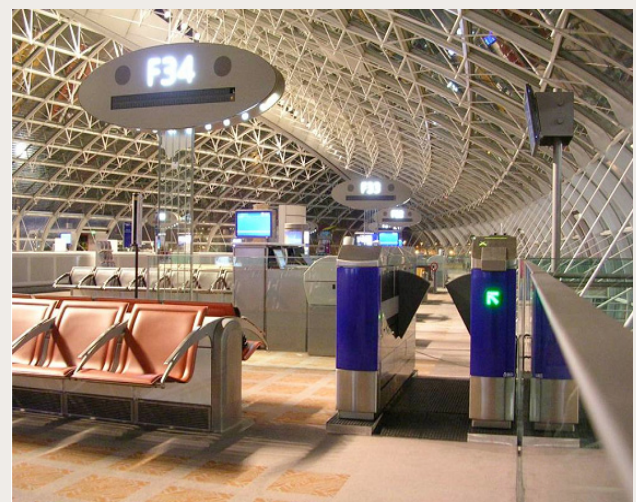
facial recognition technology to perform the customs and immigration checks that are usually conducted by a customs officer. SmartGate will be gradually opened to other nationalities that have International Civil Aviation Organisation (ICAO)-compliant e-passports. In the United States, the Customs and Border Protection (CBP) operates various "trusted traveler" programs that allow low-risk, pre-approved individuals to use kiosks for expedited border crossing. For example, international travelers can enroll in the Global Entry program after paying a fee, passing a background check, submitting biometric information including a fingerprint and photograph, and participating in an in-person interview with a CBP officer. Once enrolled, travelers can use an automated kiosk and express lane to go through passport control more quickly.[33]

Others in the travel industry are using kiosks as well. Some hotels are beginning to allow guests to avoid lines and check in at kiosks that can look-up a reservation, allocate a room, and dispense a room key. Hotels also offer automated check out, for example, through a dedicated electronic kiosk in the hotel lobby (where guests can print a receipt) or through an application accessible through the in-room TV, so that travelers can more easily complete their stay. Car rental companies have deployed electronic kiosks in airports that allow customers to easily complete their car reservation. Using a kiosk, customers can quickly enter their personal information, scan their driver's license, and then purchase any upgrades, insurance, and add-ons like navigation systems or child seats. The technology frees employees from mundane tasks like data entry and allows them to focus on providing a best customer experience. And asking the customer to use the technology does not seem to slow down the service encounter; Hertz, which has deployed check-in kiosks at airports around the world, found that the average time for check in was only about five minutes.[34]

VENDING MACHINES AND "REVERSE" VENDING MACHINES
Vending machines are one of the most basic self-service technologies that replace vendors selling individual items. Vending machines today sell everything from beverages to food to retail products. The electronics retailer Best Buy has introduced Best Buy Express, self-service kiosks in airports that allow travelers to buy small electronics like chargers, music

players, digital cameras, and headphones. Kiosks are also used to sell tickets, for example movie tickets at theaters and rail tickets for subway and train systems.

Even traditional vending machines are being upgraded to advanced interactive touch screen displays. For example, at the 2008 Beijing Olympics, Coca-Cola introduced the Video Vendor, a vending machine with a 46-inch touch screen display showing video, sound, and graphics. Not only can vendors use this to create a more interesting encounter for their customers, customers can use the Video Vendor to find out more product information, such as the nutritional value of a snack. Coca-Cola has also developed Freestyle, a robotics-enabled kiosk that lets customers create their own unique beverage to suit their preferences. Freestyle uses 30 different flavor cartridges from which customers can mix and match to produce more than 100 different drinks.[35]

DVD rental kiosks have also becomes popular in recent years with self-services rentals from Redbox and Blockbuster. Redbox, launched in 2002, now offers $1 per night DVD rentals at over 19,000 kiosk locations in the United States, including at grocery stores, pharmacies, and fast food restaurants. Each kiosk can hold approximately 630 DVDs and offers around 200

Figure 4: eCycling Station from ecoATM[39]

different movies. Customers use a touch screen display to select an available movie and then swipe their credit card to rent a DVD. Customers are then charged a fixed rate per night until they return the DVD at any Redbox kiosk. Using the Redbox Web site, customers can also choose a movie online and then use the company's real-time inventory tracking system to reserve a DVD to pick up at the location of their choice.[36] Because of the convenience and pricing model, Redbox has quickly obtained a 19 percent market share in the rental market.[37]

Smarte Carte, Inc. operates a variety of self-service devices familiar to most travelers in the United States. The company created the self-serve baggage cart in the 1970s and since then has upgraded the devices as technology improves to make change, accept credit cards, and be remotely managed electronically. Today self-serve vending machines at the airport provide access to luggage carts, storage lockers, charging stations, and Internet access, providing automated solutions to services that in the past would have require an attendant. For example, the "Charge Carte" has standard power cables for cell phones, MP3 players, and other portable electronic devices, allowing customers to rapidly charge their device. Airports even offer self-serve massage chairs, which replace the 15-minute shoulder massages offered by airport masseuses.

Similar self-service technologies have also been deployed at airports, train stations, hotels, and entertainment venues. For example, amusement parks and water parks around the country provide their customers with wristbands embedded with radio-frequency identification (RFID) tags that give them access to a variety of services. For example, at Hyland Hills Water World in Colorado guests can use digital kiosks to load funds onto their RFID wristbands and then use the wristbands to purchase food or rent a storage locker, eliminating the need to carry keys or cash. The wristbands can also be used to automatically identify guests (for example, to locate a lost child), run loyalty or season pass programs, and provide keyless access to the guests' rooms at resorts.[38]

In addition to traditional vending machines where consumers put in money and in return get a product, various "reverse vending machines" allow consumers to deposit some type of goods and receive a payment in return. Perhaps the best known of these is the Coin-Star "Coins to Cash" machines, self-service kiosks that consumers can use to automatically count their spare change, and receive a gift card or voucher for the cash value. Found in high-traffic locations like grocery stores and banks, these machines not only get more coinage back into the economy, thereby reducing the need of governments to produce coins—an expensive process—they also reduce costs for banks by reducing the need to handle coins.

Another innovative "reverse vending machine" is the ecoATM kiosk which is billed as an automated recycling station for mobile phones and other consumer electronics like MP3 players, GPS systems, and laptop computers. The kiosks can identify the consumer electronic device, complete a visual inspection, and calculate a secondary-market value. For consumers, the process is effortless—they insert their recyclable electronic product, receive a quote, and, if they accept, their device is binned and they can receive gift card or make a charitable donation for the value of their device.[40]

In 2008 more than $192 billion in retail sales were purchased using self checkout, representing almost 5 percent of total retail sales.[44]

SELF CHECKOUT

Self checkout is one of the most widespread applications of self-service technology. Using self-checkout systems retailers can allow their customers to scan, bag, and pay for their own items, rather than having to employ a worker to complete the same task. Given that there are over 60 billion transactions a year in retail stores alone, 68 percent of which are in grocery, gas, and convenience stores, the potential savings are significant as a large number of these transactions could easily be done with self-service applications.[41] Already self checkout is widely deployed in retail locations such as grocery stores, hardware stores, and warehouse clubs. As of the end of 2008, there were over 90,000 self-checkout systems deployed globally, and this number is expected to quadruple by 2014.[42] An online survey found that 68 percent of U.S. adults who use the Internet have used self checkout at a retail store and 21 percent have used an in-store kiosk.[43] Most of these self-checkout systems

are in North America, where in 2008 more than $192 billion in retail sales were purchased using self checkout, representing almost 5 percent of total retail sales.[44]

Self checkout benefits both consumers and businesses. For example, it can reduce the amount of time customers spend waiting in line, one of the biggest complaints of customers. NCR, a leading provider of self-checkout devices, estimates that the technology can reduce the average queue time for a customer by 40 percent. Typically only one attendant is needed to manage four or six self-checkout stations. Self-checkout can also lead to lower costs for consumers if stores reduce their labor costs, or a higher quality consumer experience if workers are redeployed to other tasks. One U.S. grocery store chain found that after implementing self-checkout, 10 percent of their sales were from self-checkout and they were able to redirect 7 percent of their front-end labor to other store operations.[46] The average use is much higher: data from self-checkout installations at major grocery stores has found that 15 to 40 percent of the daily transaction volume and 12 to 30 percent of the daily sales volume of these stores are now being handled by self-checkout machines.[47] The UK-based retailer Tesco has also invested heavily in self-checkout technology for its retail stores, going so far as completely replacing cashiers with self checkout at its Tesco Express stores (the store is still supervised by at least one worker). Stores also benefit from self checkout because it has the potential to reduce store theft. Employee theft is substantial: in 2008, retailers lost approximately $15.9 billion to employee theft.[48] Not only has self checkout not lead to more customer theft (partially because of countermeasures such as in-store security cameras and weight scales), it can also reduce employee theft because fewer employees will be handling cash transactions.

Home Depot has been one of the leaders in using self-checkout technology. After piloting the technology in 2002, it quickly deployed the technology to almost 800 stores within a year. Today, Home Depot has implemented self-checkout systems at all of its retail stores in the United States, and they are used for at least 35 percent of all transactions.[49] In Home Depot stores, four self-checkout stations are used to replace three traditional checkout lanes. Since one cashier stays to help customers with self-checkout, this eliminates the need for two cashiers. In Home Depot's case they re-

deployed their workers to add around 40 hours per week per store to the sales floor. As the former CEO Robert Nardelli describes, "Using technology as an enabler to eliminate tasks, we've been taking those task hours and reallocating our labor hours to the selling floor in our stores."[50]

Retailers are not the only users of self-checkout technology. Libraries have also introduced self-checkout for library books, thus freeing librarians from the monotonous task of scanning and stamping books. Instead, library patrons can use self-checkout kiosks to scan their library card and books, and then receive a receipt when a book is ready. Some libraries also allow their patrons to pay library fines and fees at kiosks. In addition, libraries may offer online self-service options, such as reserving library materials or applying for a borrower's card.

RETAIL KIOSKS

In addition to self checkout, many retailers have deployed kiosks in their stores to provide their customers better access to products and services. For example, retailers may use kiosks to bring online resources into the store. BMW deployed over 550 kiosks at its dealers so that customers could access the wide range of multimedia content available on their Web site, such as the BMW film series.[53] Retailers may also use kiosks to allow customers to obtain loyalty cards or buy gift cards. An example of this is Cabela's, a large retail chain for outdoor products, which introduced kiosks in their stores. Not only do the kiosks provide access to the store's popular Web site so that customers can purchase goods not available in the store, in addition,

Figure 5: Self-checkout terminals deployed by region, 2008[45]
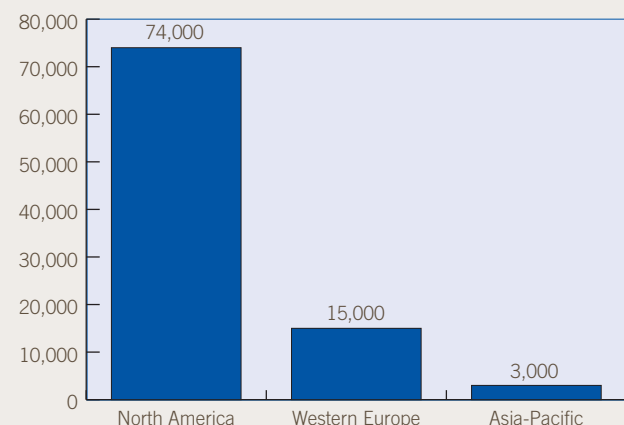
customers can use the kiosks to look up product information, check product availability, register for promotions, and join the store's loyalty program. Kiosks are also used to provide a self-service option for the most common customer service requests, such as purchasing gift cards, obtaining store loyalty cards, creating or checking gift registries, or even applying for a job.

Stores can also use kiosks to provide an innovative service unique to their industry. Virgin Megastores USA, for example, used kiosks to improve the listening stations they provide for their customers. In the past, customers were either limited to a small selection of CDs preselected by the staff to which they could listen, or they had to find a representative to unwrap their CD and then manually play the music. In 2005, Virgin replaced these listening stations with kiosks that could access an online database of 200,000 CDs containing 2.5 million tracks. To use these kiosks, customers only have to scan the barcode of the CD they are consid-

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BOX 1: THE FIRST SELF-SERVICE GROCERY STORES

Even before self checkout came along, grocery stores have long been among the leaders in implementing self service. In the early part of the 20th century, most grocery stores were run entirely by clerks: customers would give their order to a clerk and the clerk would get the items from a shelf. Clearly this process was incredibly inefficient. In 1916, Clarence Saunders opened a grocery store with a revolutionary set of ideas: eliminate all of the unnecessary clerks, give customers a shopping basket and allow customers to get items from the shelves themselves. His store, Piggly Wiggly, was a success (in part because of its competitive pricing enabled by self service), and his franchise and his business model quickly spread across the nation. Today virtually every grocery store in the United States follows this model.[51]

Saunders was a big proponent of self-service and his innovations did not stop with Piggly Wiggly. In 1937 he opened a new automated store in Memphis, Tennessee called "Keedoozle" (for "Key Does All"). Customers would enter the store, receive a mechanical "key" (an aluminum device with a roll of paper tape) and take the key to different display cases containing the groceries. To make a purchase, the shopper puts the key in a slot and then presses a button, which records the purchase on the paper tape by punching holes in the tape. Once the customer was done shopping, she could take the key to a cashier. The cashier would use the key to automatically calculate the total bill and then activate a chute system to automatically dispense the groceries. The customer could then go to a nearby lounge and wait for the order to be bagged and delivered. Saunders claimed that the store was much more efficient than a traditional grocery store—requiring about half the workers of a comparable store—and eliminated shoplifting. The store passed these savings on to customers in the form of prices lower than competitors by 10 percent. Unfortunately, Keedoozle was ahead of its time and eventually closed, as the technology was only able to handle products in cans and cartons and the mechanical system was prone to failure.[52]

BOX 2: MULTI-USER, MULTI-TOUCH SURFACE COMPUTING

Advances in technology lead to innovations in self-service technology and one important technology that has recently emerged is Microsoft Surface. Microsoft Surface is a large, table-like computing device with a horizontal display that people can interact with using touch and gestures. It incorporates several innovations including multi-user interaction (the ability to have multiple users interact with it at once), multi-touch input (the ability to accept input from multiple contact points, rather than a single contact point like typical touch-screens), and object recognition (the ability to recognize a physical object placed on the surface of the device).

Microsoft Surface has been used in various self-service applications from restaurants to retail store to showrooms. For example, AT&T installed Microsoft Surface at some of its retail stores. Customers can use the device to learn more about different cell phone models. When a phone is placed on the display, the device automatically recognizes the phone and shows customers information about the model. In Las Vegas guests at the lounge of the Rio Hotel can use the device to order their drinks from the table, play games, watch videos on YouTube, and even flirt with people at different tables. And in Seattle, guests at Hotel 1000 can use a Microsoft Surface installation as a virtual concierge to learn about nearby points-of-interest and get directions, to learn more about the hotel's services, and to view their photos and videos.[54]

ering purchasing and then they can listen to a 30- to 60-second sample of each track.

Retail locations for telecommunication providers, for example a mobile phone company, also can use kiosks to allow customers to pay their bills. In the United States this type of service is particularly important for the more than 20 percent of individuals without access to the Internet or the 16 percent of households that do not use a bank.[55] For example, Verizon Wireless uses bill payment kiosks in its retail stores so that its store staff can focus on sales and customer service, rather than processing bill payments.

As technology advances, some retailers are taking advantage of fast network connections to implement two-way video solutions that let a customer use an in-store kiosk to communicate with a virtual staff member. By using virtual staff, companies can make more efficient use of their customer service agents and provide better service to their customers.

HUMAN RESOURCES KIOSKS

Some businesses use kiosks to provide their employees electronic access to human resources (HR) information and services. In particular, this is useful for businesses where all workers do not have ready access to a computer at work, such as a factory or retail store, or

may not have access to a computer at home. HR kiosks provide employees access to information such as past pay statements, benefits, and training opportunities, as well as let employees administer their retirement accounts, enroll in benefits, and request leave. Employees can use kiosks for day-to-day activity such as recording their time sheets or completing online training. Companies also use kiosks to process job applications from potential candidates. HR self service, whether delivered via a kiosk or online, can yield significant cost savings to a company. As shown in Figure 6, the average cost of many HR processes is significantly lower when completed with a self-service application rather than when completed manually. For example, the total cost of labor (for employees, managers, and HR staff) of enrolling a worker in company benefits costs on average around $30 if completed manually but drops to about $5 using self-service technologies.[56]

DIGITAL PHOTOGRAPH PRINTING

Digital photograph printing constitutes a significant share of the kiosks implemented worldwide.[58] By using more efficient equipment, the average cost of printing a photo at a kiosk is approximately $0.29 compared with $1.00 on a home printer.[59] Available at pharmacies, supermarkets, and convenience stores, these kiosks allow customers to make high-quality prints from digital images within seconds. The Kodak Picture

Figure 6: Cost of HR application, self-service vs. manual[57]
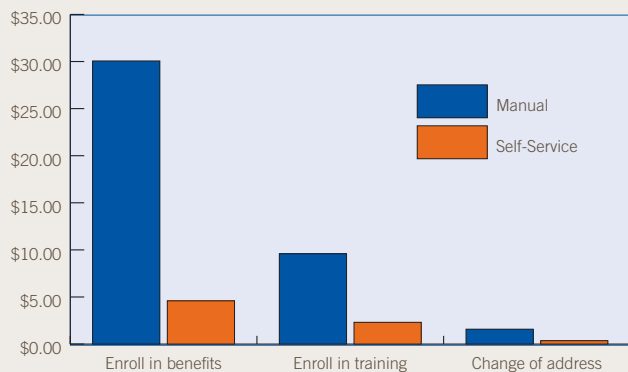
Kiosk, for example, allows consumers to make prints from a digital camera, camera phone, or digital media (e.g., a USB drive or memory card). Using the kiosks, consumers can also edit their photographs, including standard features such as removing red eye, enlarging, cropping, and adjusting the brightness, color and contrast. Special effects can also be added to the photo, such as adding text or converting a photograph to black and white or sepia tones. In addition to standard prints, many of the kiosks can produce additional products including calendars, greeting cards, posters, and a movie DVD of the images. As of early 2009, Kodak has installed over 100,000 photo kiosks worldwide.[60]

POSTAL KIOSKS

The U.S. Postal Service (USPS) created the automated postal center (APC) to provide a self-service option for customers. The APC is a self-service kiosk at which customers can complete 85 percent of the retail transactions available at a full-service counter, including buying stamps and mailing letters and packages. Using the APC, a customer can weigh and ship packages up to 70 pounds, perform zip code lookups, and purchase shipping options such as delivery confirmation, signature confirmation, or insurance. Most APCs are located in the lobby of a post office, and many offices provide 24/7 access to the machine. As of 2008, USPS had deployed APCs at almost 2,500 locations; however, this represents only a fraction of the 27,000 post offices operated by USPS employees.[61] Retailers, businesses, and organizations can also deploy postal kiosks to provide this service on-site.

USPS also offers various other self-service options directly to its customers including traditional vending machines to buy stamps, telephone and mail ordering of stamps, and an online store to buy stamps and other postal merchandise. USPS also created "Click-N-Ship," an online service that allows customers to use their computer to print postage labels and schedule packages to be shipped.

ELECTRONIC VOTING

Electronic voting is an example of how technology can make self-service accessible to more individuals. While most voting is already "self service" (since it is supposed to be the voter, not an assistant, who casts a ballot), not all individuals are able to vote independently on traditional voting technologies like paper ballots, punch cards, and lever machines.[62] Electronic voting has the potential to revolutionize the voting process for blind, disabled, or illiterate voters. With other technology, many of these voters could vote only with the assistance of poll workers, which compromised both the confidentiality and the integrity of their ballots. Electronic voting machines can make voting simpler or add new features, such as a photo of a candidate for illiterate voters. Audio-based electronic voting machines also can enable blind and illiterate voters to vote privately and independently. At Auburn University, researchers have developed Prime III, a secure, multimodal electronic voting system that allows all users to vote on the same machine. As the research team describes the voting system, "If you can't see, hear, read or if you have a physical disability, you can still vote on Prime III."

In addition, electronic voting can improve voting accuracy thus providing voters with a better experience. In the 2000 U.S. presidential election, for example, some punch-card voting machines created ballots with half-punched ballots. When election officials could not determine voter intent, they had to discard these ballots. Electronic voting machines eliminate this problem, because in the binary world of computers, "dimpled chads" do not exist. With paper ballots, voters can also easily overvote or undervote, mistakenly rendering their ballot invalid. Electronic voting machines help eliminate these problems by preventing voters from casting invalid ballots, thereby ensuring that more ballots count.

Finally, electronic voting systems can also be used to increase voter convenience. For example, electronic

voting machines can show voters a summary of their ballot, allowing them easily to verify that they have not made an error. In addition, many electronic voting machines enable multilingual and non-English speaking voters to vote using their preferred language. Electronic voting also makes it easier to implement early voting. Early voting helps make voting more accessible to people who might otherwise be unable to vote on the day of the election. Early voting with paper ballots is impractical and expensive because custom ballots must be made available for each precinct. For example, in Riverside County, California, election officials switched to electronic voting machines after they discovered that they wasted over half a million dollars in unused paper ballots in one election because of low voter turnout.[63] Electronic voting machines can host ballots for every precinct, so election officials can more easily provide early voting.

As of 2008, USPS had deployed APCs at almost 2,500 locations; however, this represents only a fraction of the 27,000 post offices operated by USPS employees.[61]

HEALTH CARE KIOSKS

Self-serve computer kiosks can be used by hospitals to automate a number of patient interactions. They can be used to facilitate patient management activities such as patient admission, discharge, and transfer. Kiosks can also be used to process copayments, receive patient consent forms, request prescription refills, collect demographic data, perform clinical prescreening, verify insurance eligibility, and perform satisfaction surveys. Another common application of kiosks in hospitals is for way-finding (i.e., providing patients with directions to their appointments). Finally, kiosks can offer all of these services in multiple languages. Kiosks benefit hospitals by freeing nurses and hospital staff from routine activities and allowing them to work more efficiently. Patients benefit from kiosks by experiencing shorter waiting times, more convenience, and more privacy.[64] Currently, only a small percentage of U.S. hospitals have such kiosks. A 2008 survey of hospitals found no more than 5 percent of hospitals had adopted kiosks for most patient management activities. The same survey found that 13 percent of hospitals had a patient kiosk for way-finding.[65]

Health kiosks are also found outside of hospitals and medical offices to provide health care directly to the consumer. For example, in the United States, kiosks that monitor blood pressure have become commonplace in many pharmacies. As the technology has advanced, retailers are now deploying more advanced health care kiosks to help treat and screen patients for common conditions. For example, the grocery chain Kroger has launched a pilot in Kentucky to install health kiosks at its stores that allow customers to learn their weight, body mass index, body composition, blood pressure, heart rate, and blood oxygen levels. Shoppers could record these measurements in an online database and track their health over time.[66]

Another innovative application is EyeSite, an interactive kiosk developed by SoloHealth, which provides consumers a self-service option for assessing their vision and learning about eye health conditions. Using an interactive video interface, the kiosk can help the customer assess his distance and near vision and understand if his prescription has changed. After completing the exam, patients can use the kiosk to find a nearby eye care provider to follow-up with a comprehensive exam if needed. This also means that patients who simply want to buy new prescription glasses can use the kiosk to see if their vision has changed, and if not, avoid an unnecessary trip to the eye doctor.

Similar applications may be possible in the future including hearing tests, bone density measurements or screening for obesity, hypertension, stress, and depression. Some solutions may even eliminate the need for a doctor's visit. For example, the technology exists today to perform an automated refraction (sight test) and determine the prescription for corrective lenses. Such services if implemented in low-cost kiosks will likely face opposition from some ophthalmologists or optometrists who traditionally perform eye exams.

INFORMATION KIOSKS

Many interactive electronic kiosks are the digital version of the information kiosks of the past that were staffed by attendants. Airports, convention centers, and shopping centers all can use information kiosks to provide public access to online resources. For example, an electronic kiosk in an airport may provide access to flight information, a map of the concourse, and a directory of nearby businesses such as car rental com-

panies and hotels. At a hotel or convention center, a kiosk might provide guests access to online information such as local weather, nearby restaurants, and maps and directions. Tourist information centers can use kiosks to provide tourists with detailed information about local attractions, upcoming events, and suggested itineraries.

Internet applications

At its core, the Internet is a self-service technology allowing individuals to access information, run applications, and create content. Fast broadband Internet access and high rates of computer ownership have made it possible for consumers to access a wide array of information that was previously either unavailable to them or required them to contact a service provider to look up the information for them. Internet access has also enabled consumers to engage in a whole host of self-service retail transactions.

Indeed, various Internet applications have equipped consumers to take on new roles and responsibilities that previously required assistance from individuals employed in the service sector, including professionals from virtually every field from banking to education to retail. Many types of professions, including real estate agents, travel agents and stock brokers, have had to adapt to a new economy where they no longer have exclusive access to information. Finally, consumers have become active participants online, using the Internet to customize products from computers to cars.

ONLINE HEALTH

In health care, IT empowers patients by giving them access to the latest medical research, their own health records, and information on the quality of care they receive. Online applications such as Microsoft Health-Vault have emerged to allow individuals to track and analyze their personal health information. Patients can use consumer-friendly Web sites like Revolution Health and WebMD to access up-to-date medical information on health conditions and treatments. With online access to their personal health records and new Web-based tools, individuals can manage their health information online as easily as they manage their finances. Currently, for example, online applications allow patients to track health markers such as their blood pressure, cholesterol, and body mass index to see how these indicators change over time and how they com-

pare to healthy patients of the same age and sex. Patients can combine these online tools with medical home monitoring devices to track and compare their health between office visits. As a result, patients are less dependent on health care workers for medical solutions and can take a more active role in their own care.

ONLINE BANKING

Much like ATMs, online banking has replaced the need for tellers for most financial transactions at a bank. Banks increasingly offer online applications that meet the day-to-day banking needs of most customers, such as opening an account, checking account balances, and transferring funds. Most banks have also introduced online bill pay systems that allow their customers to send both paper and electronic checks to businesses and individuals. Self-service technology has become so mature that some banks, such as ING Direct, HSBC Direct, and E*Trade Bank, operate with only an online presence. These banks often use self-service technology even for complex transactions. For example, ING Direct offers electronic closings for mortgage refinancing that let customers submit forms online, eliminating the need for more time-consuming meeting with bank representatives. Currently 63 percent of all Internet users in the United States bank online.[67]

E-LEARNING

Online learning replaces traditional face-to-face teaching with online courses and educational activities. Fisher-Price, for example, makes online games for babies and toddlers, including games that help toddlers learn letters, numbers, names of animals, sounds of musical instruments, and other things.[68] Games for children designed to double as learning tools have also proliferated. Discover Babylon, for example, is a game that involves exploring the history of Mesopotamia to complete a series of challenges.[69] Another game, Immune Attack, is designed to engage students by having them battle virtual viruses inside a body while exploring concepts in immunology.[70] The Oregon Trail game teaches history and geography while engaging students in a set of tasks and challenges that expose them to pioneer life in the early 19th century in America. In addition, Web sites such as FunBrain.com offer children online games and activities that reinforce skills and subjects taught in schools. Children also benefit

from a host of new "intelligent" tutoring programs, like Carnegie Mellon University's "Cognitive Tutor," software, that teach a variety of subjects at different levels, from foreign languages to physics. Research has shown that such tutoring programs can improve students' performance as much as one letter grade. The software may accomplish less than a human tutor can accomplish, but at $30 to $60 a student, the software is also significantly less expensive.[71]

E-learning is not limited to youth, and has proven efficient and cost-effective for organizational or professional training. For example, Web sites such as Mango or Rosetta Stone allow users to study a foreign language online rather than take a class with an instructor. In Kenya an e-learning program was used to rapidly train over 22,000 nurses to greatly improve the basic medical skills of the healthcare workers treating critical diseases such as HIV/AIDS, malaria and tuberculosis. Online learning also gives individuals access to educational opportunities that might otherwise be unavailable.

Using online legal services, individuals can draw up a will, lease, or other simple contract and save 75 to 80 percent over using a lawyer.[72]

PROFESSIONAL SERVICES

IT also empowers consumers to do for themselves what they used to have to pay professionals to do for them. In particular, online and offline applications allow consumers to do a host of costly professional and semi-professional functions. For example, individuals can also use self-service technology for their legal needs. Using online legal services, individuals can draw up a will, lease, or other simple contract and save 75 to 80 percent over using a lawyer.[72] Similarly, individuals can use companies such as E*Trade and Charles Schwab for Internet stock trading, rather than using a stockbroker. For individuals looking to manage their money, investment strategies used to be limited by the lack of access to robust, real-time information. Now many individuals choose to forgo stockbrokers to manage their own investments because there is very little information available to professionals that cannot be found by amateurs through online research. In addition, the process

of buying a stock or bond is just a few clicks away. In Japan, online trading has exploded, with the number of accounts at Japanese electronic brokerage firms growing from fewer than 300,000 to nearly 8 million since 1999, and Internet trading now accounts for more than one-quarter of all equity trades in the country.[73] Using the Internet for stock trading has decreased the price of stock trading 90 percent.[74]

Self-service technology also allows consumers to take on many of the functions provided by travel agents. Consumers can research and plan their own itineraries using the thousands of online resources that offer detailed information about destinations. Web sites like Orbitz and Expedia let consumers bypass travel agents and directly make air, hotel, and car reservations. Neither must consumers rely on the advice of single agent for travel recommendations; Web sites like TripAdvisor, Virtual Tourist, and IgoUgo offer detailed suggestions on where to stay, what to eat, and where to visit while traveling. As a result, the use of travel agents has declined: today only 25 percent of car rentals, 30 percent of hotels, and 50 percent of airline tickets are booked through travel agents.[75]

Consumers also use the Internet to purchase insurance, a task previously fulfilled by an insurance agent or broker. Using the Internet, consumers can research costs and benefits of various types of insurance, including property, life, health, disability, and long-term care, rather than relying exclusively on an agent for this service. Consumers can use online tools to request quotes and submit applications. For example, Geico offers discounted insurance, in part because it is able to have its customers use self-service options to manage their insurance. Using the Geico Web site, policyholders can view their current insurance options and policy documents, make changes to their policies, such as changing a deductible or modifying their coverage, and make an online payment. As a result of self-service technology, insurance agents and brokers can service more clients and spend their time on more complex issues, such as answering insurance questions. In addition, it has lowered costs for consumers: purchasing term life insurance online has already reduced prices by 8 to 15 percent.[76]

Self-service is also allowing taxpayers to bypass using tax accountant services. Intuit's TurboTax software

revolutionized the tax preparation business by offering a software program with as much (or more) tax expertise as a typical tax accountant, but at a considerably lower price. Using electronic tax preparation software yields more accurate tax returns for taxpayers: after the IRS enabled e-filing, the error rate on tax returns declined from 20 percent for paper returns to under 1 percent for electronic returns.[77] In addition, because the private companies that make electronic filing software are competing intensely for market share, they have strong incentives to make their programs as easy to use and comprehensive as possible.

Buying contact lenses over the Internet enables consumers to save between 10 and 40 percent of the cost of buying from an optometrist.

Home buyers and sellers can take advantage of self-service options offered by real estate companies to accomplish for themselves what they used to have to pay a real estate agent to do. Improved access to information also allows individuals to learn about things without having to be physically present. Virtual tours of houses, for example, save prospective homebuyers hours on the road going from property to property by letting them first see inside a building before deciding if it is worth a trip to view the property in person.

For example, Web sites like Zillow and Trulia provide potential buyers and sellers detailed property information, estimates of the value of a home, historical pricing data, and a list of comparable properties on the market. Companies like Zip Realty, an online real estate brokerage, use self-service technology to lower their operating costs and then share the cost-savings with their clients. By giving their clients unrestricted online access to the Multiple Listing Services (MLS), relevant property information, and online tools to rate and review homes, prospective buyers can maximize the value of the time they spend with their agent. In return, after buying or selling a home, buyers receive a cash rebate equal to 20 percent of the real estate agent's commission and sellers pay a discounted commission to their broker. In addition, since homeowners now have access to the same information as real estate agents, some sellers to forgo using an agent altogether,

thereby allowing them to save the money it costs to pay a commission. To cater to these customers, Web sites like ForSaleByOwner.com, offer fee-for-service options to home buyers and sellers who would rather not use an agent at all. For example, sellers can purchase a flat-fee to list their property on the MLS, rather than paying a commission.

RETAIL E-COMMERCE

Self-service technology gives consumers control over their service encounter, and perhaps no service offers a better example of this than e-commerce. Buying goods and services online allows consumers the freedom to choose when and where to shop and the opportunity to research the product, the seller, and any other available options. Shopping has been transformed through the availability of online information. Currently, for example, two-thirds of U.S. consumers use the Internet to research purchases before going to the store.[78] Just about anything that can be bought in a store can be bought online, even perishables like groceries. And consumers have embraced these possibilities around the world, with more than 85 percent of the world's online population having purchased something using the Internet.[79] The Internet has also introduced many online services that substitute physical goods for digital goods. Online services like Netflix, iTunes, and the Amazon Kindle store allow consumers to find and purchase digital goods like movies, music, and e-books without ever interacting with a service worker. E-commerce retail sales provide significant savings. For example, buying contact lenses over the Internet enables consumers to save between 10 and 40 percent of the cost of buying from an optometrist.[80]

Figure 7: E-commerce retail sales as a percent of total sales, 2000-2009[82]
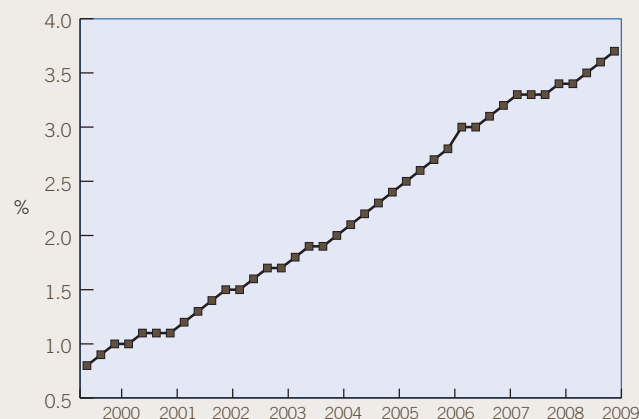
More broadly, one study found that firms engaged in e-commerce had 4 percent lower prices than firms that did not.[81]

E-retail is still a modest share of the economy (see Figure 7), but in some sectors it is emerging as a sizeable share of transactions. For example, more than half of computer hardware and software sales are purchased electronically. Similarly, a large portion of travel reservations, such as airline tickets, are made online. In 2005, over one-quarter of sales in the travel industry were made online, and today that figure is likely at 50 percent.[83]

In addition, business-to-consumer ecommerce industries such as event tickets, books, and consumer electronics show strong online sales. Online retail has grown approximately six times faster than total retail sales and will continue to grow in part because the longer people are online the more likely they are to make online purchases.[84]

CUSTOMER SERVICE

Many companies provide self-service options for customers to receive customer service online. The service options range from a simple list of frequently asked questions to advanced online applications that give customers access to detailed information and services so that many of them can solve their own problems. Instead of consumers contacting customer service representatives, they can go online and do the work themselves and find a solution in the same time or less. For example, the shipping companies FedEx and UPS allow customers to track their packages online rather than call a customer service agent to find out its status. Computer manufacturers like Dell allow customers to look up product information and get support based on the unique serial numbers printed on each device. Many businesses also give their customers online access to their accounts. For example, utility companies, cable companies, and telephone service providers all typically offer online access so that their customers can pay their bills online, see past statements, and make changes to their service. The savings here can be substantial: Gartner estimates that automated online customer service costs businesses approximately $0.24 per encounter versus $5.50 to provide customer service by telephone.[86]

Some companies have gone a step further with online self-service and created human-like automated customer service agents. For example, the furniture retailer IKEA has created "Anna," an interactive virtual agent that responds to questions from customers on its Web site (see Figure 8). Customers type questions and Anna displays an answer while an animated image of her smiles, blinks and nods. The British version of Anna even includes a text-to-speech option so that customers can hear her replies. Other organizations have implemented similar "chatbots" including the U.S. Army which created Sergeant STAR, a self-described "self-service virtual guide" to answer the questions of visitors to its Web site.

Some companies have made self-service customer support a key part of their business. For example, Cisco used self-service technology early on to manage the customer service demands of their rapidly expanding customer base. Cisco built an extensive catalog of online self-service products to allow customers to solve their own problems, often without even using a Cisco employee. These tools include an online discus-

Figure 8: Anna, the IKEA online assistant
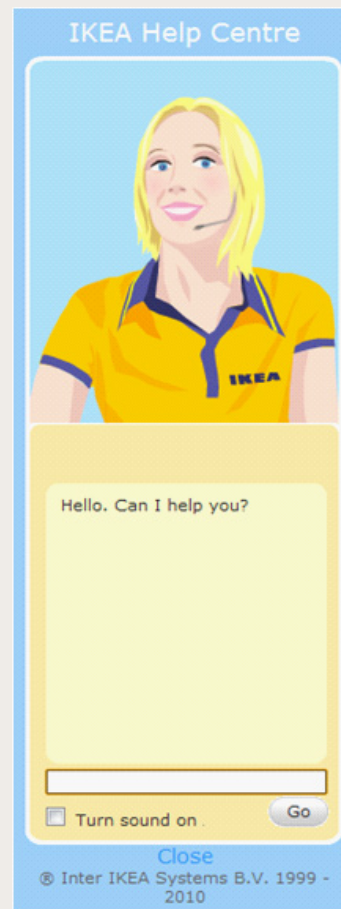
BOX 3: CO-PRODUCTION

Many companies are using the Internet to allow consumers to participate more in their businesses, especially with "Web 2.0" technology like social networking, blogs, and wikis. While not necessarily self-service, this form of co-production enlists consumers to take on the role of traditional service workers including designers, reporters, quality assurance specialists, and customer service agents. For example, the Web site Threadless hosts weekly design competitions where users submit t-shirt designs and slogans and then the online community evaluates the submissions and chooses winners. The best entries are produced and then sold online. Dell uses IdeaStorm.com to collect suggestions from customers on how to improve their products and services. Using the Web site, the community can vote on the best ideas and then track Dell's efforts to implement the suggestions. Blogs like DailyKos and Huffington Post have blurred the line between reader and contributor and extensively rely on guest posts for the vast majority of their content. Even mainstream news organizations such as CNN have launched services like iReport, which encourages its audience to report the news by submitting written commentary, photos and video which are then featured as part of the daily newscast.

Some online businesses, like YouTube, Facebook, or Second Life, exist entirely because of user-generated content, and the value of these sites is directly related to the quality of content produced by consumers. Other companies enlist users to create a better service and harness "the wisdom of the crowd" in designing products and services. For example, Netflix distinguished itself from its competitors early on by providing online tools to allow users to review and rate their favorite movies. Similarly, many e-retailers like Amazon have built their brand around the wide availability product reviews from their customers. The online electronics retailer Newegg has gone a step further and in addition to extensive user reviews, it has created an entire online community, eggXpert.com, as a self-service tool designed to have customers share their expertise and advice on products. Not only does Newegg rely on customers for content, they have even enlisted "volunteer" moderators to work jointly with staff moderators to help maintain the site.[12]

sion forum, troubleshooting engine, software center, parts ordering site, and service contract center. Cisco reported that 80 percent of its customer service was handled through self-help tools, and the company also reported increased productivity and customer satisfaction. Overall, these self-service tools save Cisco over $500 million annually.[87]

ONLINE CUSTOMIZATION

Self-service tools also let consumers customize products online. In the old economy, only the well-to-do could afford to buy customized goods. For the rest, options were limited to "off the rack." Now self-service Internet technologies are bringing customization to a wider array of consumers. Dell pioneered this approach with its use of the Internet to enable build-to-order personal computers. Other companies have embraced online customization as well. For example, consumers can design their own shoe on Nike.com or put a personalized message on M&M's. Lands' End allows customers to submit measurements online to produce custom-fit clothing. American Quantum Cycles lets customers order bikes online to fit their unique measurements. Using the Internet to receive orders, CafePress takes basic commodities like t-shirts, hats, and coffee mugs, and then prints onto them the designs submitted by customers. The Web site Partypongtable.com lets users design their own game tables, including the type of material, design, and logos.

Even vehicles can be customized online. The BMW-owned Mini brand popularized the practice of allowing customers to design their own vehicles on the Internet. Scion (a Toyota brand) adopted this practice and is probably the second-most mass customized automobile brand in the world. Unfortunately, American automobile manufacturers have limited ability to offer build-to-order, mass customized automobiles over the Internet due to automobile franchise laws in all 50 U.S. states which prohibit U.S. automobile manufacturers from selling vehicles directly to customers over the Internet (rather than through locally franchised dealers). Such regulations harm consumers and automobile manufacturers alike. For example, one Yale University

study found that the average customer using an online service to buy a vehicle pays approximately 2 percent less than someone buying in person from a dealer; these savings would likely be even greater if consumers could go online and buy a car directly from the manufacturer.[88]

ACCESS TO GOVERNMENT SERVICES
E-government can save taxpayers money and often improving service. Government agencies are increasingly offering self-service options online to renew driver's licenses, pay parking tickets, and request government records. For example, in the United States, the Internal Revenue Service (IRS) launched its "e-file" program in 1999, allowing federal income taxpayers to file their tax returns electronically. And in 2001 it launched Free File, a partnership with third-party electronic tax preparation companies, like Intuit, to allow millions of taxpayers to get access to free online tax preparation software. In 2006, more than 50 percent of individual income tax returns in the United States were filed electronically. Moreover, as Americans have switched from paper to electronic filings, the IRS has saved over 1,600 staff years and closed three paper processing facilities.[89] For each tax return filed electronically instead of on paper, the IRS saves an estimated $2.15 per return.[90] Similarly, the United Kingdom has found that processing electronic tax returns was over 40 percent cheaper than processing a paper return.[91]

Governments can also use self-service to provide citizens an easy way to find important information such as legal information, government forms, and property tax information. As an example, the Kansas Highway Patrol logs all accidents with injuries or fatalities on its Web site to streamline the process of disseminating crash information to the media and the public. Now the media and public can get the latest accident information without impeding the daily operations of the dispatchers. Many government records are also available online such as vital records and criminal records, allowing citizens to access this information online rather than in person.

Government agencies also use Internet-based tools to eliminate the need for in-person services. For example, in the United States, the Social Security Administration (SSA) is a large citizen-facing government agency with over 27,000 field employees in 1,300 field offices.

The SSA offers a number of self-service options online, such as estimating retirement benefits, requesting a change of address, setting up direct deposit, and requesting a Medicare replacement card. Citizens can even use the SSA's Web site to apply for retirement or disability benefits, rather than applying in person. In part because of greater use of self-service technology the SSA has seen an increase in worker productivity by 2.9 percent between 2005 and 2008.[92]

American automobile manufacturers have limited ability to offer build-to-order, mass customized automobiles over the Internet due to automobile franchise laws in all 50 U.S. states which prohibit U.S. automobile manufacturers from selling vehicles directly to customers over the Internet.

TICKETING AND RESERVATIONS
Electronic tickets (e-tickets) are another example of self-service technology. Many businesses, including those in the travel and the entertainment industries, have replaced paper tickets delivered by mail or in-person with e-tickets. An e-ticket may exist in electronic form only, be printed by the consumer at home or at a kiosk, or be displayed on a mobile device, such as a smart phone. E-tickets provide consumers many benefits. For example, e-tickets help eliminate the problem of lost tickets: a lost paper ticket may be impossible to reclaim, but a lost e-ticket can be easily replaced. E-tickets also make it easier for consumers to make changes, such as exchanging a ticket for a different time or date.

E-tickets are now virtually universal with airlines. In 2004, the International Air Transport Association (IATA), which represents about 93 percent of all air travel internationally, mandated that all its member airlines implement e-ticketing. As of May 2008 it had reached 100 percent compliance. By using e-tickets airlines can charge lower prices: the cost of processing a traditional paper ticket is $9 more than an e-ticket. Overall, the conversion from paper tickets to e-tickets saves the industry $3 billion annually.[94]

E-tickets are also used in the entertainment industry. Many movie theaters, sports arenas, concert halls, mu-

seums and theaters allow their patrons to purchase e-tickets online rather than buy them in person at a box office. For example, to purchase movie tickets, moviegoers can visit Web sites like Fandango or MovieTickets.com to buy tickets to upcoming shows. Tickets purchased online can be printed at home, printed at movie theater kiosks, or picked up at the box office. Moviegoers typically pay a premium for this service, in part because it allows them to avoid long lines at the movie theater and be assured of having a seat for the show.

Services like Ticketmaster allow consumers to purchase tickets for events on their Web site. Using its "TicketFast" service, Ticketmaster's customers can get their tickets immediately and print them at home. Customers also usually receive a discount for printing their own ticket, rather than having the tickets mailed to them. As of 2007, approximately 70 percent of customers choose to print their tickets at home when that option is available.[95] TicketMaster has also launched "MobileTicket," a service that allows customers to receive their ticket on their mobile phone. The ticket is displayed as a two-dimensional bar code on their cell phone and then this bar code is scanned at the point of entry to allow access to the venue.

Consumers can also use Web sites to make reservations for non-ticketed events and services. For example, Web sites like OpenTable.com allow diners to make reservations at restaurants. Outdoors enthusiasts can take advantage of the government-run Web site recreation.gov to make reservations in federal parks for camp sites and picnic shelters. In Denmark and Finland, the Omena Hotels chain runs hotels without any sales or reception clerks; guests simply make reservations online, receive PIN codes to access their hotel room, and then can go directly to their rooms when they arrive. There is no check-in or check-out procedure. Similarly, many car rental companies have created expedited programs where pre-registered travelers can reserve rental cars online so that when they arrive at their destination they can skip a long wait and go straight to their vehicle.

## Mobile devices, including smart phones and smart cards

Mobile devices serve as one of the most important channels for delivering self-service applications and its use will likely continue to grow in importance as wireless networks and low-cost mobile devices become more advanced. In particular, 3G and 4G (third and fourth generation) wireless networks allow mobile devices to access multimedia content and today's mobile phones can support advanced applications. Mobile devices include smart phones, such as the iPhone or Blackberry, smart cards, and other portable mobile electronics.

SMART PHONES

Like kiosks, smart phones provide another medium for interacting with online applications and services. One of the most interesting self-service applications on mobile devices is mobile commerce, a concept defined broadly as "commercial or financial transactions mediated through mobile phones or other handheld electronic devices."[96] Mobile commerce is exploding worldwide, with research firm Juniper predicting that, by 2011, the global value of all commercial or financial transactions effected through mobile phones will exceed $587 billion.[97] Much of this is driven by browser-enabled smart phones that allow individuals access to any Internet-based application from a mobile device. But many companies and organizations are also offering applications targeted specifically for mobile phones. By 2013, Juniper predicts that more than 2 billion mobile subscribers worldwide will have used their mobile phones for contactless mobile payments, mobile banking, or over-the-air person-to-person payments.[98]

Figure 9: Implementation of e-ticketing for air travel worldwide, 2006-2009[93]
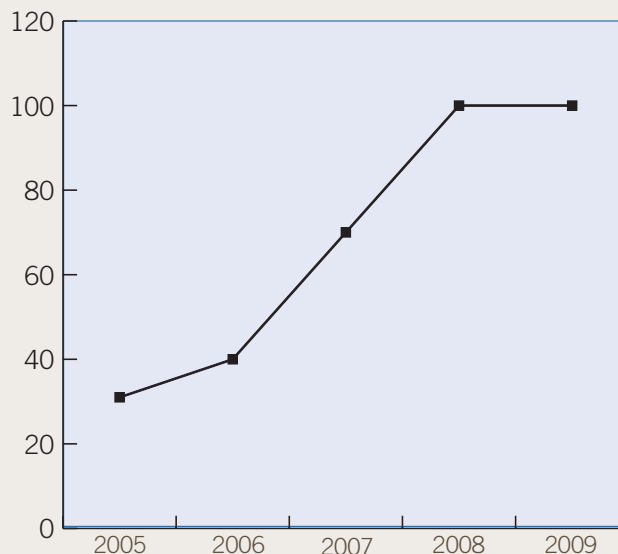
In addition, many self-service applications currently available online have been, or will be, adapted for smart phones. For example, fast food restaurants like Papa John's allow customers to order a pizza via text messaging. And banks have developed mobile applications so their customers can access their funds from their mobile phones.

Airlines have developed mobile phone check in so that travelers can check in for a flight from their smart phone. As shown in Figure 10, the mobile phone receives an electronic boarding pass, including a two-dimensional bar code that can be scanned at the boarding gate. The entire process is paperless. At present, use of mobile check in is low in the United States. At Hartsfield-Jackson Airport in Atlanta only 4.2 percent of passengers in 2009 used mobile check in (up from 1 percent in 2008), although the number will likely grow as more travelers begin carrying Web-enabled mobile phones.[99]

Mobile check in is more advanced in other countries. In Japan, for example, using mobile phones for boarding passes at airports is more common than in the United States. Travelers can also pass through security and board at the gate using their mobile phone instead of a paper ticket. Moreover, travelers can use contactless technology (i.e., using an RFID chip embedded on a mobile phone) or a standard barcode displayed on the screen of the mobile phone.

MOBILE PAYMENTS

Another important self-service technology is mobile payments systems, for example, using a cell phone as an "electronic wallet."[100] An electronic wallet is a multi-functional device possessing cash, information storage and transaction, identification and authentication, and communication functions. Combined with near field communication (NFC) technology, a specific standard of RFID technology, NFC-capable phones can securely transmit data wirelessly over short ranges between electronic devices thus enabling contactless payments. Whereas a decade ago this technology was not quite ready—the contactless microchips and mobile phones were not adequate, lacking sufficient memory and processing power—the technology has matured substantially over the past decade to the point where electronic wallets, NFC-capable phones, and NFC-enabled point-of-sale (POS) terminals are now ready for full-scale implementation and use. Mobile payments make transactions fast and easy, and either eliminate or reduce the need for tellers for many transactions.

Many of the most interesting mobile self-service applications are found in Japan and South Korea, which have more advanced mobile technology than the United States. For example, Japanese consumers use their mobile phones as an electronic credential to check into their offices, apartment buildings, and health clubs, and to register their attendance at school, eliminating the need for a service worker to perform these tasks. Japanese consumers can use their mobile devices as a mobile wallet in lieu of cash or credit cards to pay rail or subway fares (see Figure 11); to pay for taxi rides, movie tickets, and parking meters; to make purchases from kiosks and vending machines; to auction used items; and to manage loyalty cards and programs. Japanese consumers purchase hundreds of thousands of items from tickets to groceries with mobile phones every day in Japan. Because they spend an estimated 60 trillion yen ($514 billion) each year on low-value purchases, the market is primed for cash to be replaced with electronic money.

Similarly, South Koreans similarly use their cell phones for a wide range of self-service application including

Figure 10: Electronic boarding pass on an iPhone
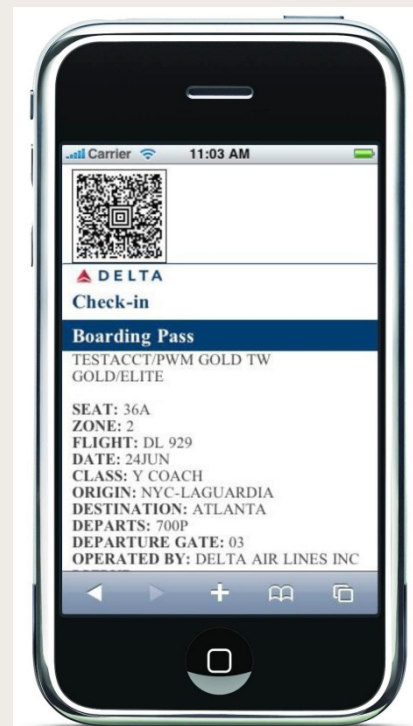
contactless payment of railway, subway, bus, taxi or limousine fare; contactless payment for purchases in convenience, fast food stores, and kiosks; to buy movie tickets and enter theatres; and as personal ID to check into workplaces or apartment buildings. Rather than require teachers to take attendance every day, students touch their mobile phones to reader terminals outside classroom doors to mark their attendance at school, with the school's server logging attendance and tardiness.

One interesting self-service payment option in South Korea is T-money. T-money is a pre-paid radio frequency (RF)-based smart card developed by the Korea Smart Card Company (KSCC) that is embedded with a central processing unit (CPU) that enables calculation on the card. One's T-money card serves as both a transportation card and electronic money card, meaning the same T-money card is accepted for payment in public transit and by affiliated merchants. T-money can be used on all public, and most private, transportation modes in Seoul, including bus, subway, and taxis, and in other venues like parking garages and toll booths. As an e-money card, T-money can be used in lieu of cash or credit cards to make payments at convenience stores, movie theatres, theme parks, vending machines, museums, kiosks, bookstores, and some merchants. Citizens can also use T-money to pay taxes and fines or to pay for other civic services.

The savings from mobile payments is substantial. As Seoul's subway system has moved from paper tickets

Figure 11: Mobile NFC Payment at a Railway Station in Japan[101]

to smart cards, it has eliminated the need for 450 million paper magnetic stripe tickets at a savings of 3 billion won ($2.4 million) per year.[102] As of March 2009, customers use T-money for 30 million public transit transactions per day (15.4 million bus and 14.6 million subway). Beyond mass transit, South Korean consumers make over 3 million e-money transactions per day using T-money, including 1.4 million T-money transactions at vending machines, over 1 million transactions in convenience stores, and some 400,000 transactions in public facilities.[103] Within the Seoul metropolitan area, 18 million T-money smart cards have been issued, with T-money accepted at the reader terminals of 19,750 buses; over 8,000 subway terminals; 73,000 taxi cabs; 21,000 vending machines; and 8,300 convenience stores, fast food stores, and parking garages.[104]

T-money has also been used for gift giving, eliminating the need for consumers to purchase gift cards. SK Telecom launched a popular service, Gifticon, which combines barcode technology with mobile payments to allow users to send gift vouchers for over 130 items. For example, an individual can go to a mobile carrier's online shop, buy an icon depicting coffee, and send it to her friend's phone, who can then go to the Starbucks, flash the icon from the phone, and get the drink. The Gifticon service has attracted 2.5 million users and delivers 70,000 gifts daily. SK Telecom expects the service to generate $10 million in revenues in 2008.[105]

Overall, Japan and South Korea lead the world in terms of per-capita number of contactless-enabled mobile phones and POS terminals deployed, the total number of contactless transactions, and the market value of contactless payments. In Japan, 17 million citizens make contactless mobile payments from their cell phones, with 65 million regularly using contactless smart cards, and 73 percent of mobile phones having electronic wallet capability. In South Korea, close to 4 million citizens use their mobile phones to make contactless payments, with 12 million phones having the capability to do so.[106] Also in South Korea, 33 million contactless transactions are made daily using either smart cards or mobile phones. While the United States has made some progress in fielding NFC-enabled credit cards and POS machines, virtually no mobile phones are equipped with NFC-enabled electronic wallets.

SMART CARDS

Only a small number of mobile phones equipped with NFC-mobile wallet capability exist in the United States. However, the United States has made considerably more progress in beginning to deploy NFC-capable contactless smart cards and credit/debit cards and getting initial merchant deployment of NFC-capable point of sale readers. A recent Nielsen survey found that only 9 million Americans had made at least one mobile commerce purchase, although 125 million Americans said they were willing to make a mobile commerce purchase in the near future, a sign of the market's immense potential.[107] In-Stat's David Chamberlain estimates that the number of wireless customers in the United States using their phones for mobile commerce transactions will reach 20 million by 2011.[108] The total size of the U.S. mobile commerce market is expected to reach $2.6 billion by year-end 2009.[109] The Tower Group has estimated that the total value of contactless micropayments (though made almost entirely from contactless credit cards) in the United States will reach $11.5 billion by 2009, and that 10 percent of U.S. payments will be contactless in 2010.[110]

Where the United States has made more progress in mobile payments is in the deployment of NFC-capable contactless credit cards and with early-adopting retail merchants that have deployed them. Each of the major U.S. credit card issuers offer contactless credit cards: American Express with ExpressPay, MasterCard with PayPass, Visa with Visa payWave, and Discover Network Zip. Thus, unlike in Japan and South Korea, where new forms of electronic money, such as Edy and Nanaco in Japan or T-Money in South Korea, were created to enable mobile electronic payments, the strategy in the United States has been to add contactless payment capability to customers' existing financial (primarily credit card) accounts. As of October 2009, more than 100 million branded contactless credit cards have been issued by U.S. card issuers.[111] Chase found that using contactless payments reduces time at the point of sale by 30 to 40 percent.[112] Another study reported that contactless transactions were 40 percent faster than those made with credit or debit cards and 55 percent faster than those made with cash. Market research firm Tower Group estimates that contactless payment can reduce individual transaction times by 10 to 15 seconds.

Historically, the United States has lagged behind leading countries in implementing electronic payment methods for the mass transit market.[113] But with nearly 33 million trips made daily on public transportation in the United States, public transit represents an ideal venue to generate a critical mass of initial demand for mobile payments and acclimate customers to paying for everyday retail purchases on a contactless basis. And indeed, over the past several years, the United

Table 1: Deployment of Contactless Fare Payment in U.S. Mass Transit[115]

City	Terminals	Projected Users	Status
Atlanta	1,500	824,000	Fully Operational
Boston	4,000	1,800,000	Fully Operational
Chicago	5,000	3,500,000	Transitional
Houston	1,500	750,000	Fully Operational
Los Angeles	6,600	3,600,000	Mid-Launch
Miami	2,000	900,000	Initial Launch
Minneapolis	1,200	425,000	Fully Operational
New York (PATH)	350	400,000	Fully Operational
Philadelphia (PATCO)	200	35,000	Fully Operational
San Diego	1,200	370,000	Initial Launch
San Francisco	4,500	2,800,000	Mid-Launch
Seattle	3,000	947,000	Mid-Launch
Washington/Baltimore	4,500	2,700,000	Fully Operational

States has started to make much more progress in deploying smart card–based (though not phone-based) contactless payment systems in mass transit, with at least 15 major U.S. metropolitan areas now in the process of or having completed deployment of contactless smart cards.[114] Washington, D.C.'s Washington Metropolitan Area Transit Authority (WMATA) was the first major American city's transit agency to deploy a system-wide contactless smart card for mass transit (SmarTrip). Table 1 displays progress in deploying smart card–based contactless payment systems in U.S. mass transit. Unfortunately, most of these contactless systems are proprietary to the issuing transit agency, meaning that one cannot use Boston's CharlieCard on the Washington Metro, or vice versa.

The primary advantages of contactless systems (over paper magnetic stripe fare cards) are lower maintenance and operating costs, speed and flexibility provided by the smart card application, better security over payments, and increased ability to collect system usage statistics. For consumers who have registered their smart transit cards online, lost cards can be frozen and new ones issued that retain the value already purchased, as opposed to lost paper cards, which cannot be recovered. One study in 2005 by a transit agency study found that eliminating or substantially reducing the need to handle cash could (by moving from cash- to electronic-based collections) deliver up to a six-fold reduction in aggregate incremental operating costs.[116]

On an ongoing basis, contactless payments are less costly than other fare media because of their lower operating and maintenance costs. In Washington, D.C., migration to electronic payments reduced staff by approximately 15 percent over a five-year period.[117] Another benefit comes from reducing the risk of loss due to fraud or fare evasion, which can represent from 5 to 15 percent of a transit operator's annual fare revenue.[118] Another advantage of electronic payment systems for transit authorities is the valuable information that smart card ticketing systems can generate; this data helps transit operators better understand consumer behavior and service customers more effectively.[119] The information can also be used for traffic management and logistics, leading to better allocation of resources, efficient timetables, reduced delays, and improved safety. Mobile electronic payments further enable transit agencies to better control, monitor, and influence ridership patterns through measures such as congestion pricing techniques.[120]

MOBILE SELF-SERVICE IN THE DEVELOPING WORLD

The wide availability of mobile phones have even introduced self-service in developing countries where the low cost of labor and lack of Internet access often serves as a disincentive to such applications. For example, sub-Saharan Africa had only 5-8 million Internet users in 2004, but 52 million mobile phone users.[121] However, individuals in the developing world increasingly use mobile applications for many purposes, from mobile banking to mobile health care. For example, in many instances, despite the availability of medicine, tuberculosis (TB) patients still die because they do not take the medication as regimented. To tackle the problem, doctors in Cape Town came up with a simple but effective idea: text message TB patients to remind them to take their medication. The medical team estimates that 71 percent of their patients had access to cell phones, and after the pilot study only one treatment failure was reported out of 138 patients. The South African government is working to expand the program nationwide to HIV patients.[122]

Whereas mobile commerce in the developed world has complemented generally well-established banking and financial infrastructure, in many developing countries, the mobile phone is stepping in to substitute for underdeveloped or nonexistent financial infrastructure. Services such as Kenya's M-Pesa allow mobile subscribers to send text messages to make or transfer payments from phone to phone. Mobile technology thus extends financial services to people who otherwise might not have access to them. In some parts of the developing world, unused mobile phone minutes are actually treated as a form of currency that is bartered in exchange for goods or services. For many consumers in emerging markets, their first banking transactions will likely be made through cell phones rather than with a bank teller.[123] As *The Economist* notes, mobile phones have "the potential to give the 'unbanked masses' access to financial services, and bring them into the formal economy."[124] Cost-effectively equipping millions more people with a mobile communications/computing device has the potential to lift the economic status of a significant number of people across the world.[125]

Kenya and the Philippines lead the developing world in adopting mobile payments (m-payments). As of June 2009, there were 7.2 million m-payment subscribers in the Philippines and over 6 million in Kenya. In the Philippines, the companies Smart Communications and Globe Telecom pioneered mobile payments through their SmartMoney and GCash services, respectively. Smart Money has just over 6 million users while GCash has 1.2 million.[126] Since its launch by Kenya's Safaricom in February 2007, M-Pesa has grown massively to reach 6.2 million registered users, accounting for 46 percent of Safaricom's 13.4 million users by the end of March 2009, with the service enrolling 11,000 new subscribers per day.[127] A total of Ksh 17.3 billion ($220 million) was transferred in March 2009 to a cumulative total of Ksh 135.4 billion ($1.73 billion) since the service's launch. M-Pesa's success in Kenya, and Smart Money's in the Philippines, has prompted many emerging market service providers and banks to enter the marketplace. GSMA (a global association of mobile carriers using GSM technology) reports that over 100 mobile payment services have launched in emerging markets to date.[128]

In Kenya, using mobile phones to transfer money is much cheaper than using traditional money transfer channels, with informal channels, such as bus or taxi drivers, costing up to 15 to 25 percent of the transferred amount.

M-payments benefit mobile subscribers in developing countries in a variety of ways. They have played a significant role in expanding the availability of micro-finance to rural and underdeveloped communities.[129] In the Philippines, millions actually receive their salaries paid directly into their phones' mobile wallet, and then pay others through text messages, sending the funds directly from their phones. Filipinos find it faster and cheaper to get money from families overseas via text message than by using a bank transfer. As another example, many Filipino farmers have to commute for hours to their banks to pay interest on their loans, and their commuting cost alone often exceeds the interest they owe; sending m-payments provides them tremendous savings in both time and money.[130] In Kenya, using mobile phones to transfer money is much cheaper

than using traditional money transfer channels, with informal channels, such as bus or taxi drivers, costing up to 15 to 25 percent of the transferred amount, and formal money transfer channels (such as banks or Western Union Money Transfer) slightly cheaper at 10 to 15 percent, but requiring a trip to town to give instructions to an agent. With M-Pesa, however, moving $5 costs only 7 percent of the funds transferred, $20 costs 3 percent, and $100 costs 1 percent.

Phone applications

IT also enables consumers to use the telephone to access self-service solutions. In particular, telephone operators have been largely replaced with digital technology. The major reason why productivity for telephone operators has increased approximately 12 percent a year since 1950 is because customers, rather than operators, now place the vast majority of calls through direct dialing. In addition, when requesting a phone listing, most consumers use a technology that allows the phone company's computer to ask the customer to say the listing they want, saving an operator from asking that. Voice recognition technology is getting so effective that there is little need for the operator to be the go-between for the customer and the telephone company computer.

The potential to automate routine telephone transactions goes far beyond telephone operators. Advances in telephone technology have also replaced centralized attendant services where individuals would call a single number and speak with an attendant to get transferred to the correct department. In its place, companies deployed dual tone multi frequency (DTMF) phone systems that let callers navigate through a preset menu to route their own call (e.g. "Press one for sales. Press two for…") or to access an employee directory.

Today, businesses are replacing these DTMF systems with interactive voice response (IVR) phone systems that use speech recognition technology to allow consumers to interact with a computer system over the phone using their voice. For example, many company phone systems allow people to look up employees' direct phone extensions. In addition, some airlines use speech recognition technology to let people check on the status of flights. Text-to-speech technology has also matured so that companies can provide information over the telephone using electronically synthesized

speech. The company TellMe even uses such systems to let people verbally surf the Web from a telephone.

Many organizations use this technology to offer self-service customer service options by telephone. For example, Amtrak created "Julie" an automated attendant to answer questions about the status of trains, discuss fares and timetables, and make reservations. In 2007, Julie answered as many calls in a day as the average Amtrak customer service agent answered in a year.[131] Similarly, many banks and utilities use the technology to allow their customers to check their account balances or hear recent transactions by phone. In 1999, 55 percent of bank call inquires were served by voice recognition systems, and without these, the number of call center agents would have had to grow by 86 percent, a large financial burden for banks.[132] The savings from IVR is substantial—the cost of an American-based, customer-service telephone agent is approximately $7.50 per phone call versus only about 32 cents per call for an automated phone system.[133]

Many applications that used to be delivered over the phone are now increasingly delivered via an online application instead. For example, online flight tracking applications have replaced the automated phone systems that people could call to find out the status and estimated arrival time of a flight (which was the original self-service technology intended to free up airline agents). Similarly, many phone companies have discontinued their time of day services that people used to call to hear a pre-recorded message stating "At the tone, the time will be…" because of the wide availability of alternatives to get this information, such as cell phone or the Internet.

IMPACT OF LABOR COST ON SELF-SERVICE TECHNOLOGY ADOPTION

The adoption of self-service technology is also driven by the cost of labor. When the price of labor is high, organizations invest more in self-service technol-ogy to reduce labor costs. Not surprisingly, countries with higher wages are generally more likely to adopt self-service technology. However, even in the United States, many organizations have not adopted self-service technology when they otherwise might have because of the low costs of unskilled labor in the United States. According to the World Bank's *Doing Business 2010* the United States ranks first along with Singapore for the ease of employing workers. The index calculates the overall costs of hiring and firing, training requirements, and the minimum wage.[134] While flexible labor markets are important for productivity growth, if labor costs are too low organizations often sacrifice capital investments because at least in the short term the returns on investment for low-skilled labor are often higher and more predictable than investments in technology.

Compared with other advanced nations, low-skilled labor is particularly cheap in the United States. In 2009 the minimum wage was raised for the first time in over a decade to $7.25 per hour; however, this is still far below other developed countries. For example, the minimum wage in the United Kingdom is $8.00 per hour (and $10.90 in London), $11.60 in Ireland, $11.75 in France, and $14.31 in Australia. In these countries investing in self-service technology makes more economic sense. Often referred to as the "Webb effect," the theory is that a higher wage floor leads to higher levels of efficiency.[135] Indeed, one study on the effects of the minimum wage on part-time employment concludes that "if the federal government raises the minimum wage employers in some sectors may expedite the adoption of automated equipment and new technology to increase labor productivity."[136]

Policymakers in the United States have largely focused on the effects of minimum wage on jobs, and not on productivity. But even here, the focus is mistaken. For example, many conservative neoclassical economists argue that raising the minimum wage can have a negative effect on employment, since they argue if you raise the price of something you get less of it (and thus lower employment). While this can be true at the micro level, it is not true at the macroeconomic level. For the most part macroeconomic employment levels are determined not by whether the minimum wage is mod-

estly higher but by overall fiscal and monetary policy. Others worry that increasing the minimum wage will reduce U.S. competitiveness especially with low-wage nations. But what these observers fail to grasp is that the lion's share of industries affected by the minimum wage are non-traded (e.g., restaurants, nursing homes, lawn care). Most industries that face international competition (e.g., much of manufacturing and services like software development) pay workers well beyond the minimum wage. Moreover, the competitive advantage of the United States cannot be low wages, given such low labor costs in nations like China. Indeed, even in Brazil, one of the only developing countries with a minimum wage, the minimum wage is $2.64 an hour, far below anything the United States could compete with. In order to remain internationally competitive firms in the United States must adopt strategies to promote labor productivity, not low labor costs.

RESPONDING TO CONCERNS OVER SELF-SERVICE

Self service is not new. After all, people push buttons on elevators to signal their floor, self-dial telephones, use vending machines, and drive cars. However, the potential of self-service was vastly limited in the pre-digital economy. In today's digital economy, consumers using digital tools from cell phones to smart cards to kiosks to broadband-enabled computers are playing a growing role in the economy.

In spite of the significant benefits of self-service, particularly for economic growth, self service sometimes gets a bad rap. There are four major concerns that have been raised: self service simply shifts work to the consumer with only the company benefiting; self service eliminates consumer choice and robs individuals of human contact; self service eliminates jobs; and finally, the economic benefits of self-service will not go to workers. All four of these concerns are either overblown or incorrect.

Concern: Self service simply shifts work to the consumer

The efforts of companies to implement self service is sometimes seen as creating work for the consumer solely for the benefit of the company. However, this is seldom, if ever, the case. First, when companies in competitive markets benefit from self service, they pass these benefits on to consumers in the form of lower prices, more convenience and better service. Second, most self-serve applications do not cost the consumer more time, they just involve one person (the consumer) doing the work instead of two people (the consumer and the service worker). In many cases the provision of services involves the participation of both service workers and consumers. In fact, this is largely what differentiates manufacturing from services. In manufacturing, the production and consumption of goods is separate. In services, they are linked and often must be done at the same time. For example, when a traveler checks in for her flight at an airport with a ticketing agent, the traveler must stand at the counter while the customer service agent does the work. If the customer uses a self-service kiosk to check in, the time spent by the customer is the same (or less given that there are shorter lines due the reduced need to keep kiosks fully utilized at all times), but the overall time to produce the service is cut nearly in half because now only one party, the customer, is engaged in the provision of the service). Granted while some self-service applications can be maddening and cost consumers time, overall self-service technologies usually cut overall labor time for both the service worker and the consumer. Moreover, self-service technology continues to improve and, over time, will only become easier to use.

Concern: Self service eliminates consumer choice and robs individuals of human contact

Some consumers complain that self-service technology robs them of the choice to get service from others. Clearly some consumers desire the ability to have choices.[137] However, in many cases, consumers still have the option to choose full service over self service. For example, airlines still allow travelers to check in with customer service agents; banks still have tellers to assist their customers; and grocery stores still have clerks to ring up groceries. What these people are usually really complaining about is that they do not want to have to pay more to get service from a person.

Even in cases where the choices are more limited, the reason is usually that people do not want full service or they do not want to pay a premium. For example, while drivers can still buy gas at full service gas stations, they make up only a small share of stations, with

the majority being self serve. But the reason there are not more full-serve gas stations is because very few people are willing to pay more for the cost of full service or wait longer to get their gas pumped for them.

Neither will a ban on self-service give everyone the benefits of full service without imposing additional costs. Generally speaking, full service costs more than self service, whether it is at a gas station, airport, parking lot, or grocery store. Even where personal service provides consumers with more value (e.g., a chauffeur-driven car is seen as a luxury), it usually costs more (which is why usually why only wealthy people have chauffeurs). Other kinds of personal service are the same. They cost more money to provide than self service and these higher costs are passed on to consumers in the form of higher prices. However, in the type of competitive markets companies face, savings from self service are passed back to consumers through lower prices, at least over the moderate to long term. As a result, the purchasing power of the average individual goes up.

Other critics lament that self service robs individuals of human contact (although these critics must have never met a disgruntled service worker). Rather than have a conversation with a person, people are being forced to interact with cold, impersonal machines. Indeed, one particularly strident critic argued that self-service involves "the sacrifice of our inherent humanity."[138] Presumably this critic would have us go back to a world of elevator operators, operator connected phone calls, and teller-mediated bank transactions and the lower productivity and higher prices that were associated with them. These complaints have been around for a long time. When telephone companies replaced operator dialing with self dialing early in the 20th century, some complained that it was a sign that society had become more impersonal and was losing the human touch. Likewise, some people initially disliked ATMs for the same reason and refused to use them. But research shows that as customers gain more familiarity with self-service technologies that they are more likely to use them and more likely to look favorably on them.[139] Moreover, as described earlier, many consumers prefer interacting with a machine as opposed to a human because it can be faster, easier to use, more informative, more accurate, or simply just more fun. For example, the National Restaurant Association found

that over two-thirds of U.S. consumers between the ages of 18 and 34 would prefer to use self-service at quick-service restaurants.[140]

However, even if self service does seem cold and impersonal to some users, this is not a trade-off without benefits. As described throughout this report, self service yields a whole host of benefits to consumers including lower prices and greater convenience. And many people gladly choose to use self-service technology precisely for the benefits—to access their cash 24/7, to skip a long line and use self-checkout, or to receive lower prices at the self-serve gas pump.

The National Restaurant Association found that over two-thirds of U.S. consumers between the ages of 18 and 34 would prefer to use self-service at quick-service restaurants.[140]

Concern: Self service destroys jobs
Some individuals and interest groups object to self service on the grounds that it costs people jobs. Indeed, with unemployment hovering just below 10 percent, shouldn't society be restricting, rather than promoting, self-service technology? Why eliminate rules prohibiting self-service gas stations if full-service stations employ thousands of workers? Why replace bank tellers with ATMs that can do the same thing? The answer is that it is better for consumers and the overall economy. Self-service gas pumps save consumers millions of dollars a year, and bank ATM machines allow customers to conduct banking transactions on their own time. There is a tradeoff but the moderate and long-term benefits to society vastly outweigh the short-term and limited benefits to protecting these jobs against change.

As such, some people may have concerns about whether the move to greater use of self-service in the economy will result in fewer jobs. Such concerns are not new. During the 1930s, a labor union wrote a letter to President Roosevelt proposing the following: "Remove the loading machines from the coal mines, complete all public work with man power, take the tractor off the farms, go into the various industries and remove enough labor-displacing machines to make employment for labor." A few years later, Congress debated legislation to require the Secretary of Labor to cre-

ate a list of all labor-saving devices and estimate how many people could be employed if these devices were eliminated.[141] When factory automation took off in the late 1950s and early 1960s, increased national concern centered on the employment effects of automation and productivity. Such concerns entered into the popular imagination of the day, with television shows and news documentaries and reports worrying about the loss of work. One particularly telling episode of "The Twilight Zone," predating the movie *The Terminator*, documented a dystopian world in which a manager replaces all his workers with robots, and in the final scene, the manager himself ends up being replaced by a robot. So great was concern with automation and the rise of push button factories that Congress's Joint Economic Committee held extended hearings on the matter in 1955. John Kennedy created an Office of Automation and Manpower in the Department of Labor in 1961, identifying, "the major domestic challenge of the Sixties – to maintain full employment at a time when automation, of course, is replacing men." Others at the time even considered schemes whereby the United States would encourage migration of Americans to other nations as the demand for labor contracted.[142]

However, both history and scholarly analysis have clearly and consistently refuted the notion that increased productivity (through automation or self-service) leads in the moderate to long term to higher unemployment. For example, new technologies (e.g., tractors, disease resistant crops, chemical fertilizers) boosted agricultural productivity, spurring a decline in agricultural employment. As food became cheaper, consumers spent the money they saved from cheaper food on other things (e.g., cars, appliances, entertainment) thus creating employment in other sectors. Similarly while auto factory automation makes it possible to produce more cars with fewer workers, it also lowers the price of cars, thereby boosting demand for cars and creating employment.

Some self-service critics, when pressed, will be willing to acknowledge this, but they argue that things are different now. Because technology is now displacing jobs not only in agriculture and manufacturing, but also in the service sector, there will be no new job-generating growth sectors to employ all those who lose their jobs. For example, author Jeremy Rifkin argues when millions of retail jobs are displaced by e-commerce and a

host of other service sector jobs undergo digital automation, there will be no new jobs to replace them. If we boosted productivity in the retail, banking, insurance, and other service sectors that were job generators up until now, where in the world will people find work?[143]

But this view fails to recognize that savings from a more efficient industry, for example, the insurance industry, would flow back to the economy in one or more of the following three ways: lower prices (e.g., lower rates for policyholders), higher wages for the fewer remaining employers, or higher profits. In a competitive insurance market, most of the savings would flow back to consumers in the form of lower prices. Consumers use the savings on lower premiums to go out to dinner a few times, buy books, or any number of other things. This economic activity stimulates demand that other companies (e.g., restaurants, book stores, movie theaters, and hotels) respond to by hiring more workers.

Conversely, banning self-service technology would not create jobs. For example, Monmouth University professor Robert Scott claims that if states banned self-service gas stations that they would, on average, each create 3,000 jobs. But this ignores the fact that consumers would be paying higher prices to support the wages of these newly hired gas station workers (and also waiting longer to get the cars filled up with gas) and because of that would have to cut back spending on other things by an equivalent amount, leading to a reduction in jobs in other sectors by an equivalent amount.[144] The only thing that would have been accomplished is that consumers would be worse off as they would be getting the same amount of gas station services, but would be consuming less of other items.

This common sense view is borne out by economists. For example, economists at the Federal Reserve write that, "Productivity grew noticeably faster than usual in the late 1990s, while the unemployment rate fell to levels not seen for more than three decades. This inverse relationship between the two variables also can be seen on several other occasions in the postwar period and leads one to wonder whether there is a causal link between them. The empirical evidence presented here shows that a positive technology shock leads to a reduction in the unemployment rate that persists for several years."[145]

Likewise, in a definitive review of the studies on productivity and employment, the OECD stated that, "Technology both eliminates jobs and creates jobs. Generally it destroys lower wage, lower productivity jobs, while it creates jobs that are more productive, high-skill and better paid. Historically, the income-generating effects of new technologies have proved more powerful than the labor-displacing effects: technological progress has been accompanied not only by higher output and productivity, but also by higher overall employment."[146] Using cross-country firm level data, the OECD has shown that technology-using industries have higher than average productivity and employment growth.[147]

"A positive technology shock leads to a reduction in the unemployment rate that persists for several years."[145]

This is not to say that productivity-enhancing technologies, including self service, do not result sometimes in short-term job loss. As discussed above, in some cases, companies re-deploy workers to provide better services and these workers end up in higher value jobs. But in other cases, companies are able to do the same with fewer workers. In fact, several studies find that in the short-run there is a small positive effect on unemployment from productivity improvements.[148] Other studies find that productivity growth has some short-term negative job impacts, but moderate- and long-term benefits. For example, Chen, Rezai, and Semmler find that while short-run productivity growth and unemployment are weakly positively correlated, in the moderate- and long-run productivity growth is strongly negatively correlated with unemployment.[149] In other words, if economies want to create jobs over the longer run, (e.g., up to ten years) embracing self-service technology is a key way to do that. The reason appears to be two-fold. First, there are jobs created in the companies providing self-service technologies. Second, and more importantly, as consumers pay relatively less for goods and services, they have more purchasing power, which stimulates a growth in other sectors, leading to a self-reinforcing economic expansion.

Finally, if some firms buy self-service devices to replace low-skilled labor, job creation will follow in industries that supply the new equipment. This means that, in general, there will be an overall shift in the economy in the direction of higher-skill and higher-wage jobs. Moreover, if the United States becomes a leader in producing self-service technology, it will experience a growth in jobs serving foreign markets. Although firms may cut some low-skilled, low-productivity jobs after adopting technology, the added efficiency of doing so reduces the price of goods and services and increases U.S. exports.

Concern: Even if self service boosts productivity, workers will not benefit

In recent years it has been a common refrain of many, particularly those on the left, that productivity increases no longer benefit average workers.[150] If this is the case, why support technological innovation, including self-service technologies to boost productivity? However, as labor economist Stephen Rose has shown:

> "the trends over the last 25 years in income growth and finds that, contrary to the conventional explanation embraced by many on the left, the fruits of productivity growth have actually been harvested by most working Americans. Much of the difference in productivity and median income growth can be explained largely by demographic change and rising non-wage benefits. This is not to say that growth in recent years has not been more inequitable than it should be, or that recent tax and social policies have not exacerbated this inequality. Both are true. However, the historical link between productivity growth and wage growth is not broken and it would be a grave mistake for our future if our nation gave up on growth."[151]

POLICY RECOMMENDATIONS

To encourage greater use of self-service technology and its related benefits, policymakers should do the following:

Resist and overturn policies that restrict business use of self-service technologies

Governments should actively resist pressure from groups threatened by self-service technology to protect them from these changes. The list of such entreaties is long and troubling. Car dealers have succeeded in getting laws passed in all 50 states making it illegal for automobile manufacturers to sell vehicles directly to the consumer, including over the Internet. Realtors

have tried to shut out Internet-based brokers to protect their 6 percent sales commissions.[152] Optometrists have worked with contact lens manufacturers to prevent online lens sellers from getting products.[153] Gas station owners in Oregon and New Jersey have resisted the move to self-service gas stations. Wine wholesalers have opposed direct online sales from wineries and out-of-state retailers.[154] And in California, grocery store unions and their allies have pressed for legislation to restrict self-service checkout at grocery stores.[155]

In other cases, some groups try to pressure lawmakers into passing bans on self-service discounts, or conversely full-service surcharges.[156] For example, in Massachusetts critics derided a $5 surcharge at the Massachusetts Registry of Motor Vehicles for citizens conducting their business in-person rather than using a self-service option such as using the Internet, the agency's automated phone system or by mail. The criticism was so strong that the Massachusetts governor rescinded the fee after only one day.[157] Likewise many states have been reticent to impose higher rates for tolls collected by toll booth clerks instead of tolls using toll transponders. Yet, these are the flip side of discounts for using self-service channels and both methods simply try to ensure that customers are paying for the full costs of their service and reward individuals who use the self-service option.

These restrictions are not limited to the United States: the European Commission is considering rules for member states that would permit manufacturers to require retailers selling their products to maintain brick-and-mortar stores and sell a certain amount of their products in these stores.[158] And a 2009 report from the European Commission found that "60 percent of cross-border transactions could not be completed by the consumer because the trader did not ship the product to their country or did not offer adequate means for cross border payment."[159]

Opponents of these innovations seldom are so crass or politically naive as to say, "Stop this innovation, it is hurting us (costing jobs, reducing profits, etc)." Rather, they couch their anti-technology claims in terms of protecting the public interest. Car dealers only wanted to protect the consumer from unscrupulous manufacturers. Travel agents, in seeking to enlist the U.S. Justice Department against the airlines forming online

travel site Orbitz, were doing it only because they "act as the public's representatives and help keep prices low."[160] Optometrists say they are only trying to protect consumers from eye damage. Alcohol wholesalers and grocery store unions are only trying to protect youth from purchasing alcohol (see Box 4).[161]

While nobody expects these groups to become self-service advocates, it is reasonable to expect policymakers not to fall for their claims of protecting the public interest, when what is really going on are efforts to protect the narrow interests of a select few in business or labor over the broader interests of consumers and the economy. Policymakers need to side with the general public and resist the pressure from those who oppose self-service innovation.

In some cases, legislative or regulatory changes are sometimes necessary to clear legal hurdles that limit the use of self-service technology. For example, the Food and Drug Administration recently passed new regulations that limit the use of self-service technology to purchase tobacco products by requiring it to be completed with a face-to-face transaction. While stopping underage smoking may be an admirable goal, a better, technology-neutral regulation would simply require age verification, and provide multiple options for satisfying that requirement, such as a face-to-face transaction or via technology (when and if it is available as a robust solution). Similarly, the online sale of alcohol is severely restricted by various state laws. Sometimes using self-service technology can even create stronger countermeasures to stop undesirable behavior. For example, a pilot project in Pennsylvania to have a kiosk sell wine can use a computer to verify if the ID card is fake, use remote monitoring to visually match a shopper's face to her ID card, and administer a breathalyzer test to ensure the purchaser is sober.[166]

In other cases, government can make regulatory or legislative changes that enable greater use of self service. For example, the growing availability of ATMs that can process checks would not have happened without the legislative reform that gave the digital images of checks the same legal status as paper checks. Likewise, Congress passed the Fairness to Contact Lens Consumers Act to give consumers the right to get their contact lens prescription from their optometrist so that they can fill it from the seller of their choice, including

online stores or discount retailers like Walmart. Government should be more proactive in identifying and overcoming these barriers. For example, the Federal Trade Commission (FTC) should be vigilant in monitoring federal and state rules and regulations that limit (or fail to encourage) self service in the private sector.

Support "prosumer" technologies like broadband, electronic IDs and mobile payment systems

Self-service is an important part of the economy, helping to boost productivity and increase consumer convenience. In the old economy, for the most part, producers produced and consumers consumed. Producers invested in new capital equipment to produce goods and services more efficiently and consumers in turn bought these cheaper goods and services. This dichotomy between producers and consumers is blurring in the new digital economy where a whole host of digital tools are enabling consumers to become, in the words of futurist Alvin Toffler, "prosumers" who act at the same time as both consumer and producer.[167]

Self-service technologies like broadband enable consumers to become more efficient, thus in turn driving higher rates of productivity and economic growth. For example, using broadband application like telemedicine and telework individuals can reduce their need to travel. By substituting bits for atoms, broadband makes distributing digital content, like movies, cheaper and more efficient. Broadband is reducing a whole host of transaction costs by making it easier to conduct business and commerce online. However, the benefits from investments in "prosumer" capital equipment do not accrue just to the individual, but they spill over to society as a whole. Thus government should consider the importance of self-service to the economy when faced with policy issues, such as investing in broadband or extending the Internet tax moratorium.

Other prosumer technologies also deserve government support. As more services become digital, the need for a robust system that allows individuals to electronically identify and authenticate themselves will continue to

grow. Consumers need a flexible and interoperable system of electronic IDs to be able to complete electronic transactions securely and privately. A nationwide system of electronic IDs would support applications such as age verification for retailers at kiosks and help prevent fraudulent transactions. Electronic IDs would also enable more secure e-commerce and give consumers more control over sensitive information, such as their online electronic health records.

Similarly, self-service can benefit from a better mobile payment system that allows consumers to use their mobile phones to pay for goods and services.[168] In many advanced countries, consumers use their phones as multifunctional electronic wallets to pay public transit or taxi fares; to make purchases from merchants, restaurants, convenience stores, and automated devices; and to check in at airports, hotels, and schools, as well as a host of other functions. A secure mobile payment system will help make self-service transactions more consumer-friendly.

Encourage greater government use of self-service technology

As the private sector pushes forward with self-service technology in response to consumer demand for greater control and convenience, people increasingly expect to have self-service options made available to them in all aspects of their lives. Government has many opportunities to use self-service technology to improve efficiency, cut costs and provide better service to its citizens. For example, less than 50 percent of citizens that apply for benefits from the Social Security Administration (SSA) do so online. Likewise, few U.S. Post Offices have installed self-serve kiosks and the U.S. Postal Service has not done enough to encourage customers to use them. To that end, government should continue to find ways to use self-service technology to improve government-citizen interaction. Where cost-effective self-service options already exist, government agencies should find ways to encourage their use. For example, the SSA can install kiosks or public computer terminals in the lobbies of its field offices to encourage citizens to use self-service options and provide access to a self-service option to those without Internet access. By using self-service technology for routine transactions, agencies can redeploy staff to higher value service and provide better quality service to citizens. Government should also reward citizens

that use low-cost self-service options. For example, a parking ticket that is paid online could be priced lower than one that is paid in person. One strategy would be for the Obama administration to create a self-service task force co-chaired by the President's CIO and CTO, and made up of officials from federal departments, to plan how the federal government can encourage the use of self-service throughout the government.

Support creation of a Center of Excellence for Accessible Design in IT-enabled Self Service

As discussed previously, self-service technology can be used to provide more accessible service to consumers; however, this is not always the case. Accessibility, much like security or privacy, must be engineered early on in the development of products and services. For example, a self-service kiosk may not always be accessible to an individual in a wheelchair or an online application may not be compliant with accessible web standards. To ensure that as more self-service technology becomes available it does not come at the expense of any particular population, Congress should fund the creation of a Center of Excellence (COE) for Accessible Design in IT at a major U.S. university. The COE would support the development of best practices for accessible design for kiosks, online services, interactive voice response systems, and mobile applications and devices.

Increase the minimum wage in order to boost self-service technology adoption

Creating an economy that encourages high-skilled labor over low-skilled labor also increases the adoption of technology, regardless of whether workers are particularly skilled in the specific technology adopted. For example, Daron Acemoglu, an MIT economist, finds that in the absence of minimum wage legislation the labor market in the United States is inefficiently biased towards low-wage jobs.[169] Industries with high-wage workers promote the investment in technology, despite skill levels, as the relative cost for performing a task is much higher for higher paid workers, and therefore the returns from training and new technology are also higher.[170] By allowing unskilled labor to be replaced by self-service technology and increasing the number of high-skilled jobs to operate these technologies, a higher minimum wage, indexed to inflation, could help create a feedback loop where companies invest in technology to replace low-skilled workers, which increases

their need for high-skilled workers, which then reduces the relative costs of investing in technology.

An additional mechanism to increase the use of self-service technology would be to replace the Earned Income Tax Credit (EITC) with a higher minimum wage. The EITC is a refundable tax credit aimed at reducing the payroll tax burden on low-income workers. Because the EITC is paid for by taxpayers and not firms, firms are shielded from the cost of subsidizing low-wage workers. On the other hand, because the minimum wage is directly paid for by firms through labor costs, paying to increase the minimum wage by reducing the EITC would shift the cost burden to firms without added any extra costs to the overall economy (because the overall cost to the economy is the same regardless if taxpayers are paying for the EITC or firms are paying for the minimum wage). And as firms begin to feel the pressure of an increased minimum wage they will be more likely to replace low-skilled labor for more efficient technology.

Provide stronger safety nets for workers adversely affected by technological change

Self-service technology often involves replacing a human with a machine and, as a result, renders many jobs obsolete, from the telephone operators who have been replaced by automatic switching technology to the elevator operators who have been superseded by computer-controlled elevators that operate automatically. Disintermediation, the elimination or reduction of unnecessary middlemen from a transaction, yields significant productivity benefits but is an unfortunate effect of implementing self-service technology. While this fact should not prevent policymakers from pursuing self-service technology, it should highlight the importance of developing worker-friendly policies that provide strong safety nets while still encouraging businesses to adopt productivity-enhancing innovations.

Policymakers can follow the "flexicurity" model in Denmark that moves away from policies that try to protect jobs and instead focuses on policies to protect people (i.e., an emphasis on employment security not job security).[171] This type of model recognizes that in today's economy changes in the labor market occur rapidly and businesses need a flexible labor market. It also recognizes that both businesses and workers benefit more from employment security and income security than from job security. Therefore policies emphasize unemployment support, workforce training, and better services to assist workers getting back into the labor market. One place to start would be to reform the unemployment insurance system in ways that, among other things, increases the minimum benefits workers receive and expands coverage so that a larger share of workers who lose their job through no fault of their own are covered.

CONCLUSION

From ATMs to e-commerce to mobile payments, self-service technology offers a broad set of benefits, including lower costs and more convenience, for consumers and businesses. Moreover, the self-service economy has the potential to contribute even more to our national prosperity and quality of life. While self-service technology is widespread, it is still relatively new and will only continue to improve in quality over time. However, policymakers must avoid enacting policies to restrict self-service while at the same time putting in place appropriate policies to stimulate the self-service economy to realize these benefits.

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