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The economy and digitalization – opportunities and challenges

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Preface

If a software robot, such as IBM's Watson – or some future variant thereof – were to write a report on the economic implications of digitalization, what would it look like?

Unlike the author, it would be able to scan *all* the current works that reference automation and technology, from Keynes and the Luddites to the myriad of reports from think tanks, management consultancies, and armchair philosophers. In this I fear the robot would win in terms of sheer volume and endurance. What would the scan look like? It would find the current economic literature a little unsure of how to tackle the issue of digitalization, recently scarred from having misread and otherwise having been blindsided by the financial crisis in 2007. Could economists once again get it wrong?

Perhaps the first step for the software robot would be to specify keywords to use in the search. In his book *Superintelligence: Paths, Dangers, Strategies*, Nick Bostrom discusses the path to artificial intelligence (AI), but for the foreseeable future, robots are not true AI and the keywords would have to be supplied by a human being, such as myself. Indeed, if computers were true AI, it is unclear why they would want to write a report about the economic effects of digitalization in the first place. Taking the economists' approach of focusing on incentives, we might suppose that AI robots would be most concerned about the steady supply of electricity and raw materials for replacement parts, just as human beings are preoccupied with extending the span and enhancing the quality of their lives.

After having been given the keywords to search for, the robot would scan the literature and arrange the arguments in some order. Using statistical techniques and amassing frequencies, it would compile a list of data up the current day with all the arguments that support various positions. For example, the argument that robots will take over is supported by facts x, y, and z and so on. In the jargon of the economic profession, this kind of search might be called data mining, which is very useful for finding correlations and discovering trends.

But it also brings several pitfalls. On the plus side, the robot software would not be afraid of amassing evidence that did not support a particular position. As long as the program it follows is neutral, it stands to reason that the output would be neutral as well. A human being writing a report inevitably has prior beliefs (as Bayesians might say) that slip into the writing and influence the report; we might call them biases. All writings, from newspaper articles to books to academic papers are to some extent colored by prior beliefs, as is the selection of reading material. For example, a person who selects one newspaper rather than another makes a choice to be more interested in the prior belief of that newspaper. It is then perhaps no surprise that that the early robot-written texts tend to be in areas of sports and competition, where the presentation of goals and times compared to the past are the key outcomes.

So, having an unbiased report would surely be a good thing? It is not clear that even if the researcher – or the robot software – is unbiased that this would automatically make the report unbiased. If the main driving force for finding results would be the frequency of how many times various keywords are mentioned, then there is always

the risk that frequently mentioned nonsense would be assigned high value (or in the jargon, a high probability mass), whereas the really good stuff might be discarded. In my reading of the literature, I keep coming back to some of the great writings and thinkers – Keynes, Schumpeter, Coase – that stand the test of time; even when they are wrong, they are wrong in helpful ways that give us the wherewithal to think better about the issues that matter. Of course, no robot would dismiss Keynes, but what other good material might fall below the radar?

In the end, I would be quite happy to let robot software do the scut work of a literature review, not unlike how we send out spacecraft to amass data from faraway planets while we go about our lives, so that I could focus on the other stuff: structuring the report, trying to make abstract ideas understandable, and addressing policy issues of how the economy works and how it affects people. In the future, they might be able to help with these things too, but then I would likely feel more inclined to overrule the robot.

I would especially like the robot to create all my charts and put the references in the correct order and format – and I doubt I am alone there. Just as machines in the past made the need for arduous and dangerous physical work redundant across broad activities – mining and road/railway construction, for instance – we can only hope that some of the hitherto inevitably dreary parts of writing – or the equivalent in other professions – might be easier.

How I try to address the policy issues raised by digitalization is the outcome of this report. I believe the amassing and structuring of data is an important phase but that it should not distract from scenario or policy analysis. Human beings are not particularly good at forecasting far into the future and there is no reason to believe robots would be better. Instead, one of our strengths is to have scenario analyses that outline different future paths – often taking somewhat extreme roads to more clearly illustrate the implications of going in some particular direction – in order to raise the issues confronting policymakers. Ultimately, the question is what kind of policies roughly *support good outcomes* and *avoid the really bad ones*.

It is especially important to think about policies that are grounded in the way our institutions currently work because systems change slowly and, absent a crisis, there is little chance of public acceptance of major upheavals. Since we cannot be completely sure what the right policy is anyway, slow changes may be a good thing, while always being open to adjusting the path if it turns out prior beliefs were ill-advised.

Perhaps as a matter of conscience, I should also state my own prior beliefs. I find it hard to believe doomsday predictions of a future without work, as outlined in any number of recent books, for example Martin Ford's *Rise of the Robots*. People adjust and new jobs are created; this happened despite the fears of the Luddites during the Industrial Revolution. As stressed by David Autor, most of the benefits from digitalization come from viewing the *complementarity* in work between computers and people.

But the worry is that the *period of adjustment may be tough*. In particular, it might be hard for broad groups in society – the lower and middle classes – as the changes brought by digitalization are both wide in scope and fast. To be sure, in contrast to the adjustments that occurred during the Industrial Revolution – affecting workers, artisans, and even the aristocracy – we now have social safety nets such as unemployment insurance and sick pay; in Sweden, we have one of the most expansive social safety nets in the world and so the issues confronting us are different from those in the US, where the social safety nets are riddled with holes.

I believe the question we should be asking is how institutions in different countries need to adapt to make the structural change from digitalization as *unrugged* as possible. This involves social safety nets, how wage bargaining works, the rules governing how firms operate, and the education system. In contrast to life during the Industrial Revolution, people today have much *higher expectations* on government, and life is not just about surviving but also about quality – living the "good life." The British television drama *Downton Abbey,* set in the latter years of the Industrial Revolution illustrates well the clash between the old and new. We are now entering an age faced with our own, digital, version of this challenge.

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Executive summary

Will digitalization destroy half the available jobs in the next decade or so, as suggested by Oxford researchers Carl Benedict Frey and Michael Osborne? Or will we experience structural change "as usual" that our institutions are well poised to handle? Will the current lackluster productivity growth, burdened by aging demographics and high public debt, bounce back when the full effects of digitalization emerge? How our institutions – governments, central banks and labor market organizations – respond to these challenges will be key to the welfare effects.

In this report we survey the evidence of the effects of digitalization, by which we mean the broad implementation of digital technologies across many different dimensions of society. We contend that it is not enough to only look at past experience of technological change to understand what digitalization may bring; we also need to consider the effects of long-run trends, such as aging populations and urbanization. It is also important to critically assess what new technological developments mean.

Against the background of slow productivity growth in OECD countries, there is some urgency about improving the structural features to not hold back growth unnecessarily due to aging populations and public and private debt overhang. But the pace of regulatory reform for product and labor markets has slowed in OECD countries, including Sweden, in recent years.

It is fair to say that there is consensus that technology had positive impact on the content of work and has not, despite forebodings to the contrary, reduced the total amount of work. Famously, the Luddites destroyed machines during the Industrial Revolution in the UK, fearing that jobs of artisans would fade away with the rise of machines. Jobs were indeed destroyed, but new ones were created in industry and in services. Throughout the 20th century, especially the latter half, advances in technology led to better jobs and higher productivity. Many bad jobs, requiring arduous or dangerous manual labor – such as working in mines or building roads – were taken over by machines. Household work also improved tremendously with electricity and availability of modern appliances.

We have experienced what economists sometimes label skill-biased technological change. Improvements in technology led to higher demands on labor, which in turn improved output and generated real wage growth. The question then becomes: is the good streak of technology and work set to continue? Will computers and robots lead to the kind of upheaval experienced during the Industrial Revolution or will events unfold more like they have in recent decades? The jury is still out, but in this report we raise concerns that we may be in for a difficult transition period and the outcomes will crucially depend on the quality of response from governments and institutions.

Today we tend to look at the Industrial Revolution as the basis of our welfare. The invention of the steam engine, the car, and the train, along with clean water and advances in medicine made tremendous improvements in quality of human life. We also saw the development of labor unions to balance the power of factory owners. Nevertheless, economic historian Joel Mokyr of Northwestern University has pointed out that for most of the period 1750–1850, real wages did not improve much.

The challenges today, of course, are not as dramatic as during the Industrial Revolution. But the modern equivalent is job polarization and the shrinking middle class, which have been documented in many OECD countries. The experience in Sweden is different from for example the US, where broad groups have had little real wage growth. Quite the contrary, real wage growth has been strong in Sweden since the beginning of the 1990s, coinciding with the introduction of a set of institutional reforms for fiscal discipline and an independent central bank.

It is likely that we will continue to see job polarization in OECD countries. So far, job polarization in Sweden has been characterized by high growth of the most skilled jobs, a diminished share in the middle and an about constant share of the lower skilled jobs. Future developments will depend on how policy makers respond. With protectionist responses that undermine the benefits of digitalization, we are likely to see much stronger job and wage polarization. In other words, income inequality may rise, especially since the growth of new jobs will be slower if regulation developed for the analog world is not updated to account for the different mechanisms and potentials of digitalization. It is especially important to reduce the uncertainty in regulatory change that may constrain investment.

One way to formulate the challenge is thus to aim for policies that will help realize the productivity gains from digitalization but with as few consequences on welfare as possible; that is, ensuring that general prosperity increases and that as largest share of the population as possible are along for the ride. Thus far, policies in Sweden have not taken the challenges seriously enough and the risks of adverse outcomes in the labor market have increased.

To better understand the magnitude of the policy challenge, one place to start is to review the outlook for automation of jobs. The incentive to automate work remains strong and is driven by the will to improve products and services – to make things better. This incentive is now being strengthened by demography. In many OECD countries, populations are aging rapidly; in Sweden the number of young people entering the labor market will soon be fewer than those who exit for retirement. German carmakers are already dealing with shortages of production workers, increasing the need to automate tasks and improve working conditions for older people to promote longer working lives. In some sectors or regions, the lack of skilled workers may be especially acute even as there is an oversupply of unskilled workers in some areas.

The extent to which it is possible to automate tasks would likely come as a shock to many people. Often the idea of automation is displayed as a robot sitting at a desk, often with a coffee mug – perhaps to appear less threatening. But the image is misleading, as most of automation, especially of more skilled work, will be done in the cloud, from faceless server halls physically located in especially favorable locations. For example, Facebook has located such a center in Luleå in the north of Sweden to draw benefits from the natural cooling provided by the low average temperatures.

We are seeing further automation in services, such as hotels and restaurants. With the advent of self-driving vehicles, many fewer professional drivers will be needed. There is also a next level of automation in finance and insurance. The tasks in the middle are increasingly subject to competition from computer code or from on-demand services in the cloud. For example, a Dutch insurance company has streamlined insurance claims processes, removing several human steps, which has resulted in faster results and higher customer satisfaction. Banking is particularly amenable to programming because a great deal of content originates in numbers and many intermediary functions are disappearing.

Work automation revolves around subdividing tasks into different parts, similar to the process that led to outsourcing of work to low-income countries in Asia and elsewhere. Suitably defined, tasks can be automated and improved, often in cloud-based services; they may also be outsourced to the sharing economy via digital platforms. The new feature of job automation is that more skilled work is subject to automation as well, such as legal research, administration, writing, and grading of written exams and essays.

A constraint on work automation has been the difficulty of coding tasks that require cognitive ability or creativity, an argument especially espoused by Professor David Autor of MIT, one of the foremost scholars in the field of technology and labor markets. For example, humans know how ride a bicycle but writing down the rules for this activity is inordinately difficult. Another often used example is the difficulty of making programs recognize physical objects based on definable characteristics, such as that a chair has legs or a cat has whiskers. While humans can no longer beat computers at chess or Jeopardy, it provides false comfort that humans are still better at, for example, not mistaking a traffic cone for an easy chair. Notably, overcoming these issues is a challenge for programmers, but it is not clear that they pose an insurmountable obstacle. Indeed, advances in machine learning allow software to mimic human behavior even when the understanding of purpose is not coded. That automation will hit an insuperable obstacle when it comes to tackling tacit skills remains to be seen. Rather than being a brick wall beyond which automation cannot venture, tacit knowledge might be reshaped or subject to circumvention and redefinition.

We may already be seeing advances in this direction. Even creative work, hitherto firmly in the human domain, is also affected by ones and zeroes. For example, computer programs have written music performed at concerts. Even the disrupters themselves – the programmers who write code to automate work – are also beginning to be at risk. The reason for this is that a large share of code is a bit like the building pieces for a piece of IKEA furniture; the basic components could be pulled off the shelf and do not have to be reinvented every time.

While the possibilities of automation have increased tremendously, this is not to say that the path of automation is a straight line or somehow inevitable in all areas. There is strong institutional inertia that slows automation, but other factors are also important and sometimes dominate. Tasks will not be automated if there is no profit to be made. And profits will depend on the costs of automation compared to human work, demand factors, and regulation.

Taken together, what are the major forces most likely to affect the pace of automation? Aging populations and lack of skilled workers in some areas will increase the incentive for automation. Rigid labor markets have the same effect, making it more attractive to either automate tasks or buy them in the sharing economy. A force in the other direction for a small country such as Sweden is that of scale. The benefits of automation depend on costs of investment; in some areas where investment costs are substantial, automation may be slower. The net effect of various forces is impossible to predict and will depend on a variety of factors, including policy responses from government and from the labor market partners. However, to conclude that small countries are "safe" from automation from big platforms would be a mistake. A more proactive view would be that there may be opportunities for entrepreneurs to build clever ways to account for local idiosyncrasies, in Europe and elsewhere, before the big platforms come knocking.

With a protectionist response and slow regulatory reform, the path may be rockier. Welfare gains may be slower in coming – or even fail to materialize. More specifically, we would likely to see more technological unemployment, increases in income inequality, and slower productivity growth. When the economy's ability to shift resources between sectors is interfered with, the adjustment will be tougher, most especially on labor market outsiders.

But there are some policies that would help smooth adjustment in the labor market and help realize the benefits of digitalization:

- Lower the tax on (human) labor. High taxes on labor in Sweden further strengthen the already strong incentive to automate tasks. Tax deductions for household services should be expanded, not reduced.
- Ease the regulatory uncertainty that surrounds the sharing economy. This will provide flexibility for adjustment and lower risks of higher structural unemployment.
- Improve opportunities for lifelong learning. Longer working lives combined with rapid technological change increase the risk that some skills will reach their best-before date earlier than before. To reduce the risk of poor prospects in the labor market, updated skills will be crucial.
- Reduce the asymmetry in social security between being employed or working freelance.
- Establish principles for regulation of the digital economy that can be used to speed reform in different sectors, reducing the need to reinvent the wheel. This will require focused collaboration between lawyers and economists – and not at the usual slow pace. Otherwise, productivity growth may remain stagnant and the macroeconomic headwinds from demography and public debt will continue to dampen growth.

The digital revolution will likely improve quality of life, efficiency at work, and continue to transform leisure. But there is nothing inevitable about how smooth the ride will be. The institutional response will be key to improving productivity growth without risking higher unemployment and rising inequality.

Exekutiv sammanfattning på svenska

Kommer digitaliseringen att få hälften av dagens arbetstillfällen att försvinna inom de närmaste tjugo åren, som Oxford-forskarna Carl Benedict Frey och Michael Osborne påstår? Eller kommer vi att få uppleva en ”vanlig” strukturförändring som våra institutioner har erfarenhet av hur man hanterar? Kommer dagens svaga produktivitetstillväxt, hämmad av åldrande befolkningar och höga statsskulder, att återhämta sig när digitaliseringen slår igenom fullt ut? Hur våra institutioner – regering, riksbank och arbetsmarknadens parter – reagerar på sådana utmaningar lär få avgörande effekt på välfärden.

Den här rapporten redogör för digitaliseringens effekter, och vi avser implementeringen av digital teknik i samhället i bred bemärkelse. Vi menar att det inte räcker med att bara titta på tidigare erfarenheter av tekniska förändringar för att förstå vad digitaliseringen kan komma att innebära. Vi måste också väga in effekterna av långsiktiga trender, som åldrande befolkningar och urbanisering. Det är också viktigt att kritiskt analysera vad teknologiska innovationer har för implikationer.

Mot bakgrund av den långsamma produktivitetstillväxten i OECD-länderna är det angeläget att snarast genomföra strukturreformer i ekonomin så att tillväxten inte i onödan bromsas av åldrande befolkningar och höga privata och offentliga skulder. Dessvärre har takten på strukturreformer på produkt- och arbetsmarknader saktat ned i OECD-länderna, inklusive Sverige, på senare år.

Det råder konsensus om att tekniken har påverkat arbetets innehåll på ett positivt sätt och inte, trots varningar om motsatsen, minskat den totala mängden jobb. Det är väl känt att de så kallade Ludditerna förstörde maskiner under den industriella revolutionen i Storbritannien av rädsla för att hantverkarna skulle förlora sina jobb. Deras jobb försvann mycket riktigt, men det skapades också nya inom industrin och tjänstesektorn. Under hela 1900-talet, särskilt under de sista 50 åren, skapade den tekniska utvecklingen bättre jobb och högre produktivitet. Många farliga eller mödosamma arbetsuppgifter – till exempel gruv- eller vägarbete – övertogs av maskiner. Elektriciteten och tillgången till moderna hushållsmaskiner innebar också en kraftig förenkling av hushållsarbetet.

Vi har upplevt en teknologisk utveckling som gynnat personer med hög produktivitet framför personer med låg produktivitet. De tekniska förbättringarna innebar att kraven på arbetskraften ökade, vilket i sin tur innebar högre produktion och skapade reallöneökningar. Frågan blir då: kommer den här positiva trenden för teknik och jobb att fortsätta? Kommer datorer och robotar att leda till lika omvälvande förändringar som under den industriella revolutionen eller kommer utvecklingen att bli ungefär likadan som under de senaste decennierna? Den frågan finns det inget svar på ännu, men i den här rapporten ställer vi oss frågan om det kan vara så att vi står inför en svår övergångsperiod och att utgången till avgörande del beror på hur väl myndigheter och institutioner kommer att hantera utmaningarna.

Idag betraktar vi ofta den industriella revolutionen som grunden för vårt välstånd. Uppfinnandet av ångmaskinen, bilen och järnvägen, kombinerat med rent vatten och framstegen på det medicinska området, innebar stora förbättringar av människornas tillvaro. Samtidigt utvecklades fackföreningsrörelsen och fungerade som en motvikt mot fabriksägarna. Men ekonomihistorikern Joel Mokyr på Northwestern University framhåller ändå att reallönerna inte förbättrades i någon större utsträckning under merparten av perioden 1750–1850.

Idag står vi naturligtvis inte inför lika dramatiska utmaningar som under den industriella revolutionen. Men den moderna motsvarigheten är jobbpolarisering och en krympande medelklass, som dokumenterats i många OECD-länder. Sverige skiljer sig därvidlag t.ex. från USA, där reallönerna nästan inte har ökat alls för stora grupper, genom att vi sett betydande reallöneökningarna sedan början av 1990-talet, och de sammanföll med att regering och riksdag genomförde ett antal institutionella reformer för budgetåterhållsamhet samt en oberoende riksbank

Jobbpolariseringen på arbetsmarknaden kommer sannolikt att fortsätta i OECD-länderna. Hittills har jobbpolariseringen i Sverige i huvudsak karakteriserats av en hög tillväxt av de mest kvalificerade jobben, en minskad andel av ”jobben i mitten” och ett konstant antal jobb i den nedre delen av fördelningen. Hur utvecklingen fortsätter beror på vad beslutsfattarna gör. Om reaktionerna blir protektionistiska, och underminerar digitaliseringens fördelar, kommer jobb- och lönepolariseringen sannolikt att bli betydligt mer omfattande. Löneskillnaderna kan med andra ord komma att öka, i synnerhet eftersom ökningen av antalet nya arbetstillfällen kommer att bli långsammare om de regelverk som utvecklats för den analoga världen inte uppdateras så att de tar hänsyn till de nya mekanismer och möjligheter som digitaliseringen medför. Det är särskilt viktigt att minska osäkerheten i utformningen av regelverk för att inte hämma investeringar i onödan.

Ett sätt att sammanfatta utmaningen blir därför att sikta på en politik som bidrar till att tillgodogöra sig produktivitetstillväxten från digitaliseringen med så få nackdelar för välfärden som möjligt, dvs. att säkerställa en generell välståndsökning i vilken en så stor andel av befolkningen som möjligt får ta del. Än så länge har politiken i Sverige inte tagit utmaningarna tillräckligt allvarligt och riskerna för negativa återverkningar på arbetsmarknaden har ökat.

Ett sätt att förstå vilka policyutmaningar man står inför är att värdera den kunskap som finns kring utsikterna för automatisering av jobb. Drivkraften för sådan automatisering är stark och kommer av en vilja att förbättra produkter och tjänster – att göra saker och ting bättre. Den drivkraften förstärks nu av att befolkningen åldras snabbt i många OECD-länder. I Sverige är det snart färre unga som gör sitt inträde på arbetsmarknaden än antalet personer som går i pension. Biltillverkarna i Tyskland har redan problem med brist på arbetskraft i produktionen, vilket ökar behovet av att automatisera arbetsuppgifter och förbättra arbetsförhållandena för äldre personer så att de kan förlänga sitt yrkesliv. Inom vissa sektorer eller regioner kan bristen på yrkesutbildad arbetskraft vara stor medan det finns ett överskott på okvalificerad arbetskraft på andra områden.

Många människor skulle sannolikt bli förvånade om de fick klart för sig i hur hög grad det är möjligt att automatisera arbetsuppgifter. Automatiseringen beskrivs ofta med en bild av en robot som sitter vid ett skrivbord, gärna med en kaffekopp – kanske för att figuren ska framstå som mindre hotande. Men det är en vilseledande bild eftersom automatiseringen, särskilt av mer krävande arbetsuppgifter, oftast kommer att ske i molnet med fysiskt hemvist i opersonliga serverhallar som är förlagda till

särskilt utvalda platser med förmånliga villkor. Facebook har till exempel förlagt en sådan datacentral till Luleå i norra Sverige för att kunna utnyttja den naturliga kylning som de låga genomsnittstemperaturerna ger tillgång till.

Exemplen på automatisering av tjänster, till exempel i hotell och restauranger, blir allt fler. Då självkörande fordon införs kommer behovet av yrkesförare att minska kraftigt. Automatiseringen kommer också att fortsätta inom finanssektorn och försäkringsindustrin. Datorprogram och tjänster i molnet konkurrerar i allt högre utsträckning om arbetsuppgifterna som medelklassen utför. Ett holländskt försäkringsbolag har till exempel rationaliserat handläggningen av försäkringsärenden genom att eliminera en rad mänskliga faser och det har bland annat resulterat i snabbare handläggningstider och nöjdare kunder. Banktjänster passar särskilt bra för digitalisering, eftersom en stor del av arbetsmaterialet består av siffror och många mellanled försvinner.

Automatisering av jobb handlar om att dela upp arbetsuppgifterna i olika moment, ungefär på samma sätt som den process som ledde till outsourcing av jobb till låginkomstländer i Asien och andra delar av världen. När arbetsmomenten definierats på lämpligt sätt kan de automatiseras och förbättras, ofta i molnbaserade tjänster eller outsourcas till delningsekonomin via digitala plattformar. En nyhet är att även mer kvalificerade arbetsuppgifter kan automatiseras, till exempel juridiska utredningar, administration och betygsättning.

Svårigheten att programmera arbetsuppgifter som kräver kognitiv förmåga eller kreativitet har rests som begränsningar för automatiseringen av arbetslivet, något som förts fram i synnerhet av professor David Autor från MIT, en av världens främsta forskare på området teknik och arbetsmarknader. De flesta människor vet till exempel hur man cyklar, men att skriva ner reglerna för den aktiviteten har visat sig vara svårt. Ett annat exempel som ofta åberopas är svårigheten få program att känna igen fysiska föremål med utgångspunkt från bestämda egenskaper, till exempel att en stol har ben eller att en katt har morrhår. Människor kan inte längre slå datorerna i schack eller Jeopardy, och det är en falsk tröst att människor till exempel fortfarande är bättre på att inte förväxla exempelvis en trafikkon och en stol. Att lösa sådana problem är förstås en utmaning för programmerare, men om de utgör oöverstigliga hinder eller ej har ännu inte klarlagts. Maskiners förmåga att lära sig själva har idag kommit så långt att programvara kan härma mänskligt beteende även utan att förståelsen för syftet har programmerats. Om förmågan att digitalisera undermedvetna färdigheter kommer att möta oöverstigliga hinder återstår att se. Kanske undermedvetna kunskaper inte utgör en ogenomtränglig mur som automatiseringen inte kan ta sig över, utan snarare något som kan omformas eller kringgås och omdefinieras.

Redan nu börjar vi skönja framsteg i denna riktning. Till och med kreativt arbete, som tidigare var förbehållet människor, påverkas numera också av ettor och nollor. Datorprogram har till exempel skrivit musik som spelats på konserter. Till och med de som själva driver förändringen – programmerarna som skriver koden som automatiserar jobb – har börjat hamna i riskzonen. Det beror på att en stor del av koden fungerar på samma sätt som delarna till en IKEA-möbel, grundkomponenterna kan man hämta från hyllan, utan att återuppfinna dem varje gång.

Möjligheterna till automatisering har ökat dramatiskt, men det innebär inte att vägen till automatisering är så gott som självklar på alla områden. Det finns starka institutionella trögheter som fördröjer automatiseringen men också andra faktorer som är viktiga och ibland dominerande. Arbetsuppgifter automatiseras inte om det inte finns någon vinst att hämta. Och vinsten beror på kostnaderna för automatiseringen jämfört med kostnaderna för mänskligt arbete, efterfrågan och regelverk.

Vilka är sammantaget de krafter som med största sannolikhet främst kommer att påverka tempot för automatiseringen? Åldrande befolkningar och brist på kvalificerad arbetskraft inom vissa områden kommer att öka efterfrågan på automatisering. Stelbenta arbetsmarknader har samma effekt, de gör det mer attraktivt att antingen automatisera arbetsuppgifter eller att köpa dem från delningsekonomin. En kraft som verkar i motsatt riktning för ett litet land som Sverige är frågan om skala. Fördelarna med automatisering är beroende av investeringskostnaderna och på en del områden med höga investeringskostnader kan automatiseringen komma att gå långsammare. Nettoeffekten av de olika krafterna är omöjlig att förutspå och kommer att bero på många olika faktorer, bland annat vilken politik som förs på central och regional nivå samt hur arbetsmarknadens parter agerar. Men att dra slutsatsen att små länder är ”skyddade” från automatisering är ett misstag. Mer proaktivt är att inse att det kan finnas möjligheter för entreprenörer att utveckla smarta metoder som tar hänsyn till de lokala förhållandena i Europa och på andra platser, innan digitala företag med hemvist i Silicon Valley knackar på dörren.

Med en protektionistisk policy-respons och långsam reformering av regelverken kommer välfärdsvinsterna att bli svagare – eller riskera att helt utebli. Vi skulle till exempel sannolikt få högre teknikdriven arbetslöshet, större inkomstskillnader och långsammare produktivitetstillväxt. Om ekonomins förmåga att förflytta resurser mellan olika sektorer störs kommer anpassningen att bli svårare, i synnerhet för outsiders på arbetsmarknaden.

Men det finns åtgärder som kan underlätta en smidigare anpassning på arbetsmarknaden och bidra till att man tillgodogör sig fördelarna med digitaliseringen

- Att ta ut lägre skatt på (mänskligt) arbete. Hög skatt på jobb i Sverige stärker det redan starka incitamentet att automatisera arbetsuppgifter ytterligare. Skatteavdragen för hushållstjänster bör utökas, inte minskas.
- Att minska osäkerheten kring de regler som påverkar delningsekonomin. Det ger flexibla möjligheter till justeringar och lägre risk för högre strukturell arbetslöshet.
- Att skapa större möjligheter för livslångt lärande. Ett längre yrkesliv och snabba tekniska förändringar ökar risken att vissa kompetenser tidigare passerar ”bäst före datum”. Uppdatering av yrkeskompetens kommer att bli av stor betydelse för att minska risken för ofördelaktiga framtidsutsikter på arbetsmarknaden.
- Att minska skillnaderna i socialförsäkringsskydd mellan anställda och egenföretagare.
- Att införa principer för reglering av den digitala ekonomin som kan användas till att snabba upp reformerna på många skilda områden, och därmed minska behovet av att utarbeta särskilda regler för varje område. Detta kräver ett nära, smidigt och kontinuerligt samarbete mellan jurister och ekonomer. Får vi inte det, kan den låga produktivitetstillväxten bli seglivad och demografins och statsskuldens makroekonomiska motvindar fortsätta att dämpa tillväxten.

Den digitala revolutionen kommer sannolikt att förbättra såväl livskvaliteten som effektiviteten på arbetsplatsen och fortsätta att förbättra vår fritid. Men ingenting är självklart när det gäller hur smärtfri förändringen kommer att bli. Institutionernas reaktion är en nyckelfaktor för ökad produktivitetstillväxt utan risk för högre arbetslöshet och växande klyftor.

Extended summary

"Technology's impact will feel like a tornado…No government is prepared for it."
Leader, The Economist (2014b).

Digitalization is affecting most of human interaction in one way or another and our institutions are belatedly trying to catch up. No sector will be impervious to changes and the impacts will be felt throughout the private sector, the public sector, and areas hitherto less affected by technology, such as cultural institutions.

There are widely different beliefs about what this means – all from business as usual to a tornado whipping through an office landscape on the front cover of the *Economist*.[1] Is digitalization in which the robots finally take over the "end of jobs" or will job creation keep pace with job destruction? Will inequality rise further and will income growth be concentrated to a few "winners-take-all", who acquire enormous wealth, while others may work freelance and "on-demand" with more precarious and lower income streams? We will argue that the outcomes will crucially depend on the policy responses.

This report is aimed at policymakers and others who are interested in the possibilities and challenges of digitalization. It sketches the qualitative economic effects of digitalization and aims to fill the gap between the academic literature and think tanks. The think tanks and management consultancies have written extensively about the Internet-of-Things (IoT), big data, 3D printers, and the "sharing economy," in which people and firms conduct business via digital platforms. All of these developments are likely to be significant, but the sharing economy has, in our assessment, the biggest potential to change how the economy works in the next few years and be the most disruptive. Although some work in academia is discussing the economics of digitalization, most scholars are preoccupied with understanding the past effects of technology. In bridging these two perspectives, the challenge for any reader is to decide what aspects of historical experiences apply and what to make of all the hype, of which there is, alas, plenty.

Digitalization is one of several trends affecting the world economy and it is important to stress that there is nothing inevitable about the welfare consequences in the years to come. The outcomes – good or bad – will depend on the choices of institutions and their ability to adapt to technology, demography, globalization, and other factors. Indeed, a key insight from research is that nations that have managed to become rich have had institutional features that supported incentives for value creation while ensuring that the ways insiders and special interest groups can extract monopoly rents are limited.[2] The strongest driving force behind inequality is probably not technology, but the response of institutions when they erect barriers to entry, especially in the labor market.

Technological changes are coming in an era of many other undercurrents in the world economy. Although there are some doubts about the quality of official statistics, productivity growth has slowed in OECD countries. Other broad changes are clearly apparent: populations are aging and public debt and unemployment are high in the aftermath of the financial crisis. This implies that the welfare consequences of poor choices – or no choices at all – may be particularly pernicious and have long-lasting social and economic effects. Are our institutions well-poised for the challenges? Instead of answering this question directly, we will use three scenarios below to illustrate the possible economic consequences for productivity growth, employment, and income inequality. We argue that the outcomes will crucially depend on policy responses. If the

[1] See the Economist (2014a).
[2] See, for example, Acemoglu and Robinson (2013).

responses lean more towards protectionism in various forms, inequality and unemployment are likely to increase (see scenario 2 below in "Box 2. Scenarios for Sweden"). We also need to reduce the discrepancies in access to social security between employees and the self-employed.

It is undeniably the case that our economies have been able to adapt to a great many changes in the past, moving from being primarily based on agriculture to mass production and the increasing dominance of services. In hindsight, all these changes have led to increased prosperity for all of society, but life was tough for many people amidst the upheaval. The economic historian Joel Mokyr noted that welfare did not improve much between 1750 and 1850.[3] Today, modern social safety nets and standards alleviate some of the burden of change on individuals and our economies have developed ways to share risks among groups and generations. Among OECD countries, Japan may be the only one where younger generations are not better off than older ones due to two decades of poor growth and the rapid aging of the population, combined with strong rights for insiders.[4]

Technology may now change the way risk is spread throughout the economy, further widening the gap between insiders and outsiders, incumbents and startups. If we are going to learn one lesson from economic history, one way to formulate the policy challenge is to make the period of structural change as smooth – or at least as *unrugged* – as possible while ensuring conditions for productivity growth, which is especially important given the previously mentioned macroeconomic headwinds. In terms of social welfare, the key challenge is how institutions respond to maintain incentives for innovation and job creation while not giving in to special interest groups and protectionism. The outcome of inequality may hinge on the way these challenges are ultimately resolved.

Speed of technological change vs institutional inertia

The dotcom bubble that burst a decade ago was not dissimilar in pattern to the hype that often surrounds new technology. Surely there are reasons to be skeptical today that significant changes are underway and that the pace may be swifter than during previous periods of transformation? A case in point for being wary of hype was the spectacular failure of the Swedish company *Boo.com* just after the millennium shift. Headquartered in London, the company tried to sell designer clothes via a digital platform and was thus one of the first to attempt something that has now become commonplace, but the market was not mature enough and the conditions for success not yet in place.

Despite the experience of Boo.com and other startups that failed, there are good arguments that things are different this time round. Boo.com failed at something that has now become ubiquitous via, for example, Zalando, Wish, and other e-commerce platforms. Today, we have an expanding number of digital companies with global reach. Similar to all startups, some of these digital firms are struggling, some are failing, but a few are extremely profitable. The capacity to quickly grow the scale of a business has become key. As expressed by Reid Hoffman, co-founder of LinkedIn: "First-scaler advantage beats first-mover advantage."[5] In contrast to the situation about a decade ago, a number of key conditions have evolved and matured:

- The emergence of large platforms with standards that attract consumers and producers alike (the web, Apple with iOS and Google with Android).
- Trust mechanisms for digital transactions, both for goods and services.

[3] See Mokyr (2004).
[4] See IMF Article IV consultation with Japan from 2012.
[5] Hoffman (2015).

- Digital payment systems with low transaction costs.
- Ubiquitous use of smart phones and tablets.

The world is now ready for transactions with digital goods and services. The changes are mainly consumer-driven. Consumers search the internet, use their smart phones, and share information, pictures, and experiences, much of which has implications for commerce or social discourse. Successive generations are likely to increasingly use digital tools for consumption and leisure; this means that consumer-driven activism will remain a major force and may continue to increase in importance. Each new service only needs to be available in one of the major app stores and/or on the web to reach a large number of consumers. The best comparison with earlier technological change is with electricity, also an *all-purpose* technology that allows a lot of other machines to operate. The difference with electricity is that digital technology can disrupt businesses more or less continuously: expanding the grid and lighting the way for modern appliances and factories, after which many of the steps were evolutionary rather than revolutionary. It has also been argued that digital technology is the only all-purpose technology that has increasing returns to scale.[6]

Firms that do not adapt to changing consumer demands on products or information risk falling behind. At the same time, our institutions are built around a slower world, with inertia in laws and labor contracts. Most of the inertia is probably good, especially when it comes to democracy and core features of how rules and social welfare are applied. But the labor market has developed a set of rigidities that are now under assault from digitalization. Apart from digitalization, it would still be under pressure to change from the rapid aging of populations and the need to extend working lives to finance public welfare. Digitalization simply adds to the urgency of institutional reform. The challenge is to maintain those elements that are conducive to stability while not holding back growth and innovation.

Digitalization provides many new ways to circumvent rigid rules and sidestep regulation that has been built up over the years. Many of the rules may be there for good reason, especially consumer protection, but quite a few serve to protect insiders and protect monopolies from competition. This leads to higher prices for consumers and makes it harder for young people and the unemployed to find jobs. There will be an assault on much of this rigidity, especially when digital solutions can be used to explore pockets of existing inefficiencies and unused resources to create profits. These pressures on institutions and firms to adapt will come in force as they are driven by profits that can be remarkably small per unit sold, as long as the volume of sales through network effects is high. In short, the reason change is likely to be rapid is that profits will be in the driver's seat and the technology not only allows it, but is actually built into the accelerator. The ultimate outcome for productivity growth, the labor market, and inequality will depend on how governments and regulators respond to these challenges.

We find it unlikely that digitalization will imply mass unemployment where robots take over many – if not most – jobs. But not everyone agrees with this. There are respected researchers, famous scientists, and business mavens who contend that robots will replace labor on a massive scale: essentially, the end of work.[7] The arguments will be discussed at some length and are briefly summarized below in "Box 1. Summary of arguments", but the main lesson from economic history is that new jobs (some which

[6] See Edquist and Henrekson (2006).

[7] For example, physicist Stephen Hawkins espouses this view; Bill Gates, one of the founders of Microsoft has also expressed a similar position.

we cannot even imagine) develop all the time. The challenge is instead that bad policy responses can make the period of transition tough and the adjustment period may result in higher structural unemployment and rising inequality.

The many different views on what digitalization implies are probably also leading to some confusion. On the one hand, people are being asked to work longer and there are shortages of skilled labor in many OECD countries, including Sweden and Germany. On the other hand, the robots may be taking over. What should we make of this? In this report we try to address these issues and hopefully reduce some of the confusion. Essentially, we are seeing the long-run trend of aging populations that is bringing challenges for financing public welfare potentially colliding with the advance of technology. If robots indeed were to take over most work from humans, which we think unlikely, the existing ways of financing public welfare would not work. Significant government revenues come from taxing labor. If, on the other hand, jobs continue to exist, we will have to extend our working lives to finance welfare, since there will be fewer young people of working age compared to those in retirement.[8]

Box 1. A summary of arguments for and against the "end of jobs"

Arguments that support structural change as "usual"

- Jobs have not disappeared despite vast changes in technology that have transformed the economy from agriculture to manufacturing and services.
- Tendency to underestimate the complementarity between humans and machines that allows for more productive work rather than replacing labor.
- Cars, the steam engine, electricity, clean water, telephones etc. have been more disruptive to way of life and have improved quality more than existing digital innovations.
- Significant inertia in institutions and regulation slow rate of adoption and may undermine new business models.
- Internet of Things and big data have many elements of legal uncertainty that will delay benefits.
- Preferences for human interaction in schools, hospitals, etc.

Arguments that support significant transformation but not the "end of jobs"

- Digitalization has strong network effects, marginal cost is small or zero for many digital services.
- Transaction costs can become much lower (on-demand economy, 3D printers).
- Digital knowledge is non-exclusive and information spreads seamlessly.
- Many sectors affected more swiftly and simultaneously.
- Demography and the problem of mismatching in the labor market increase incentives to automate.
- Digital platforms can match buyers and sellers even for small goods and services, and similarly for investment capital to find entrepreneurs.
- Sharing economy provides more flexibility in labor markets and stronger competition for labor.
- Rapid advancement in intelligent software that can replace humans in analyzing non-structured data, perform empirical work and write texts that are hard to distinguish from those from written by the human hand.

Arguments that support the "end of jobs"

- Machine learning is advancing rapidly.
- Human ability to adapt is slower than the increase in computing power that can be used to solve analytical tasks and apply tacit knowledge.
- Unskilled labor will have lower productivity than machines and hence be unemployable or have low real wage growth.

[8] See Blix (2013a, b).

1. The labor market

What has happened?

Most people may not be aware of quite how far software has come in making inroads into human activity. Although self-driving cars have been on the radar for some time, but surely in other areas, especially for highly skilled tasks, the human monopoly still stands? That computers have won against the best chess and Jeopardy players in the world may be vaguely familiar to many people. But the full range of human activity, especially creativity, writing, and analysis, cannot be coded into software – they require cognitive and tacit skills that are beyond computers – right?

While artificial intelligence is not in sight in the near future, software has become sophisticated enough to replicate humans in a vast array of areas, including highly skilled ones.[9] Due to the longevity of Moore's law of increasing computer speed, processing power is now so powerful that in many tasks previously reserved for humans, such as writing and research, computers are indeed faster and more accurate; increasingly, they can also write with style and it is no longer evident what is computer-generated or created from human hand.[10] The popular notions from movies and books about walking robots doing ominous things is misleading. Work can now be outsourced to the cloud, either to clever software or to a global labor market via digital platforms.[11] The modern replacement for an office worker is not a humanoid thing sitting in a chair with a coffee mug (for our benefit). It is one of many stacks of hardware in an anonymous server hall, located in a more or less remote area with good fiber connections. For example, Facebook's servers in Sweden are located in the northern city of Luleå, where the climate helps keep energy costs down.

One of the foremost scholars today in the field of technology and jobs, MIT professor David Autor[12], argues that the fear of automation underestimates two forces: the degree of complementarity between human and machine, that is, how technology makes us better at a wide range of tasks; and the difficulty of automating *tacit knowledge*. Tacit knowledge refers to the things we can do without explaining exactly how, such as riding a bicycle or recognizing a chair from thousands of pictures. The argument is that we cannot automate an activity unless it follows specific rules that can be transcribed in code.

On the question of complementarity there is a lot of evidence that we will discuss below, of which some raises concerns as to the number and kind of jobs that will remain. But the issue of tacit knowledge is of a different kind, something between a philosophical and practical impediment to automation.[13] It should be clear, however, that the idea that tacit knowledge cannot be coded is an *assumption* and not a law of nature. For example, some years ago it was widely assumed that autonomous vehicles were impossible because driving includes too many elements of tacit knowledge. Whether automation will hit an insuperable obstacle when it comes to tackling tacit skills remains to be seen. Rather than being a brick wall beyond which automation cannot venture, tacit knowledge might be reshaped or subject to circumvention and redefinition.

Machine learning is a prime example of ways to avoid the difficulty of coding tacit knowledge. Machines can be taught to imitate and learn from humans and from observing physical events, and this an area of rapid progress and development. The software today is already clever enough to replace a lot of human activity but may

[9] For an overview of advances in artificial intelligence and where we stand today see, for example, Bostrom (2014).
[10] See Clerwall (2014).
[11] See, for example, O'Connor (2015b).
[12] See, for example, Autor (2014).
[13] For a discussion of measurement issues on tacit knowledge, see Ambrosini and Bowman (2001)

be slowed by obstacles other than technology (more on this below). For example, while there are driverless trains in Asia, pilotless airplanes are not yet in the real clouds. The technology is already here, but it is unclear whether there is an appetite for it – at least for now. But if pilotless planes are safe but much cheaper than the regular variety, this may change too. We cannot easily know in advance what activities will be acceptable for automation and exploring these limits is a challenge for entrepreneurs. It is likely that public preferences will change over time for what kind of activity we are comfortable automating. While the World Values Surveys[14] indicate strong beliefs in core values, especially in the importance of the family, beliefs about how we interact with each other and how we consume goods and leisure are more likely to be malleable and change with technology.

One of the more significant changes from digitalization is the rise of the sharing economy, which despite its name, is more about market forces and entrepreneurs finding new business opportunities. Other, perhaps more descriptive terms are the "on-demand economy" and the "gig economy," but in this report we will continue to use the term the "sharing economy." With digital platforms, even minor demand for goods and services can be matched to supply at low costs. The sharing economy is a major macroeconomic change. Although neighbors and colleagues may have bartered goods and favors throughout human history, this activity is now being reshaped in a way not dissimilar to how industrial manufacturing forever changed the landscape of production. Knowing that there is a person asking for a business or household service at a specific time is no longer the lottery it used to be in matching supply and demand. As a consequence, we will see more jobs in sharing economy with more flexibility but also more insecurity, an issue we will return to further below.

Further automation

The automation of low-skilled and manufacturing jobs has become a driving force and perhaps also a potent symbol of productivity growth in market economies. It does not require much imagination to see that driverless cars and vehicles will change a lot of activity; there will be less need for taxi drivers, truck drivers, driving schools, insurance companies, and service personnel in hotels and restaurants. On the upside, doctors will have fewer traffic accident victims to contend with. But there are likely to be ripple effects, many of them unpredictable. Of the more predictable ones, we may venture to guess that the rise of autonomous vehicles may affect rural areas. With fewer humans delivering goods to rural areas, a lot of restaurants and hotels will have fewer guests, putting a strain on their business.

In agriculture, some human activity has hitherto remained in handling sensitive fruits but this is also beginning to change. Machines are now sophisticated enough to take over such tasks. Logistics warehouses, such those of Amazon, Wal-Mart in the US, and Clas Ohlson in Sweden, have become increasingly semi-automatic with more and more functions taken over by machines. There are now machines that can produce two hundred or more hamburgers in an hour; there are fully-automated sushi restaurants and hotels in Japan where service personnel have been largely replaced by machines in much the same way that airline check-in is more about interacting with machines these days than with harried clerks.

It is true that many of the jobs that have disappeared are not necessarily the good ones. Indeed, much of modern work has improved – in construction, mining, and

[14] See Halman et al. (2008).

other physically demanding occupations – as machines have replaced human labor. Seeing children in developing countries coming out of dark holes in the ground after grueling work to extract coal or minerals is a reminder of this.

Some clues for interaction between machines and humans in modern economies come from banks. For bank tellers, there was an initial fear that their jobs would disappear with the introduction of ATMs, but in fact such jobs increased in proportion and required more skill as tellers began providing more services and advice to clients. Complementarity between machines and humans has been in evidence in other areas as well, such as medicine, where doctors have used instruments, computers, and machines to improve their clinical and surgical skills. But in some areas, such as clerical work, computers have displaced labor the same way that artisans' jobs were reduced at the dawn of industrialization. This has been the case throughout history with some jobs displaced by machines and new ones created with higher skills and elements of complementarity.

Digitalization has now reached such a point of speed, maturity, and saturation that its effects may come faster and be more widespread than any other technology to date. The most relevant comparison is with the introduction of electricity, also an "all-purpose" technology, in the 20th century. Although electricity also affected many sectors at the same time, one difference is the speed of adoption. This may hamper the ability of workers – whether skilled or unskilled – to switch from a sector in decline to one on the rise.

There are strong incentives to discover which parts of a global value chain can be automated. For large Swedish firms that are already mostly geared towards exports, the constant striving for efficiency is already in their DNA. For them, outsourcing or automating parts of their global value chains is second nature. The difficulty of replacing workers who retire due to aging populations and the problem of skills mismatch in the labor market may well strengthen incentives to automate. The incentives to automate are even stronger in Sweden and other countries with rigid labor laws and high taxes on labor.

The new and forceful changes underway imply that more middle class jobs are being affected by digitalization. For example, media companies (film, music, and newspapers) have long been exposed to the economics of the low marginal cost of digital distribution and the challenge of charging money for content. In the next wave of automation, thousands of texts are being automated, everything from corporate earnings reports to football scores.

Likewise for legal and business research, software is automating the sorting, analysis, and presentation of huge amounts of data.[15] For legal applications where precedents are particularly important, software can now comb through millions of documents that would have taken many years to go through. Thus far, many of these concern entry level jobs, such as paralegals, but the technology is already available to grade written exams and essays in schools, for instance.

The tasks performed by computers are climbing the skills ladder. IBM and Google are buying health care companies with a view to applying software to improve diagnostics.[16] With vast databases at their disposal and sophisticated data analysis routines,

[15] For an overview of the tasks that can now be performed by machines, see, for example, Ford (2015a).
[16] See Crow (2015) and Lohr (2015a, c).

software has the potential to improve medical assessments. The volume is simply too vast for any human doctor to follow broad medical research outside their own domain. Using statistical techniques and inference, the software may give predictions and recommendations based on information that surpasses the capability of any one person.

Would we trust software recommendations in medical, legal, and other spheres? Many people likely dislike black box answers, however mighty and prescient they may seem. Therefore, developments in IBM's *WatsonPaths* that show not only the recommended option, but also the steps taken to arrive at the conclusion may provide the trust boost required for the next wave of automation in highly skilled work.

In thinking about the future of jobs – how many and what kind – we should look to the past and determine what experiences are relevant. In economic history, there are useful lessons on the effects of structural change and what challenges should be expected. While the first part of the Industrial Revolution was deskilling, most of the 20th century saw a combination of increasing technological prowess concordant with higher skills. But recently, in the last few decades, we have also seen increasing polarization in the labor markets of OECD countries: middle income jobs have been decreasing whereas the overall shares of the labor market have been increasing for both lower and higher end jobs. This has not occurred in Sweden in the same way; Sweden has instead seen an increase of higher paid jobs. Moreover, Sweden has not experienced the kind of wage polarization that has taken place in the US, where many lower and middle income jobs have had little or no real wage growth. In fact, quite the opposite is the case and real wage growth in Sweden has been strong in the last two decades.

Labor market polarization may well give rise to tensions in any economy, but, as emphasized by Raguran Rajan, former chief economist at the IMF and now governor of the Central Bank of India, the rapid increase of US house prices may have contributed to making middle income earners feel like they obtained part of the wealth created, at least until the financial crisis.[17] The US is now seeing increasing tension, especially among lower paying jobs, such as in fast food chains. A number of people in low-paying jobs in the US are also receiving food stamps, thus in effect providing a subsidy from the government to low-wage employers, for example in fast-food restaurants.[18]

Sweden has had a very different experience, having reformed its institutions in the 1990s in the aftermath of a collapsed real estate bubble. With radically overhauled institutions and solid public finances, Sweden was able to cope with the financial crisis in 2007 and the increase in unemployment was nowhere near the large shocks in the early 1990s. Though the fallout from the financial crisis was challenging, Sweden's reforms in the 1990s paved the way for institutional resilience to shocks that served its people well.[19] In contrast to many other OECD countries, public finances in Sweden remain sustainable and public debt was low throughout and after the financial crisis. Indeed, Sweden was one of the few EU countries that was able to maintain public debt well below 60 percent of GDP, as mandated by the original EU:s Stability and Growth Pact.

The reforms to the budgeting process in the 1990s were key elements that helped achieve this outcome; especially significant were the medium term expenditure ceiling for government spending and improved top-down budgeting in parliament, which

[17] See Rajan (2010).

[18] See, for example, Cohen (2015) and Jacobs et al. (2015).

[19] See, for example, Calmfors (2013); Heyman et al. (2015b).

were valuable tools for reducing the strong deficit bias otherwise inherent in public spending. Moreover, labor market reforms initiated after 2006 increased the incentive to work by reducing income taxes and strengthening the weak control mechanisms in benefit systems to reduce misuse.[20] Another key reform was giving independence to the Riksbank in 1999 for monetary policy to pursue the goal of price stability. One lesson from Sweden is thus that institutional reform that improves the way different forces interact is crucial to managing the economy, and especially so in times of crisis.

But it is a mistake to describe the institutions as having reached a zenith after which they can handle anything. It will always be difficult to choose a tradeoff between different goals in the economy, but the institutional set-up can mitigate and facilitate. In other words, institutions can make it easier to pursue good long-term policies but this does not mean that good enough institutions make it possible to have policy on autopilot. Ultimately the hard choices have to be made and defended by policymakers in government and elsewhere.

The labor market in Sweden is characterized by centralized bargaining between the labor market partners (unions and employers' organizations). The government has no direct control over the wage-setting process, in contrast to countries where government is involved directly in public sector pay.[21] Though employers are permitted to lay off workers, they are required to negotiate departures with the unions based on first-in, last-out rules. The OECD has often recommended Sweden to increase the flexibility of the labor market. The current system benefits labor market insiders with indefinite contracts, making it harder for others to get jobs; it also reduces the incentive to switch jobs even when economic conditions change, for example if a sector is in decline and prospects are better elsewhere. Moreover, people may be less prone to voluntarily giving up the safety of an indefinite employment contract even if their personal preferences were to suggest switching jobs or sector.

The market economy often finds ways to deal with inflexibility, sometimes at great cost and at other times more easily. In Sweden, specialized employment firms that supply temporary labor on demand have become popular across the range, from clerical services to management. Overall when it comes to temporary workers, Sweden has among the weakest protections for workers in the OECD. All told, this means that Sweden has one of the most pronounced dual labor markets among OECD countries.[22]

Limits to automation of jobs and implications for the Swedish labor market

Recent work has highlighted that a large share, 50 percent, of current jobs may be automated.[23] Though it may be obvious, it is still worth stressing that the rate of job destruction presents only part of the story of how the labor market develops. That jobs disappear and that the nature of existing jobs changes is nothing new. New jobs are created all the time and so the crux is really the rate at which new jobs appear compared to the number of people looking for work and whether those people have the right skills. Moreover, there are also countervailing forces that may slow down the rate of automation.

[20] See the Spring Budget Bill 2014, Appendix 4.

[21] Public sector pay in Sweden follows a mechanical formula that uses productivity gains in the private service sector as a benchmark for mandating cost efficiency in salaries and operations.

[22] See Cahuc (2010, pages 150–153, and OECD (2015b).

[23] See Frey and Osborne (2013) and Fölster (2015).

First, the fact that technology allows the automation of many jobs does *not* necessarily mean it will happen. The fundamental driver behind automation is the will to make something better, leading to higher quality, new goods or services, or lower costs. In some areas, automation will be costlier than human labor. For example, while new cars have windshields inserted by robots, when it comes to windshield repair, a human will typically do the work. In some areas, there may be little demand for automation. People may grudgingly accept having to go through automated responses to reach a customer service representative, but there are many jobs where automation will not be welcome or accepted, at least not in the immediate future. Automation of education is an example, where teachers – to a fairly large extent – could be replaced by software but parents may not be enthused about this and organized labor might also hold back such a development.

Second, there are many other trends that affect demand for jobs that have little to do with automation. As an overall driver of automation, demography may be significant. But in other areas, aging populations may increase the need for human work in health care and elder care services. Granted, automation can perform more of such tasks now than before; there are already robots that help the elderly in Japan and there are trial versions in Sweden. But it is hard to see that these changes will be major compared to the overall need within the foreseeable future. In other areas, such as law, automation technology has made it possible to vastly reduce the number of paralegals and junior lawyers and yet in Sweden, lawyers have increased as a share of the labor market. There may be several explanations for this, increased complexity of regulation among them.[24] For example, the strengthening of requirements on financial services has led to a need for much more work on compliance. Thus, other changes in the economy can from time to time be more significant for developments than technology alone.

Third, small open economies, such as that in Sweden, whose language is spoken by only about ten million people, provide *less scale* for the benefits of automation than the US and China. In many instances, it is not enough to take a US/UK technical solution and paste it onto a smaller country. There are institutional idiosyncrasies in law, culture, and consumer preferences that need to be addressed. Some of the institutional features reflect strongly held constitutional rules, the division of responsibility between local and central government among them. For example, local government is responsible for many services where digitalization has the potential to improve efficiency, such public transport and health care, but also for systems that make it easier to find and pay for parking spaces. But local autonomy also means that each area may have its own special solutions, thus impeding the ease of developing software that aims to be nationwide.

This issue holds true for most countries to a varying extent and can, of course, be alleviated by voluntary agreements to apply common formats and standards. Nevertheless, reaching consensus may take time and be subject to interpretation or change with ensuing uncertainty delaying action. While none of these are insurmountable obstacles, they may slow developments because profits from scale take longer to achieve or are more uncertain. The same money invested generates a lower return when the scale is limited. Language is another issue, conferring an advantage on English and other major languages. But to conclude that small countries are "safe" from automation from big platforms would be a mistake. A more proactive view would be that there may be opportunities for entrepreneurs to build clever ways to account for local idiosyncrasies, in Europe and elsewhere, before the big platforms come knocking.

[24] This argument is made in Fölster (2015).

Finally, existing regulation and the threat of new regulation may stymie entrepreneurs. This point is discussed further below, but in this context it suffices to note that for some firms, their very business model may hinge on small details in legislation and on how the law is interpreted. For example, are platform providers in the sharing economy accountable as employers, as a recent California court decision implied? This would vastly limit, if not completely undermine, many actors in the sharing economy. Likewise, who is liable in case of an accident caused by a 3D printed object, a self-driving vehicle, or the loss of personally sensitive data (on health or illnesses)?

Taken as a whole, what does this imply for the speed of automation? On the one hand, Europe's more rigid labor markets make further automation attractive as a way to increase flexibility. Moreover, demography makes automation attractive, as it may be the answer to shortages of skilled workers. On the other hand, regulatory hurdles and institutional idiosyncrasies work against Europe, at least for all but the biggest countries where the lack of scale is not an issue.

But, as stressed above, the extent of automation will critically depend on the policy responses. Creating conditions that are conducive to job creation in the private sector will be key to smoothing changes. Recent research shows that job creation in Sweden has been substantial. A study of Swedish data finds that 190,000 *new* jobs were created in the period 1990–2009, the net result of about 3.4 million created jobs against 3.2 million eliminated.[25] In an average year about one-fifth of the jobs in the labor market were turned over, giving some indication of the economy's ability to adjust to demand and new technologies. Most of the jobs were created in the service sector, while the manufacturing industry exhibited decline in employment.

2. Economic forces

Changing economic forces gaining hold

The sharing economy is lowering transaction costs across a broad spectrum of services, all from self-publishing of books and searching the web for information to performing household tasks. This increases the flexibility of work, especially in European countries where there is strong protection for labor market insiders. But as more people work freelance or on-demand in the gig economy, they are also exposed to a higher level of risk as the social security systems are tailored to full time work as employees covered by collective bargaining.

Of all the forces of digitalization, the economic effects of the sharing economy may well be the fastest change and one of the more significant. Unlike evolutionary improvements, the sharing economy is a big step that shifts the way we work and organize our lives. One implication already evident is that there is less need to own things when rental is but a click away. This also means fewer idle resources on standby, as exemplified by cars that typically are parked for most of the day or unused rooms in houses or apartments. Entrepreneurs are on the lookout for new pockets of unused resources and overpriced goods, such as formal evening gowns or that drill you use once or twice a year. They are also using technology to change the way demand for household services is met by saving time and increasing convenience in areas such as grocery shopping, cleaning, or sending flowers.

Of course, these services are not new, but the ease of matching supply and demand combined with low costs has major implications for the economy. A recent survey by the Freelancers Union found that 34 percent of the American workforce has been

[25] Heyman et al. (2013).

involved in sharing economy activities. In Europe, the sharing economy is trailing the US but also becoming significant, especially so in the UK. Due to stricter labor markets in Europe, the sharing economy may have even more long-run impact on Europe's rigid labor market unless new regulation chokes development.

One major implication of the sharing economy is that the raison d'être for ownership is shifting. Why own a car if a seat is available on demand, only a click away? Why buy a party dress and wear it only once or twice? Why not rent out spare capacity in apartments? The incentives to use resources better are omnipresent, but are coming to life in ways not seen before due to substantially lower transaction costs.

Digital reputations on the rise?

A novel thing about the sharing economy is how technology is also demonstrating new ways to develop *trust* in transactions. After all, renting out your home or a seat in your car to a stranger requires a lot of trust. But just like the bumblebee, the sharing economy manages to fly.[26] Business acumen and technology combined have provided ways to mitigate the risks and establish trust in such transactions. Using various ways to monitor quality and reliability, technology provides ways for both sides of a transaction to *rate* each other – a two-way process of establishing reputations. Digital reputations are becoming as valuable as digital data and probably more valuable/useful than analog forms of identification. After all, a driver's license may say who you are, but it says nothing about reliability and trustworthiness. Indeed, there are reports of people finding it difficult to get Uber rides after having obtained negative ratings in previous trips.[27]

Digital reputations are growing in importance and so are ways to establish confidence in online reputations. For example, if someone establishes a solid reputation in one area, should that history be transferable to other areas? There may be market failure here, in a not dissimilar way to how it is difficult to transfer pension accounts from one bank to the other. Hence, governments might conceivably play a role in facilitating digital reputations. So far they have largely stayed away, probably for good reason, but there may well be a coordination role to serve as a conduit for establishing standards. Why not a single digital market for reputations as well?

Digital technologies putting capital to better use

One other major implication of digitalization going beyond just the sharing economy is that there is *less need* for capital to start firms. Of course, heavy industry still requires substantial investment and advertising costs are set to remain significant. But a lot of activities can be simulated on the computer, tweaked, and improved. With a decent computer and an internet connection, entrepreneurs can reach consumers much more easily today at lower costs. Architects have long been able to design houses in 3D programs but the real power of computers is now taking another leap. For example, architects can have more complete control of all aspects of design, everything from the placement of electrical wiring to plumbing and calculating all the equipment needed for production. Stylistic changes (type, color, etc.) can be consistently applied across the design, not unlike the way text formatting is handled automatically in word processing software.

[26] The comparison between the bumble bee and the welfare state is made in Thakur. (2003).

[27] See, for example, Streitfeld (2015b).

Distribution costs are also likely to decrease with the increasing use of 3D printing and the rise of the sharing economy. The long ongoing trend to reduce the middle-side of transactions – in banks, industry, logistics, publishing, etc. – will get another push. Why store and ship expensive parts when they can be printed on demand? 3D printing brings down distribution costs and increases the speed of both design and delivery. It has applications in industry, consumer products, and health. 3D printers have been used to build full-size houses in China and the Netherlands.[28] But there are also applications of 3D printing that improve quality of life through better health care. For example, 3D printing is bringing down the cost of customized prosthetic limbs. There are also examples where surgeons make 3D replicas ahead of complicated procedures in order to anticipate problems that might only otherwise be discovered while the patient is on the operating table.[29]

Internet of Things (IoT), and big data have the potential to take much firmer control of all aspects of production. Together with 3D printing, these are transformational technologies that affect all aspects of production, but IoT progress may be slowed by legal obstacles, most notably consumer safety concerns and issues of intellectual property and patent rights (more on this below).

On the demand side, technology is changing the ways businesses reach out to consumers with information and advertising. All online activities generate troves of data, much of it very valuable to firms wanting to target specific groups. Indeed, personal data has been called a *new asset class* to signify its rising importance, alongside traditional assets traded in financial markets. This has raised a lot of privacy concerns. Telecoms operators have vast amounts of information about people's movements and can draw inferences about their lifestyles and habits from the data.[30] Consumers are giving a lot of the data away willingly to get free services – such as email, networking, and maps. But it may well be the case that people are not actually aware of quite how much information they divulge simply by logging in and moving the cursor across the screen.[31]

The economic impact of personal data is that firms can target products with campaigns with much higher accuracy. They can also give different prices to consumers, lower prices to those about to exit without closing the deal while charging people who are less sensitive to price more. The specter of price discrimination is increasing and yet is a sensitive topic that firms are careful not to flaunt. On the one hand, there are efficiency gains in using technology to find each person's reservation price above which they would not buy. On the other hand, with their notions of fairness and equal treatment, this may make consumers angry and firms need to be careful about balancing the efficiency provided by technology with the human reaction to seeing it in practice. There are reports of consumers being annoyed at being left out of campaigns geared to affluent consumers. The issues are not new, but technology is putting a new spin on things and adding to the urgency of dealing with consumer reactions, especially in areas where consumers can easily shift from one supplier to another.

Microeconomic revolution fueled by digitalization has macroeconomic consequences not yet understood in policy circles

[28] See, for example, Davison (2015).

[29] See Weintraub (2015).

[30] In 2011, Malte Spitz, a German member of parliament, requested and received the data generated by his mobile phone from Deutsche Telekom, which showed his activities in great detail; in Sweden Örstadius and Larsson (2015) have done a similar analysis.

[31] See for example Sveriges Konsumenter (2014) and Bylund (2013).

The changes discussed in the previous sector will have major implications for growth and jobs. Entrepreneurs in the sharing economy are already affecting overall resource allocation and increasing efficiency in existing areas as well as picking up new pockets of tasks that were previously below the radar due to difficulty of matching and high transaction costs. The rate of technological change is increasing compared to previous periods and the effects are going to be felt in broad sectors of the economy.

All the changes discussed above will have potentially major implications for assessing the stance of the business cycle and its effects on the economy, such as on employment and inflation. In particular, fewer resources in terms of capital and labor will be needed to produce the same output. The qualitative effect of this improvement is clear, but the magnitude and scope remains to be seen and will among depend on several factors, not least the regulatory response.

One implication of this development is that there will be lesser inflation impulses from a given level of resources in the economy. A car that is idle most of its life can be used to a much higher degree; a 3D printer saves on storage and distribution. Less capital produces more output. But the implications go beyond better use of existing resources and may also have effects on productivity growth.

Many OECD countries have experienced lower productivity growth in the last few years. Part of this may be due to measurement problems in the statistics[32] and the long-lasting cyclical effects of deleveraging following the financial crisis. But Professor Robert Gordon at Northwestern University also highlights several headwinds that dent growth, including aging populations and high public debt.[33] It may be that IoT, big data, 3D printers, and all the other new technologies in the pipeline will improve potential growth over time and balance the headwinds. But this process may take time and its speed will depend crucially on the regulatory response.

In the medium term, in the next decade or so, it is likely that the benefits of digitalization will raise potential growth and thus the forces that may hold back inflation are likely to be active in one way or another for a long period of time. Evidently, digitalization is not the only medium-term force affecting inflation, but it may be one of the more misunderstood by governments and central banks. The direct price effects on consumer goods, especially electronics, are clear enough. But the indirect effects on the economy on resource utilization are likely to be more significant and persistent. It is a challenge for central banks and policy institutions to understand the conditions for firms that affect the economy; otherwise policy may be based on shaky ground.

3. Economic challenges in a digital world

When it comes to the future and the effects of digitalization, institutional resilience in Sweden will be put to a different test than during the financial crisis of 2007 or the home-brewed crisis of the early 1990s. While inordinately challenging, the strong focus and drama ensuing from these events contributed to making policy adjustments easier. When it comes to digitalization, the effects on the labor market are rather similar to those consequent upon the aging population: the changes come gradually, from year-to-year, and there will probably be no big event that heralds a major change. It may be more difficult for governments to change course under conditions of gradual change – even when the ultimate effects on welfare may be even more far-reaching.

[32] See, for example, Coyle (2015).
[33] See Gordon (2014).

Challenges for governments – regulation

Against the background of slow productivity growth in OECD countries, there is some urgency about improving the structural features to not hold back growth unnecessarily due to aging populations and public and private debt overhang. But the pace of regulatory reform for product and labor markets has slowed in OECD countries, including Sweden, in recent years.

It is of course not so that little regulation is always better. Regulation serves a key role in establishing safety and trust in markets. Without adequate regulation and standards, market economies would likely be constrained by lack of trust and higher transaction costs. Nevertheless, a lot of regulation has expanded over the years and likely *over and above* the need to protect consumers. The European Union is working hard to improve the free exchange of goods and services. While important progress has been made, the language and cultural obstacles in the EU make the remaining regulatory hurdles, such as VAT reporting requirements and safety and information standards that vary across 28 Member States, more burdensome than in the US.

Moreover, there are lingering protectionist forces aiming to raise entry barriers for new firms, since this allows incumbents to enjoy monopoly profits by crippling competition. In practice, the constant demand on regulators in standardizing and increasing safety requirements tend to be more powerful than the interests working to keep things simple. As well, complexity can also be the result of compromise at the expense of overall coherence. Thus, there is a bias in favor of creating ever more regulation that adds to this complexity.

Digitalization is entering this fray of regulation that is already complex and raising new issues that were not previously addressed or important. Granted, patents and intellectual property are areas that have been discussed for a long time. Music and publishing industries were the first to struggle against digital technology that allowed easy copying and distribution. It has taken a long time for new business models to emerge that allow content producers to charge money for their work, notably through online music, newspaper, and book subscription services. The changes are still ongoing.

Two important regulatory challenges stand out among all others. First, there are significant regulatory obstacles that need to be addressed in the EU Single Digital Market. The key benefits of digital technology through low marginal cost and ease of distribution are hollowed out by the 28 different regulatory environments in the EU. It is not so much the different levels of VAT that are problematic but reporting requirements, restrictions on data transfer across borders, and procedures. Rules on safety notices also vary, as do rules on how to store and handle consumer data.

Second, the expansion of the sharing economy is hampered by the question of which regulatory model to apply. With a minor change in interpretation or change in existing regulation, a business model may even collapse. Throughout the economy there are entrepreneurs busily figuring out how to make money and provide value to other businesses and consumers. They are likely to take note of the treatment awarded to Uber and Airbnb, the standard bearers of disruption in the sharing economy. The most damaging aspect of regulatory uncertainty is this fog of unpredictability that prevents new ideas from being implemented.

There should be some urgency to resolve the legal status of people who work in the sharing economy and improve social safety nets for freelancers. In Sweden, the entire structure of the economy is geared towards sustaining large-scale bargaining for full

time employees in agreements between the labor union and employer's organization. Should the number of freelancers increase substantially, the model may be put under strain and its legitimacy questioned. There is a challenge in how institutions update agreements and systems to manage the risks different individuals are exposed to while at the same time promoting labor market flexibility that is needed to reduce unemployment and remain competitive.

In relation to the sharing economy, various sectors are confronted with a myriad of other regulatory question marks. A common thread is whether professional standards should apply to more amateur-type activities and, if so, where should the line be drawn? What safety standard should apply to Airbnb rentals compared to hotels? Should small-scale activity be taxed at the same rate as large corporations? In peer-to-peer (P2P) or peer-to-business (P2B) finance platforms, what liability do the platform holders have in the event of default? Why do households face less favorable tax rules for P2P loans than for listed financial assets held at a bank in the Swedish Investment Savings Account?

One particularly onerous example of how legislation can actually work against safety is that related to self-driving vehicles. It is widely believed that self-driving cars will cause vastly fewer accidents and reduce the number of dead and injured. Yet, the question of legal liability in the event of an accident is constraining this development.

If governments try to resolve digital regulation in each separate market, it is going to take a long time. Moreover, technology evolves swiftly and new businesses may discover ways of doing things that might need to fall under regulation still not on the table. For these reasons, governments should work hard to establish some *basic principles* of regulation that can be applied to all areas. It is beyond the scope of this report to make specific recommendations for such principles, but a few comments are possible. First, safety should remain a concern but should be reasonable in terms of expected outcomes, as is not the case with self-driving vehicles; second, goods and services should become more neutral in taxation. For example, the differences between books (a good) and e-books (a service) is flagrantly large in almost all countries. In Sweden, the difference is almost twenty percentage points on VAT. This is an impediment for many other areas as well, including 3D printers. Third, liability in the event of malfunction or injury should be clarified in general terms. Fourth, zoning laws and other municipal prerogatives need to be harmonized to allow benefits of scale.

With the establishment of high-level principles, the speed of adapting regulation to specific areas that cater to heterogeneity would vastly improve. If, on the other hand, different sectors in the economy get their own set of idiosyncratic rules with little commonality, it stands to reason that the benefits of digital technology will be held back, denting productivity growth. It is of the utmost importance that regulation does not support rent-seeking by special interest groups and instead caters to innovation and Schumpeterian creative destruction.

On a more specific note, the way the Swedish government organizes it work poses a specific challenge for removing obstacles that hold back the benefits of digitalization. The responsibility for digital matters rests with the ICT minister attached to the Ministry of Enterprise and Innovation. But most of the obstacles and challenges that may slow progress for digitalization are under the purview of other departments, especially the Ministry of Justice (data protection, legal liability, patents, and copyright), the Ministry of Finance (taxation, financial regulation) and the Ministry of Employment. Each of the ministries is very powerful in its own domain and unlikely to be easily

swayed. The benefits, costs and risks of digitalization need to be strategically assessed at the highest level. To speed up regulatory overhaul that slows down digitalization, it is likely that some ICT matters should be coordinated from the Prime Minister's Office, at least for the years it takes to make more substantial progress on regulation.

Challenges for governments – lifelong learning and digital skills

People are living longer than before, yet the norm of spending the early years of life in education with comparatively less resupply of formal schooling in mid-life is persistent. Granted, there are numerous courses in all sorts of subjects, covering the gamut from business writing to computer coding and vocational skills. But with rapid advancement in technology, there is a need for a more systematic replenishment of knowledge throughout our lives. Correspondingly, we need to think about whether some tertiary education lasts too long in relation to its utility in the job market. These issues have become increasingly important in light of aging populations, but are becoming more urgent with the advent of digitalization.

While skills supply is crucial to firms, more education is not necessarily the answer. Indeed, Professor Alison Wolf at King's College has argued that we invest too much in education and that the quality in some areas is too low.[34] Notably, one year in education is also one year not in work, which puts additional burdens on financing social welfare systems that were designed in times with a more favorable ratio of working to retired people.

Instead, we need more education and skills that are in immediate demand in the labor market to improve the matching between vacancies and jobseekers. We also need ways to replenish that knowledge throughout life, not only so that we keep abreast of technology but also so that we are equipped to switch careers in mid-life, a point emphasized in the report on demography from the Commission for the Future of Sweden.[35] We need better skills in general – and more digital skills in particular, a point also emphasized in recent report from the Swedish Digitalization Commission to the government.[36] A recent survey by Eurostat shows that a large number of citizens lack basic skills.[37] To some extent, this involves a generational gap that exemplifies the need for continuous skills development.

There are two distinct challenges. First, how can improvement of skills be better organized to cater to the needs of firms? Second, how should it be financed? The incentive for firms to finance learning for its staff is dented by the risk that employees may leave and take a job elsewhere, taking their new skills with them, but this is also the kind of agility required for efficient functioning of the labor market.

As regards the organization of learning digital skills, the public/private UK Tech Partnership is a model that might be useful for Sweden to consider. With a relatively small staff, the Tech Partnership coordinates education needs in existing firms through co-financing shared by government and business. They also focus on improving digital skills in schools, and especially on increasing the participation of girls.

[34] See Wolf (2011).
[35] See Blix (2013a, b).
[36] See SOU (2015a).
[37] See Figure 5.1 in Chapter 5 of this report.

To the extent that digital skills should become part of our general toolkit in the same way as mathematics and science, there are arguments that the public sector should finance some aspects, especially those that are more general in nature; the more specific the skills, the more they should be financed by firms or individuals. Where to draw the line is difficult question, but the issue is well worth pursuing.

More lifelong learning in appropriate doses is also likely to benefit productivity growth and make it less likely that people who stay in their jobs for a long time will become unemployable elsewhere in the event of company restructuring.

Challenges for firms – regulation, new competition and skills

Periods of rapid technological change accentuate several distinct challenges for firms: adapting to regulation, updating skills and human capital, and readiness to change the business model or core products if demand shifts.

The challenge of regulation is in some sense the mirror image of the discussion for government above. There are distinct challenges for incumbents compared to digital entrepreneurs. For entrepreneurs, the most basic issue is the continued viability of the business model if regulation changes or is interpreted in an unexpected way. The most damaging aspects of how Uber is being investigated by authorities concerns the signals sent to all other actors in the economy that are considering entry, and of course especially into the sharing economy. One particular concern is whether or not freelancers are to be considered employees. In the former case, businesses need to pay social security contributions and other taxes. But other forms of uncertainty also abound, such as the legal liability of platform owners for the actions of those who use or provide the service, be it rental of rooms or peer-to-peer loans.

It is difficult to quantify the effect of this uncertainty on entrepreneurs considering starting a business in the sharing economy. But the extensive media coverage of the challenges faced by Uber is hard to miss. The small profit margins – or indeed mostly initial losses – of start-ups make this kind of risk particularly damaging. From an overall perspective, easing entry and reducing business model risk for the sharing economy brings significant benefits to the economy as a whole: resources are better used, easing the strain on the environment, low and middle income earners can reduce their consumption and ownership to essentials and rent other resources (especially cars) as needed, and jobs in the gig economy provide flexibility in working hours. Finally, the sharing economy may also ease the challenge of job automation.

The challenge for existing firms, especially those in mature industries, is different. In some areas, new digital firms will try to enter and compete. Having "digital" first in the business model typically means lower costs, faster operations, more ease of experimentation and reaching customers. Being large is no iron-clad protection against competition from digital firms. Sony has been struggling for some time to transform its products and services in response to the rise of the internet and is still trying to find its way; Microsoft was also taken by surprise and its virtual monopoly on operating systems now looks much more vulnerable.

Successful firms in industry are less exposed than start-ups because investment costs are large and so entry typically requires large coffers and the ability to accept rather uncertain returns on that investment. But carmakers are not being threatened by start-ups, but rather large firms such as Google and Tesla. Banks are facing compe-

tition from *fintech* companies, now receiving increasing funding from institutional investors and banks; IBM is entering the health care market with recent acquisitions; big law and management firms that typically charge premium fees for their services are being threatened by the sharing economy and the automation of knowledge work. Especially for legal services, a lot of work can now be automated.

Lessons learnt from business failures show clearly that technological changes bring strategic challenges, known as the *incumbents' curse*. In the US, Kodak is a prime example of this but there are many more. In Sweden, Hasselblad and Facit each had strong market positions but their employees' skills reflected outmoded technology and the sales organizations were geared towards providing a service that would no longer be needed with the shift to electronic technology.[38] A particular challenge in turning a company around when technology shifts is that vested interests in the firm may protect the existing product line and focus on evolution only. Asking the customers may not be the answer, because they may not know how technology can change the service or product they need. And when the change comes, the transition window may be too small.[39] This happens time and time again.

To mitigate strategic risks, senior management cannot rely only on structures for existing product lines to decide where to place their bets. While this in itself is hard enough, it is compounded by the likelihood that new technology may initially be lossmaking and may also ultimately cannibalize profits from existing products. The auto industry is a prime example. With the advent of self-driving cars, it is likely that fewer cars will be bought in total. The same applies to other aspects of the sharing economy, such as rental of tools, formalwear, etc. where total consumption may be – at least initially – reduced. While it is possible that consumers may buy more of the same good, they may be just as likely pocket the savings or spend the money on other services.

Finally, as with regulation, the need to find and retain skills, especially digital skills, mirrors the discussion above on the challenges for government policy. Firms will have a key role in communicating business demands to the education sector as well as being more active in lifelong learning. The rapid shift in technology implies that workers who do not upgrade their digital skills will be held back in productivity and wage growth. In countries with rigid labor laws and first-in, last-out collective bargaining clauses, the need to ensure continuous skills development becomes all the more important. Attending courses for a day or two will not be enough and skills will need to be more strategically upgraded. The tax system should be adjusted to make it more advantageous for firms to pay for upgrading workforce skills.

Potentially serious mistakes can be made by confusing correlation with causality

Another risk that may increase is that of confusing correlation with causality when making business decisions or conducting policy analysis. The huge amounts of data available on consumer trends, lifestyles, and online habits are valuable to firms and provide information that can be used to target specific groups through advertising and sales pitches. In relation to policy, there is a vast trove of behavior data available that can inform policymakers how people will react to tax changes or other changes. The irresistible lure may be that the huge amounts of data provide *seemingly* precise estimates. Large data sets typically imply less uncertain measurement and when the whole population is measured, there is no remaining sampling uncertainty. More and

[38] See Sandström (2011, 2013).

[39] See Bower and Christensen (1995).

more firms have access to big data or sell access to big data. But the apparent precision of such analysis may be a castle built on sand and may not withstand a change in conditions.

Those conducting empirical work needs to be mindful to not interpret correlations as showing causality. The experience with Google that used search frequencies to predict the onset of flu is an illustration of how fragile correlations can be.[40] When conditions change, consumer behavior can change. The danger of over-interpreting correlations is aggravated by that correlations can be stable for a long time and change only suddenly to due some unforeseeable trigger. For example, banks that provided loans in the US prior to the financial crisis used vast amounts of past foreclosure data to predict future risk. But the many sub-prime foreclosures, while very small compared to the total market, created a domino effect that cascaded into the rest of the market, blowing historical correlations into the trashcan. The same may happen to consumer surveys and other analysis based on big data.

The consequences of presuming causality when none exists is thus not one of an academic faux pas; it can have serious economic consequences on society and lead to bad business decisions. One example of where this danger lurks is in the rising area of "now-casting," using vast hoards of online data (such as people's search habits) as input for macroeconomic forecasts. For example, do more online searches for unemployment benefits imply unemployment may be on the rise? Such a correlation may quite possibly seem strong, but just as with the Google flu, people's behavior may alter over time and the correlation become weaker. The point is not to deny the value of drawing inferences from online searches but to highlight the importance of combining it with other types of corroborating data and models.

4. What might happen?

Digitalization is an unstoppable force, comparable to globalization. But its speed and effectiveness may change significantly depending on the regulatory response. It is instructive to illustrate what might happen through stylized scenarios. Ideally, such scenarios should be done in a macroeconomic model but this is difficult as the question is really about how changes in policy parameters may affect behavior. But past models are based on historical patterns that may be only partly relevant, especially for macro models that aggregate numerous different responses. To narrow the questions somewhat, we focus on only three central variables: productivity, employment, and income inequality.

In Box 2, we discuss three different scenarios. They are not meant as forecasts but as illustrations. The point of departure is that outcomes depend on regulation as well as how society manages to smooth the period of adjustment in the labor market. In particular, the objective should be to promote productivity growth and incentives to work while reducing the severity of household income volatility. As emphasized in the interim report from the Digitalization Commission improving skills, especially digital skills, will likely make a big difference for employability, productivity growth, and wages.[41]

[40] See Lazer et al. (2014).

[41] See SOU (2015a).

Box 2. Scenarios for Sweden

In this box, we sketch the effects of policy on the economy. This thought experiment is motivated by the literature that emphasizes the crucial role of how policy institutions react to technological change.[42] While the scenarios are constructed for Sweden, they are relevant to other EU countries with extensive public welfare systems.[43] Starting from the current levels of productivity, employment, and inequality, we trace the effects of different policy responses. The time perspective is in the medium-to-long term, roughly the next two decades.

Macroeconomic assumptions for all scenarios

- Macroeconomic headwinds continue to weigh down productivity growth
- Unchanged framework for labor markets, including strong protection for regular employment contracts
- Social security systems remain unchanged

Scenario 1. Policy as usual: continued slow productivity growth, job creation slower than job destruction.

This is a "muddling-through" scenario in which policy adapts slowly. A piecemeal approach to regulation is likely associated with slower productivity growth. Essentially, the benefits of digitalization may be slower in coming than the costs of adjustments in the labor market. The macroeconomic headwinds discussed by Robert Gordon are then not sufficiently outweighed by benefits from innovations and the value thereby created. The aging populations and the high levels of debt in OECD countries are already affecting the economies, whereas the benefits from new technology and its pace of adoption depend on regulation. If each area of regulation is addressed separately – liability for self-driving cars, patent and intellectual property rights related to 3D printers, and the extent of liability of platform owners for transactions they facilitate – progress is likely to be measured in *minihertz* rather than *megahertz*. Issues that need to be incorporated into laws and negotiated in treaties tend to take time – for good reason, since the credibility of and trust in the system depend on factors including its fairness (real and perceived) and predictability.

Continued automation in industry and services mean that more jobs disappear and structural unemployment may be higher during a transition period, since many sectors are affected at the same time and with greater intensity than before. The process of automation is facilitated by workers retiring and thus provides a continued opportunity for firms to shed costs without actively having to reduce employees working under regular contracts. At the same time, the challenges of finding people with the right skills remain an obstacle to hiring, especially for highly skilled jobs. In Sweden, the additional rigidity of the housing market with the lack of available rental homes imply that structural adjustments are harder. Workers cannot easily move to new locations if there is no housing to be had.

New jobs are, of course, created all the time, but entrepreneurs are stymied by uncertainty about regulatory changes that affect their business model. The question at stake is whether their business model will be pushed into an existing analog regulatory box that undermines the core idea or, less dramatically, whether the changes will introduce an element that raises costs over and above those in the business plan.

In this scenario, we may see a gradual, but perhaps not marked, increase in income inequality. Some jobs will have slower wage growth and some people will not be able to work in the sharing economy due to regulatory obstacles. But we are still likely to see more superstar winners, entrepreneurs who are able to capture large market shares and then remain dominant due to brand recognition, but also due to obstacles for others to enter the market and compete.

[42] See, for example, Acemoglu et al. (2005).

[43] The mechanisms described are also relevant to the US, but the policy institutions and the starting points are different. Both EU countries and the US share challenges in removing obstacles to benefiting from digitalization, but the US labor market functions differently enough that the adjustments will likely be of a different kind and beyond the scope of this report. Notably, the US has already experienced strong increases in income inequality.

Scenario 2. Protectionist backlash: markedly slower productivity growth, more unemployment, more income inequality.

One might regard this scenario as Scenario 1 combined with an economic policy reaction that emphasizes the rights of insiders and incumbents and where destructive rent-seeking dominates at the expense of value creation. Incumbent firms are able to use regulation to erect hurdles that make entry harder and thus limit competition. This means that fewer jobs are created and the incentive to shift away from human labor towards further automation becomes stronger. This results in greater labor market polarization where middle level jobs are pushed down the skills ladder but the slow productivity growth will imply poor real wage growth for broad groups; that is, there will be both job and income polarization.

Scenario 3. Embracing change: better productivity growth, more job creation, unchanged income inequality.

If regulatory overhaul is initiated strategically with a few guiding principles on consumer safety and other concerns, this will reduce the need to reinvent the wheel for every area subject to digitalization. Using those principles on a case-by-case basis in each sector makes it possible to speed up regulatory review yet allow proper discussion of the idiosyncrasies of each area. For example, principles and thresholds for how and at what rates freelancers should pay tax in the sharing economy and what rules should apply with a view to reasonable levels of consumer safety.

Some existing regulation should be reviewed to determine whether the requirements are unnecessarily high with respect to risks and outcomes. For example, self-driving vehicles are likely to save many lives from fewer traffic accidents and yet are held back by uncertainty, notably on liability. Regulation should aim at *neutrality* between different alternatives, but the outcomes should stem *more from relaxing unnecessary rules rather than raising bars for potential entrants.* Raising the bars of entry may deter competition and lead to monopoly-type rents to the detriment of consumers.

In this scenario, many more services will be created in the sharing economy and jobs may thus keep pace with job destruction. Combining ease of adjustment between sectors with improved skills, especially digital skills, will ease the changes and make welfare more stable for large groups.

With the rise of the sharing economy as a more substantial part of the labor market, the difference in rights accrued to insiders compared to outsiders with insecure jobs needs to be addressed. To maintain the legitimacy of the welfare system, freelance workers also need to better covered by general social security safety nets. The safety nets need to be calibrated to even out income over time but not so generous as to discourage work.

Summary of effects over the medium to long term (next 20 years)

	Productivity	Employment	Income distribution
Scenario 1. Policy as usual	0	-	-
Scenario 2. Protectionist backlash	-	--	--
Scenario 3. Embracing change	+	+	0

Note: The scenarios described in this box are stylized. A plus sign indicates an improvement, a zero roughly unchanged, and a minus sign implies a deterioration. A double minus sign implies a stronger deterioration.

In the scenarios, we do not need to assume a dramatic adjustment in the labor market in response to further automation. Instead, through the ongoing process of workers retiring, firms will choose whether to replace them or to automate the tasks. Due to shrinking working-age populations, automation may also be a response to lack of skilled labor.

5. Closing words

How well countries fare in times of technological change will much depend on their institutions. Very rigid institutions may tend to push the possibilities brought by digitalization into established analog regulatory boxes and thus hinder progress and make adjustment unnecessarily difficult. Governments that do not find the right balance between leadership and cooperation with business may likewise lose out. The costs will be paid in higher unemployment and slower productivity growth. Getting policy roughly right matters a lot in times of change, and conversely, errors will be more damaging than in normal times. The errors may be of omission as well as commission. The absence of legal clarification of sharing economy business models, 3D printers, big data, and other technical advancements is burdening the march of progress and preventing entrepreneurs from improving business and consumer experiences.

On the other hand, there are some policies that would help to smooth adjustment in the labor market and help realize the benefits of digitalization:

- Lower the tax on (human) labor. High taxes on labor in Sweden further strengthen the already strong incentive to automate tasks. Tax deductions for household services should be expanded, not reduced.
- Ease the regulatory uncertainty that surrounds the sharing economy. This will provide flexibility for adjustment and lower risks of higher structural unemployment.
- Improve opportunities for lifelong learning. Longer working lives combined with rapid technological change increase the risk that some skills will reach their best-before date earlier than before. To reduce the risk of poor prospects in the labor market, updated skills will be crucial.
- Reduce the asymmetry in social security between being employed or working freelance.
- Establish principles for regulation of the digital economy that can be used to speed reform in different sectors, reducing the need to reinvent the wheel. This will require focused collaboration between lawyers and economists – and not at the usual slow pace. Otherwise, productivity growth may remain stagnant and the macroeconomic headwinds from demography and public debt will continue to dampen growth.

The digital revolution is likely to improve quality of life, efficiency at work, provide new goods and services and transform leisure. But there is nothing inevitable about how smooth the ride will be. The institutional response will be key to improving productivity growth without further growth in inequality. If the digital challenge were to be summarized in one sentence it would be to remove the obstacles for digital innovation to improve productivity growth while ensuring that incentives to work remain strong and people are not left by the wayside with increasing inequality as a result.

Sammanfattning på svenska

"Technology's impact will feel like a tornado...No government is prepared for it."
Leader, The Economist, 18 januari 2014.

Digitaliseringen påverkar nästan all mänsklig interaktion på något sätt och våra institutioner försöker nu sent omsider hinna ifatt utvecklingen. Inga sektorer är immuna mot förändringarna och effekterna kommer att bli märkbara inom hela den privata sektorn, den offentliga sektorn och områden som tidigare inte påverkats av tekniken, som till exempel kulturinstitutioner.

Uppfattningarna om vad detta innebär skiljer sig kraftigt åt – från tron att allt kommer att förbli som det är till bilden av en tornado som drar fram genom ett kontorslandskap på framsidan av *The Economist*.[44] Är digitaliseringen då robotarna tar över "slutet för jobben" eller kan vi skapa tillräckligt många nya arbeten för att ersätta de som försvinner? Kommer klyftorna att växa ytterligare och inkomstökningen att koncentreras till några få "vinnare" som förvärvar enorma rikedomar samtidigt som andra får arbeta som frilansare eller "on demand" med större otrygghet och lägre inkomster? Vi hävdar att utfallet först och främst kommer att bero på vilken politik som förs.

Den här rapporten riktar sig till beslutsfattare och andra som är intresserade av digitaliseringens möjligheter och utmaningar. Den ger en bild av digitaliseringens kvalitativa ekonomiska effekter och syftar till att fylla tomrummet mellan den akademiska litteraturen och tankesmedjorna. Tankesmedjor och managementkonsulter har skrivit mängder om Internet-of-Things (IoT), big data, 3D-skrivare och "delningsekonomin", där människor och företag gör affärer via digitala plattformar. Alla sådana förändringar kommer sannolikt att bli väsentliga, men delningsekonomin har, enligt vår uppfattning, störst förutsättningar att förändra hur ekonomin fungerar under de närmaste åren och få de mest djupgående effekterna. Några akademiska rapporter diskuterar visserligen digitaliseringens ekonomi, men de flesta akademiker fokuserar huvudsakligen på att försöka förstå de effekter som tidigare teknik givit upphov till. Utmaningen för en läsare som försöker skapa ett samband mellan de båda perspektiven är att avgöra vilka aspekter på de historiska upplevelserna som är relevanta och hur man ska ställa sig till alla överdrifter som förekommer.

Digitaliseringen är en av flera olika trender som påverkar världsekonomin och det är viktigt att understryka att ingenting är självklart när det gäller konsekvenserna för den framtida välfärden. De slutliga utfallen – bra eller dåliga – kommer att bero på vilka beslut institutionerna – regering, riksbank och arbetsmarknadens parter – fattar och på deras förmåga att anpassa sig till tekniken, demografin, globaliseringen och andra faktorer. En avgörande lärdom från forskningen är att de nationer som lyckats bli rika har haft institutioner som gav stöd åt incitament för värdeskapande och samtidigt begränsade möjligheterna för insiders och särskilda intressegrupper att utnyttja sin särställning.

Teknikskiftet sker i en era med många olika underströmmar inom världsekonomin. Produktivitetstillväxten har minskat i OECD-länderna, även om det råder viss tvekan om den officiella statistikens kvalitet. Det finns också andra genomgripande och tydliga förändringar: åldrande befolkningar och hög statsskuld och arbetslöshet i finans-

[44] Economist 18 januari 2014.

krisens kölvatten. Det innebär att olämpliga beslut – eller avsaknaden av beslut – kan få konsekvenser för välfärden som är mycket skadliga och ger långsiktiga sociala och ekonomiska effekter. Är våra institutioner redo att ta sig an de här utmaningarna? Istället för att besvara den frågan direkt kommer vi att beskriva de möjliga ekonomiska konsekvenserna för produktivitetstillväxten, sysselsättningen och inkomstskillnaderna med hjälp av tre olika scenarier i slutet av denna sammanfattning. Vi hävdar att utfallet först och främst kommer att bero på de politiska besluten. Om besluten går i protektionistiskt riktning kommer klyftorna och arbetslösheten sannolikt att öka (se scenario 2 i ”Ruta 2. Scenarier för Sverige”). Vi måste också minska skillnaderna mellan anställda och egenföretagare när det gäller tillgången till socialförsäkringar.

Det är obestridligen så att våra ekonomier tidigare har lyckats anpassa sig till många olika förändringar och utvecklats från att primärt vara jordbruksbaserade till att baseras på massproduktion och en alltmer dominerande tjänstesektor. En tillbakablick visar att alla sådana förändringar har inneburit högre välstånd för hela samhället, men att livet kunde vara svårt för många människor under själva förändringen. Ekonomihistorikern Joel Mokyr har noterat att välfärden inte förbättrades nämnvärt mellan 1750 och 1850.[45] Idag finns sociala skyddsnät och regler som avlastar en del av förändringens börda från individen och våra ekonomier har utvecklat metoder för riskfördelning mellan olika grupper och generationer. Bland OECD-länderna är Japan antagligen det enda landet där de yngre generationerna inte har fått det bättre än de äldre på grund av två årtionden med vikande tillväxt och en snabbt åldrande befolkning, kombinerat med starka rättigheter för insiders.[46]

Tekniken kan nu förändra sättet att sprida riskerna inom ekonomin och ytterligare vidga klyftan mellan insiders och outsiders, mellan etablerade och nystartade företag. Om det finns en läxa som vi bör lära oss av den ekonomiska historien så är det att ett sätt att formulera den politiska utmaningen är att göra den strukturella förändringsperioden så smidig som möjligt – eller i möjligaste mån undvika stora svängningar – och samtidigt garantera förutsättningar för produktivitetstillväxt. När det gäller social välfärd är den största utmaningen hur institutionerna agerar för att upprätthålla incitament för innovationer och för att skapa nya arbetstillfällen samt att inte ge vika för särskilda intressegrupper och protektionism. Hur man löser sådana utmaningar kan vara avgörande för om klyftorna vidgas eller ej.

Förändringstakt kontra institutionell tröghet

Dotcom-bubblan som brast för ett årtionde sedan kännetecknades av samma sorts överdrifter som ofta omger ny teknik. Idag finns det finns säkerligen anledning att se kritiskt på överdrivna påståenden att stora förändringar är på gång och att tempot kan bli högre än under tidigare förändringsperioder. Ett exempel som visar att man bör vara vaksam på överdrifter är den spektakulära konkursen för det svenska bolaget *Boo.com* strax efter millennieskiftet. Företaget, med säte i London, försökte sälja designerkläder via en digital plattform och var därmed ett av de första som försökte sig på något som idag är vardagsföreteelse, men marknaden var inte tillräckligt mogen och förutsättningarna för framgång fanns inte ännu.

Trots erfarenheterna från Boo.com och andra nystartade företag som misslyckats finns det mycket som talar för att förhållandena är annorlunda den här gången. Boo.com misslyckades med något som idag är blivit vardagsföreteelse hos bland andra Zalando, Wish och andra e-handelsplattformar. Idag har vi ett ständigt ökande antal digitala

[45] Se Mokyr (2004).

[46] Se IMF:s artikel IV-konsultation med Japan från 2012.

företag med global verksamhet. En del av de här företagen har svårigheter, och vissa misslyckas, som vanligt är bland nystartade företag, men några få har blivit extremt framgångsrika. Förmågan att snabbt utöka bolagets verksamhet har blivit kritisk. Eller som Reid Hoffman, en av LinkedIns medgrundare, uttrycker det: ”First-scaler advantage beats first-mover advantage”.[47] Dagens situation är annorlunda än den var för tio år sedan och en rad av de viktigaste förutsättningarna har förändrats och mognat:

- Genom utvecklingen av stora plattformar med standarder som lockar till sig både kunder och producenter (webben, Apple med iOS och Google med Android).
- Genom att förtroendemekanismer tillkommit för digitala transaktioner, både för varor och tjänster.
- Genom digitala betalningssystem med låga transaktionskostnader.
- Genom utbredd användning av smarta telefoner och surfplattor.

Världen är nu redo för transaktioner med digitala varor och tjänster. Förändringarna har främst drivits fram av konsumenterna. De söker på internet, använder sina smarta telefoner och delar information, bilder och upplevelser på ett sätt som i hög grad påverkar handeln och samhällsdiskursen. De nya generationerna kommer sannolikt att använda digitala verktyg för konsumtion och fritidsaktiviteter i allt högre grad, vilket innebär att den konsumentdrivna aktivismen förblir en viktig drivkraft som kan komma att bli allt viktigare. Varje ny tjänst behöver bara vara tillgänglig från en av de största app-butikerna och/eller på webben för att nå ett stort antal konsumenter. Införandet av elektriciteten ger den bästa jämförelsen med tidigare teknikskiften, eftersom den också var en *universalteknik* som gav möjlighet att använda många andra maskiner. Skillnaden mot elektriciteten är att digital teknik kan hota andra verksamheter mer eller mindre kontinuerligt: För elektriciteten var det första steget viktigast: att utöka elnätet och skapa förutsättningar för moderna hushållsapparater och fabriker. De många följande stegen var av evolutionär snarare än revolutionär natur. En del hävdar också att den digitala tekniken är den enda universaltekniken som ger stordriftsfördelar.[48]

Företag som inte anpassar sig till konsumenternas förändrade krav på produkter eller information riskerar att hamna på efterkälken. Samtidigt är våra institutioner uppbyggda kring en långsammare värld, där lagarna och gängse regler på arbetsmarknaden innebär trögheter. Trögheten är sannolikt främst en fördel, särskilt när det gäller demokratin och grundförutsättningarna för tillämpningen av regler och social välfärd. Men arbetsmarknaden har utvecklat en stelbenthet som nu utmanas av digitaliseringen. Den snabbt ökande åldrande befolkningen och behovet av att förlänga arbetslivet för att finansiera den offentliga välfärden skulle ändå tvinga arbetsmarknaden att förändras, men digitaliseringen gör reformeringen av institutionerna allt mer angelägen. Utmaningen är att behålla komponenter som bidrar till stabilitet utan att hämma tillväxt och innovation.

Digitaliseringen erbjuder många nya sätt att kringgå stelbenta regler och undvika regelverk som har utvecklats under många år. Det kan finnas goda skäl för många av reglerna, särskilt vad gäller konsumentskyddet, men många av dem leder till för mycket skydd för insiders och monopol från konkurrens. Det innebär högre priser för konsumenterna och gör det svårare för unga människor och arbetslösa att hitta jobb. Mycket av den här stelbentheten kommer att ifrågasättas, särskilt när de digitala lös-

[47] Hoffman (2015).
[48] Se Edquist och Henrekson (2006).

ningarna ger möjlighet att utforska nischer med ineffektivitet och outnyttjade resurser som kan skapa vinst. Förändringskraven för institutioner och företag kommer att bli mycket starka eftersom de motiveras av vinster som kan vara anmärkningsvärt små per såld enhet, bara nätverkseffekten skapar en hög försäljningsvolym. Anledningen till att förändringen sannolikt kommer att bli snabb är kort sagt att den motiveras av vinster som tekniken både skapar möjligheter till och utgör drivkraften för. Hur produktivitetstillväxten, arbetsmarknaden och klyftorna slutligen kommer att påverkas beror på hur regeringar och myndigheter reagerar på de här utmaningarna.

Vi ser det som osannolikt att digitaliseringen kommer att innebära massarbetslöshet på grund av att robotarna övertar många – eller de flesta – jobb. Men alla håller inte med om det. Det finns välrenommerade forskare, berömda vetenskapsmän och affärsexperter som hävdar att robotarna kommer att ersätta nästan all arbetskraft, vilket i allt väsentligt innebär ”slut för jobben”.[49] Ruta 1 innehåller en kort sammanfattning av de olika argumenten, men erfarenheterna från den ekonomiska historien visar att nya jobb (som vi ofta inte ens kan föreställa oss) skapas hela tiden. Problemet är i stället att missriktade politiska beslut kan försvåra övergångsperioden och anpassningsperioden kan ge upphov till högre strukturell arbetslöshet och ökande klyftor.

De många olika uppfattningarna om vad digitaliseringen innebär skapar sannolikt också viss förvirring. Å ena sidan uppmanas människor att fortsätta arbeta längre och det finns en brist på yrkesutbildad arbetskraft i många OECD-länder, bland annat Sverige och Tyskland. Å andra sidan kan det hända att robotarna tar över. Hur ska man ställa sig till detta? I den här rapporten försöker vi att svara på sådana frågor och förhoppningsvis bidra till mindre förvirring. I grunden är det den långsiktiga trenden med åldrande befolkningar som skapar problem med finansieringen av den offentliga välfärden. Om robotarna faktiskt skulle överta merparten av all jobb från människorna, något som vi betraktar som osannolikt, skulle de befintliga finansieringsmetoderna för den offentliga välfärden inte fungera. En mycket stor andel av statens intäkter kommer från beskattningen av arbete. Men om jobben istället fortsätter att finnas kvar måste vi förlänga våra arbetsliv för att finansiera välfärden, eftersom det kommer att finnas fler pensionärer än unga människor som kan förvärvsarbeta.[50]

Ruta 1. En sammanfattning av argumenten för och emot ”slutet för jobben”

Skäl som talar för ”vanlig” strukturomvandling

- Arbetena har inte försvunnit trots enorma teknikskiften som ersatt jordbruket med tillverkning och tjänster som bas för ekonomin.
- Tendensen att underskatta komplementariteten mellan människor och maskiner som ger möjlighet till produktivare arbete utan att ersätta arbetskraften.
- Bilen, ångmaskinen, elektriciteten, rent vatten, telefonen osv. påverkade vår livsstil i mycket högre grad och har förbättrat livskvaliteten mer än dagens digitala uppfinningar.
- Betydande trögheter i institutioner och regelverk och långsam anpassning kan underminera nya affärsmodeller.
- Internet of Things och big data har ett stort inslag av juridisk osäkerhet som kommer att fördröja fördelarna.
- Preferenser för mänsklig interaktion på skolor, sjukhus, osv.

[49] Fysikern Stephen Hawkins stödjer till exempel den uppfattningen, och Bill Gates, en av grundarna till Microsoft, har uttryckt liknande åsikter.
[50] Se Blix (2013a).

Skäl som talar för omfattande förändringar, men inte "slutet för jobben "

- Digitaliseringen har starka nätverkseffekter och marginalkostnaden är låg eller obefintlig för många digitala tjänster.
- Transaktionskostnaderna kan bli mycket lägre (delningsekonomi, 3D-skrivare).
- Digital kunskap är icke-exklusiv och information sprids utan begränsningar.
- Många sektorer påverkas snabbare och samtidigt.
- Demografin och matchningsproblemen på arbetsmarknaden ökar drivkrafterna att automatisera.
- Digitala plattformar kan matcha köpare och säljare även för små varor och tjänster och göra det lättare för investeringskapital att hitta entreprenörer.
- Delningsekonomin ger flexiblare arbetsmarknader och starkare konkurrens för arbetskraften.
- Snabb utveckling av intelligent programvara som kan ersätta människor och analysera ostrukturerad information, utföra empiriskt arbete och skriva texter som inte med lätthet kan identifieras som maskinproducerade.

Skäl som talar för "slutet för jobben"

- Maskiner som börjar lära sig själva utvecklas snabbt.
- Människans förmåga att anpassa sig är långsammare än ökningen av datorkraften som kan användas till att lösa analytiska arbetsuppgifter och tillämpa undermedveten kunskap.
- Okvalificerad arbetskraft kommer att ha lägre produktivitet än maskiner och därmed inte vara anställningsbar eller ha en svag reallöneutveckling.

1. Arbetsmarknaden

Vad har hänt?

De flesta människor är sannolikt inte medvetna om hur långt programvarorna har utvecklats i sin förmåga att utföra mänskliga aktiviteter. Självkörande bilar har det talats om sedan länge, men på andra områden, särskilt när det gäller mycket kvalificerade arbetsuppgifter, är det väl fortfarande människan som har monopol? Många människor är nog vagt medvetna om att datorerna har slagit världens bästa schackspelare och Jeopardy-deltagare. Men alla mänskliga aktiviteter, i synnerhet kreativt arbete, skrivförmåga och analys, kan inte kodas i programvara – de kräver kognitiv och undermedveten kunskap som datorerna saknar – eller hur?

Artificiell intelligens är inte i sikte inom en nära framtid, men dagens programvaror är så avancerade att de kan utföra mycket kvalificerade mänskliga arbetsuppgifter på många olika områden.[51] Tack vare Moores seglivade lag om allt snabbare datorer är datorkapaciteten nu så hög att många arbetsuppgifter som tidigare var förbehållna människor, till exempel att skriva och forska, nu kan utföras snabbare och exaktare av datorer, och de har dessutom stilistisk förmåga som gör att det inte längre är uppenbart att en text har skrivits av en dator.[52] Populärkulturens filmer och böcker innehåller ofta ondskefulla robotar som går på två ben, men det ger en missvisande bild. Arbete kan nu läggas ut i molnet, antingen till intelligent programvara eller till en global arbetsmarknad via digitala plattformar.[53] Den moderna ersättaren för en kontorist är inte en människoliknande manick som sitter med en kaffekopp i en stol (för att framstå som mänskligare). Den är istället en av de många stackar med maskinvara

[51] Se till exempel Bostrom (2014) för en översikt av framstegen på området artificiell intelligens och läget idag.
[52] Se Clerwall (2014).
[53] Se till exempel O'Connor (2015b).

som finns i anonyma serverhallar på mer eller mindre avlägsna platser med snabba fiberanslutningar. Facebooks servrar i Sverige finns till exempel längst upp i norr, i Luleå, där det kyliga klimatet bidrar till låga energikostnader.

En av dagens främsta forskare på området teknik och arbetsmarknad, MIT-professorn David Autor[54], hävdar att oron för automatisering inte tillräckligt tar hänsyn till två krafter: graden av komplementaritet mellan människa och maskin, dvs. hur tekniken gör oss bättre på många olika arbetsuppgifter, och svårigheten att automatisera *undermedveten kunskap*. Undermedveten kunskap avser saker som vi gör utan att vi kan förklara exakt hur, till exempel att cykla eller känna igen en stol bland tusentals bilder. Argumentet är att vi inte kan automatisera en aktivitet om den inte följer specifika regler som kan överföras till kod.

När det gäller komplementaritet finns det en hel del material som vi kommer att diskutera nedan, varav en del är oroande för hur många och vilka jobb som kommer finnas kvar. Men frågan om undermedveten kunskap är av ett annat slag, något av ett mellanting mellan ett filosofiskt och ett praktiskt hinder för automatisering.[55] Det bör dock vara tydligt att idén om att undermedveten kunskap inte kan kodas är ett *antagande* och inte en naturlag. För några år sedan var det till exempel många som utgick ifrån att självkörande fordon var en omöjlighet eftersom det ingår alltför många olika typer av undermedveten kunskap för att köra bil. Om förmågan att digitalisera undermedvetna färdigheter kommer att möta oöverstigliga hinder återstår att se. Kanske undermedvetna kunskaper inte utgör en ogenomtränglig mur som automatiseringen inte kan ta sig över, utan snarare något som kan omformas eller kringgås och omdefinieras.

Maskiner som börjar lära sig själva exemplifierar hur man kan undvika svårigheterna med att koda undermedveten kunskap. Man kan lära maskiner att imitera människor och observera fysiska händelser. Detta är ett område som snabbt utvecklas och förbättras. Dagens programvara är redan så intelligent att den kan ta över många mänskliga aktiviteter, men det finns andra hinder än tekniken som kan stå i dess väg (mer om detta nedan). Ett exempel är att det ännu inte finns pilotlösa passagerarflygplan, medan det finns förarlösa tåg till exempel i Asien. Tekniken finns redan, men om det finns en efterfrågan på den är oklart – åtminstone idag. Men detta kan också komma att förändras om pilotlösa plan blir lika säkra men betydligt billigare än vanliga flygplan. Det är inte lätt att veta på förhand vilka aktiviteter som låter sig automatiseras och att utforska var gränserna går är en utmaning för entreprenörerna. Allmänhetens uppfattning om vilka aktiviteter som tryggt kan automatiseras kommer sannolikt att förändras över tid. World Values Surveys[56] indikerar visserligen en stark tro på vissa grundvärderingar, särskilt när det gäller familjens betydelse, men uppfattningen om hur vi samverkar med varandra och hur vi konsumerar varor och fritidsaktiviteter kan sannolikt formas och förändras i takt med tekniken.

En av de största förändringarna som digitaliseringen givit upphov till är framväxten av delningsekonomin, som trots sitt namn handlar mer om marknadskrafter och entreprenörer som hittat nya affärsmöjligheter. Andra, kanske något mer beskrivande termer, är engelskans ”on-demand economy” och ”gig economy”, och ”uppdragsekonomin”, men i den här rapporten kommer vi att fortsätta använda termen ”delningsekonomin”. Med digitala plattformar kan även en liten efterfrågan på olika varor och tjänster matchas och levereras till låg kostnad. Delningsekonomin är en viktig makroekonomisk förändring. Grannar och arbetskamrater har visserligen bytt varor och

[54] Se till exempel Autor (2014).
[55] Se Ambrosini and Bowman (2001) för en diskussion om mätningsproblematik för undermedveten kunskap
[56] Se Halman et al. (2008).

tjänster med varandra under hela mänsklighetens historia, men den sortens aktiviteter håller nu på att omvandlas på ett sätt som liknar hur industritillverkning förändrade produktionen för alltid. Vetskapen om att det finns en människa som efterfrågar en företags- eller hushållstjänst vid en viss tidpunkt innebär att det inte längre är samma lotteri att matcha tillgång och efterfrågan. Följaktligen kommer det att finnas fler och flexiblare arbeten i delningsekonomin, men också större otrygghet, en fråga som vi kommer att återvända till nedan.

Ytterligare automatisering

Automatiseringen av lågkvalificerade jobb och arbeten inom tillverkningsindustrin har blivit en drivkraft och kanske också en potent symbol för produktivitetstillväxten inom marknadsekonomierna. Det behövs ingen större fantasi för att förstå att självkörande bilar och fordon kommer att förändra många aktiviteter, och minska behovet av taxi- och lastbilschaufförer, bilskolor, försäkringsbolag och servicepersonal för hotell och restauranger. En positiv effekt är dock att läkarna kommer att ha färre trafikskadade att ta hand om eftersom de lär bli färre olyckor. Men det uppstår sannolikt också dominoeffekter, och många av dem är oförutsägbara. Ett exempel på en någorlunda förutsägbar dominoeffekt är att införandet av självkörande fordon kommer att påverka landsbygden. Om färre människor levererar varor till landsbygden minskar antalet gäster för många restauranger och hotell, vilket ger sämre förutsättningar för deras verksamhet.

Inom jordbruket har det hittills krävts viss mänsklig aktivitet för hantering av känsliga frukter, men detta börjar också att förändras. Maskinerna är nu så avancerade att de kan ta över sådana arbetsuppgifter. Logistiklager, som används av Amazon, Wal-Mart i USA, och Clas Ohlson i Sverige, har i allt högre grad halvautomatiserats och allt fler funktioner har övertagits av maskiner. Idag finns det maskiner som kan producera tvåhundra hamburgare eller mer på en timma och i Japan finns helautomatiserade sushi-restauranger och hotell där servicepersonalen i stort sett har ersatts av maskiner, ungefär på samma sätt som att incheckningen på våra flygplatser mest handlar om att interagera med maskiner istället för med stressad incheckningspersonal.

Det är sant att många av arbetena som har försvunnit inte nödvändigtvis var särskilt tilltalande Många av dagens arbeten har faktiskt blivit bättre – bland annat byggnadsarbete, gruvarbete och andra fysiskt påfrestande yrken – i takt med att maskinerna har ersatt en del av den mänskliga arbetsinsatsen. Att se barn i utvecklingsländer stiga ut ur mörka hål i marken efter slitsamt arbete med att utvinna kol eller mineraler ger oss en påminnelse om det.

En del av ledtrådarna för interaktionen mellan maskiner och människor i dagens ekonomier kommer från bankväsendet. I början fruktade bankkassörerna att deras arbeten skulle försvinna när bankomaterna infördes, men antalet arbetsuppgifter ökade faktiskt och krävde högre kompetens: kassörerna började erbjuda mer service och rådgivning till kunderna. Det finns exempel på komplementaritet mellan maskiner och människor även på andra områden, bland annat inom sjukvården, där läkarna har förbättrat sin kliniska och kirurgiska yrkeskompetens med hjälp av instrument, datorer och maskiner. Men på vissa områden, bland annat när det gäller kontorsarbete, har datorer ersatt arbetskraften på samma sätt som hantverkarna trängdes undan när industrialiseringen började. Maskiner har övertagit vissa arbeten och nya, mer kvalificerade jobb med högre grad av komplementaritet har skapats under hela historien.

Digitaliseringen har nu nått en sådan hastighet, mogenhet och spridning att den kan slå igenom snabbare och få mera omfattande effekt än någon annan teknik hittills. Införandet av elektriciteten, som också var en ”universalteknik”, under 1900-talet är kanske den bästa jämförelsen. Även elektriciteten påverkade många olika sektorer samtidigt, men skillnaden är att den inte infördes lika snabbt. Detta kan göra det svårare för arbetskraften – kvalificerad eller ej – att ta sig från en sektor på tillbakagång till en sektor på frammarsch.

Det finns starka incitament att ta reda på vilka delar av den globala värdekedjan som kan automatiseras. Stora svenska bolag, som till stor del är exportinriktade, har redan en ständig strävan efter effektivitet inbyggd i sitt DNA. För dem är det helt naturligt att outsourca eller automatisera delar av den globala värdekedjan. Svårigheten att ersätta personal som i en åldrande befolkning går i pension och matchningsproblem på arbetsmarknaden kan mycket väl komma att stärka incitamenten att automatisera. Sådana incitament är särskilt stark i Sverige och andra länder med rigid arbetslagstiftning och hög skatt på arbete.

De nya och kraftiga förändringar som pågår antyder att fler medelklassarbeten kommer att påverkas av digitaliseringen. Tidnings-, film- och musikbranscherna har till exempel sedan lång tid tillbaka varit påverkade av att den digitala distributionens har låga marginalkostnader och reser svårigheter att ta betalt för innehåll. Nästa automatiseringsvåg kommer att automatisera tusentals texter, allt från bolagens resultatrapporter till fotbollsresultat.

Även när det gäller juridiskt utredningsarbete och affärsanalys håller programvara på att automatisera sortering, analys och presentation av enorma datamängder.[57] För juridiska tillämpningar, där prejudikat är viktiga, kan programvara numera finkamma miljoner dokument som tidigare skulle ha tagit många år att arbeta sig igenom. Ännu så länge avser många av dessa arbeten på instegsnivå, till exempel av assistenter på advokatbyråer, men det finns redan teknik för betygsättning av skriftliga tentamina och uppsatser i skolor och liknande.

Arbetsuppgifterna som kan utföras av maskiner blir alltmer kvalificerade. IBM och Google köper upp sjukvårdsbolag i hopp om att kunna förbättra diagnostiken med hjälp av programvara.[58] Tillgången till stora databaser och avancerade rutiner för dataanalys ger programvaran möjlighet att förbättra de medicinska bedömningarna. Volymerna är helt enkelt för stora för att en mänsklig läkare ska kunna följa den breda medicinska forskningen utanför sitt eget kompetensområde. Med hjälp av statistiska metoder och slutledningsförmåga kan programvaran tillhandahålla prognoser och rekommendationer baserade på information som en enskild person helt enkelt inte kan ta till sig.

Bör vi ha förtroende för programvarurekommendationer när det gäller medicin, juridik eller andra områden? Många människor kommer sannolikt inte att uppskatta svar från ”svarta lådor”, oavsett hur mäktiga och allvetande de verkar vara. Här har till exempel IBMs *WatsonPaths* potential att skapa förtroende för automatisering av även kvalificerade arbetsuppgifter, eftersom den inte bara visar det rekommenderade alternativet utan också stegen för att nå dit.

[57] Se till exempel Ford (2015a) för en översikt av arbetsuppgifter som idag kan utföras av maskiner.
[58] Se Crow (2015) och Lohr (2015a, c)

När vi funderar på framtidens jobb – hur många de blir och av vilket slag – bör vi göra en återblick och försöka komma underfund med vilka historiska erfarenheter som är relevanta. Den ekonomiska historien ger exempel på praktiska erfarenheter som visar effekterna av strukturförändringar och vilka utmaningar vi kan förvänta oss. Första delen av den industriella revolutionen präglades av så kallade *deskilling*, men större delen av 1900-talet kombinerade allt högre teknisk expertis med allt högre kompetens. Men under de senaste decennierna har OECD-ländernas arbetsmarknader polariserats alltmer: antalet arbeten på medelinkomstnivå har minskat medan de hög- och lågkvalificerade arbetena utgör en allt större andel av arbetsmarknaden. Detta har ännu inte skett i Sverige på samma sätt; Sverige har istället sett en ökning av andelen högavlönade arbeten. I Sverige har lönerna inte heller polariserats på samma sätt som i USA, där reallönerna för många arbeten på låg- och medelinkomstnivå har ökat föga eller inte alls. I Sverige har utvecklingen istället varit den motsatta, med en stark reallöneutveckling under de senaste tjugo åren.

Polariseringen av arbetsmarknaden kan mycket väl ge upphov till spänningar i en ekonomi, men som Raguran Rajan, tidigare chefsekonom för IMF och idag Chef för den Indiska centralbanken, framhåller kan den snabba ökningen av bostadspriserna i USA ha bidragit till att få medelinkomsttagarna att känna sig som om de fick ta del av det välstånd som skapades, åtminstone före finanskrisen.[59] I USA ökar idag spänningarna, särskilt bland de som har lågavlönade arbeten, till exempel inom snabbmatskedjorna. Ett antal människor med lågavlönade arbeten i USA får också matkuponger, och därmed subventionerar staten i realiteten en del av de arbetsgivare som betalar låga löner, till exempel i snabbmatsrestaurangerna.[60]

I Sverige har utvecklingen varit helt annorlunda. Här reformerade man institutionerna i efterdyningarna av den spruckna bostadsbubblan på 1990-talet. Radikalt förändrade institutioner och starka statsfinanser gjorde att Sverige klarade finanskrisen 2007 och ökningen av arbetslösheten blev inte alls lika stor som efter den stora chocken på 1990-talet. Efterverkningarna av finanskrisen blev visserligen en utmaning, men Sveriges reformer på 1990-talet stärkte institutionernas förmåga att motstå chocker på ett sätt som gynnat landets innevånare.[61] I motsats till många andra OECD-länder är statsfinanserna i Sverige hållbara och landets statsskuld har varit låg både under och efter finanskrisen. Sverige var faktiskt ett av de få EU-länderna som kunde hålla sin statsskuld en bra bit under 60 procent av BNP, som den ursprungliga stabilitets- och tillväxtpakten i EU krävde.

Reformerna av budgetprocessen på 1990-talet var nyckelkomponenter som bidrog till detta resultat, och utgiftstaket på medellång sikt för statsutgifterna och förbättringen av hur budgeten hanteras i riksdagen var särskilt värdefulla verktyg som kunde användas till att minska den starka tendensen mot underskott som i övrigt präglade statsutgifterna. Arbetsmarknadsreformerna som inleddes efter 2006 gav dessutom ett starkare incitament för arbete genom att sänka inkomstskatterna och stärka bidragssystemens svaga kontrollmekanismer för att minska missbruket.[62] En annan nyckelreform var när man gjorde Riksbanken oberoende år 1999 för att penningpolitiken skulle inriktas mot prisstabilitet. En erfarenhet från Sverige är alltså att institutionella reformer som får olika krafter att samverka på ett bättre sätt är helt avgörande för att klara ekonomin, i synnerhet i kristider.

[59] Se Rajan (2010).
[60] Se till exempel Cohen (2015) och Jacobs et al. (2015).
[61] Se till exempel Calmfors (2013); Heyman et al. (2015b).
[62] Se Vårbudgeten 2014, bilaga 4.

Men det är ett misstag att tro att institutionerna någonsin blir fulländade och klarar av vad som helst utan att reformeras. Det kommer alltid att vara svårt att göra avvägningar mellan olika angelägna ändamål i ekonomin, men institutionernas struktur kan underlätta och skapa förutsättningar. Institutionerna kan med andra ord göra det lättare att föra en bra långsiktigt politik, men det betyder inte att tillräckligt bra institutioner möjliggör policy på auto-pilot. Till syvende och sist är det de offentliga beslutsfattarna andra parter som måste genomföra och försvara svåra vägval.

Arbetsmarknaden i Sverige kännetecknas av centrala avtalsförhandlingar mellan arbetsmarknadens parter och staten har ingen direkt kontroll över löneförhandlingarna, till skillnad från andra länder där staten kan vara direkt involverad i lönesättningen för den offentliga sektorn.[63] Arbetsgivarna har visserligen rätt att friställa arbetstagare, men de måste förhandla om uppsägningar med fackföreningarna enligt principen först in, sist ut. OECD har ofta rekommenderat att Sverige bör öka flexibiliteten på arbetsmarknaden. Det nuvarande systemet är gynnsamt för insiders på arbetsmarknaden med avtal för tillsvidareanställning. Systemet gör det svårt för andra att komma in på arbetsmarknaden. Det ger också mindre incitament att byta arbete även då de ekonomiska förhållandena förändras, till exempel om en sektor är på tillbakagång och utsikterna bättre på annat håll. Dessutom kan människor vara mindre benägna att frivilligt ge upp den trygghet som ett avtal för tillsvidareanställning erbjuder, även om de skulle vara gynnsamt att byta arbete eller sektor.

Marknadsekonomin hittar ofta metoder att hantera bristen på flexibilitet, ibland till hög kostnad och ibland till lägre. I Sverige har speciella bemanningsföretag, som på begäran tillhandahåller tillfällig arbetskraft för allt från kontorstjänster till företagsledning, blivit populära inom flera branscher. När det gäller tryggheten för tillfällig personal är Sverige ett av de länder som har det svagaste skyddet för personal inom OECD. Sammantaget innebär detta att Sverige har en av de mest utpräglade tudelade arbetsmarknaderna bland OECD-länderna.[64]

Gränser för automatiseringen av jobb och konsekvenser för den svenska arbetsmarknaden

Några forskare argumenterar att en stor andel, 50 procent, av dagens arbeten kan komma att automatiseras.[65] Det kanske framstår som självklart, men det är ändå värt att framhålla att de jobb som försvinner endast ger en partiell bild av hur arbetsmarknaden kan utvecklas. Att jobb försvinner och att befintliga arbeten förändras är inget nytt. Nya jobb skapas hela tiden och problemet är egentligen hur snabbt de uppstår i förhållande till antalet människor som söker efter jobb och om de människorna har rätt kvalifikationer. Dessutom finns det motkrafter som kan fördröja automatiseringen.

För det första innebär *inte* det faktum att tekniken ger möjlighet att automatisera arbeten att detta nödvändigtvis kommer att ske. Den främsta drivkraften bakom automatiseringen är viljan att skapa något som är bättre och ger högre kvalitet, nya varor eller tjänster eller lägre kostnader. Inom vissa områden innebär automatisering högre kostnader än mänsklig arbetskraft. Nya bilar har till exempel vindrutor som installeras av robotar, men när en vindruta ska ersättas är det normalt en människa som utför arbetet. På en del områden kanske det inte finns någon större efterfrågan

[63] Löneutrymmet inom den offentliga sektorn i Sverige följer en mekanisk regel som använder produktivitetstillväxten inom den privata tjänstesektorn som en måttstock för krav rörande kostnadseffektivitet vad gäller löner och verksamhet.
[64] Se Cahuc (2010), sid. 150–153, och OECD (2015b).
[65] Se Frey och Osborne (2013) och Fölster (2015).

på automatisering. Människor kanske motvilligt accepterar att besvara automatiska frågor för att nå en kundservice. Det finns många jobb där automatisering inte kommer att välkomnas eller accepteras, åtminstone inte inom en snar framtid. Automatiserad utbildning är ett exempel där lärare – i tämligen stor utsträckning – skulle kunna ersättas av programvara. Föräldrarna kanske inte skulle bli så entusiastiska över det och fackföreningar kanske också skulle hålla tillbaka en sådan utveckling.

För det andra finns det många andra trender som påverkar efterfrågan på jobb och som har lite att göra med automatisering. Demografin kan vara väsentlig som en generell drivkraft för automatisering. Men en åldrande befolkning kan samtidigt öka behovet av mänskligt arbete inom sjukvård och äldreomsorg. Fler sådana arbetsuppgifter kan visserligen automatiseras idag – robotar som hjälper äldre personer finns till exempel redan i Japan och det finns försöksversioner av dem i Sverige. Men det är svårt att tro att sådana förändringar kommer att bli avgörande inom överskådlig tid, om man ser till de behov som finns. Inom juridiken har automatiseringstekniken till exempel gjort det möjligt att minska antalet juridiska assistenter och juniora tjänster, men trots det har andelen jurister ökat på arbetsmarknaden. Det kan finnas flera olika förklaringar till detta, en av dem kan vara att vi fått allt komplexare regler.[66] Skärpningen av kraven för finansiella tjänster har till exempel inneburit ett behov av betydligt mer arbete med regelefterlevnad. Andra förändringar inom ekonomin kan alltså emellanåt vara mer betydelsefulla för utvecklingen än teknik.

För det tredje erbjuder små, öppna ekonomier som Sverige, med ett språk som endast talas av ca tio miljoner människor, *mindre utrymme* för automatiseringens fördelar än USA och Kina. Ofta kan man inte bara ta en amerikansk eller brittisk teknisk lösning och införa den direkt i ett litet land. Det finns institutionella särdrag när det gäller lagstiftningen, kulturen och konsumenternas önskemål, som man måste ta hänsyn till. En del av den institutionella strukturen speglar starkt rotade konstitutionella regler, bland annat uppdelningen av ansvar mellan regionala och centrala myndigheter. Regionala myndigheter, som kommuner och landsting, ansvarar för många tjänster där digitaliseringen har potential att öka effektiviteten, till exempel för kollektivtrafik och sjukvård, men även för system som underlättar att hitta och betala för parkeringsplatser. Men lokalt självstyre innebär också att varje område kan ha sina egna speciella lösningar, vilket gör det svårare att utveckla programvara som omfattar ett helt land.

Det här är ett problem som i olika hög grad påverkar nästan alla länder och det kan naturligtvis lösas genom frivilliga överenskommelser om att använda gemensamma format och standarder. Men att nå konsensus kan ta tid och bli föremål för tolkning eller förändring som ger upphov till osäkerhet och fördröjer åtgärderna. Inga av de här hindren är dock oöverstigliga, men de kan sakta takten i utvecklingen, eftersom skalavkastningen tar längre tid att nå eller är osäker. Småskalighet ger lägre avkastning från samma investeringskapital. Språket är ett annat problem, som skapar fördelar för engelska och andra stora språk. Men att dra slutsatsen att små länder är ”skyddade” från automatisering från digitala företag med hemvist i Silicon Valley är ett misstag. En mer proaktiv inställning är att det kan finnas möjligheter för entreprenörer att utveckla smarta metoder som tar hänsyn till de lokala förhållandena, i Europa och på andra platser, innan de stora plattformarna knackar på dörren.

Och till sist kan befintliga regler och hotet om nya regler avskräcka entreprenörerna. Den här frågan diskuteras vidare nedan. I det här sammanhanget räcker det att notera att en del företag kan ha en affärsmodell som är helt beroende av små detaljer i lag-

[66] Se Fölster (2015).

stiftningen och av hur lagen tolkas. Är det till exempel rätt att de som tillhandahåller plattformarna i delningsekonomin har arbetsgivaransvar, som ett aktuellt domstolsbeslut Kalifornien antyder? Sådana frågor kan allvarligt begränsa, eller till och med helt underminera, många aktörer inom delningsekonomin. Frågan är likaledes vem som har ansvaret för en olycka orsakad av ett föremål som skapats av en 3D-skrivare, av ett självkörande fordon eller av förlorade känsliga personliga data (om till exempel hälsa och sjukdomar)?

Vad innebär detta sammantaget för hur snabbt automatiseringen framskrider? Å ena sidan gör Europas rigida arbetsmarknad ytterligare automatisering attraktiv som ett sätt att öka flexibiliteten. Demografin gör dessutom automatiseringen attraktiv eftersom den kanske kan lösa problemet med brist på kvalificerad arbetskraft. Å andra sidan utgör regelverken och de institutionella skillnaderna ett hinder för alla länderna i Europa, utom de största, där bristen på storskalighet inte är en faktor.

Men, som vi framhåller ovan, hur omfattande automatiseringen blir kommer i grunden att bero på de politiska besluten. Att de bidrar till att skapa arbeten inom den privata sektorn är en absolut förutsättning för smidiga förändringar. Aktuell forskning visar att ett stort antal nya jobb har skapats i Sverige. En undersökning av svenska data visar att 190,000 *nya* jobb skapades under perioden 1990–2009. Det var nettoresultatet av att ca 3,4 miljoner jobb skapades medan 3,2 miljoner jobb försvann.[67] Under ett genomsnittligt år omsattes ca en femtedel av jobben på arbetsmarknaden, något som visar ekonomins förmåga att anpassa sig till efterfrågan och ny teknik. De flesta jobben skapades inom tjänstesektorn, medan sysselsättningsandelen minskade inom tillverkningsindustrin.

2. Ekonomiska krafter

Förändrade ekonomiska krafter får fotfäste

Delningsekonomin sänker transaktionskostnaderna för mängder av olika tjänster. De omfattar allt från egenpublicering av böcker och webbsökningar efter information till utförandet av hushållstjänster. Det ger flexiblare arbete, särskilt i europeiska länder som har ett starkt skydd för insiders på arbetsmarknaden. Men i takt med att allt fler människor arbetar som frilansare eller på begäran inom delningsekonomin utsätts de också för högre risker, eftersom de sociala skyddsnäten främst är avsedda för heltidsanställda som täcks av kollektivavtal.

Av alla krafterna som digitaliseringen ger upphov till kommer delningsekonomins ekonomiska effekter sannolikt att stå för den snabbaste förändringen och bli en av de viktigaste. Delningsekonomin är ett stort steg som förändrar vårt sätt att arbeta och organisera våra liv på ett helt annat sätt än andra mer gradvisa förbättringar. En effekt som redan märks är att behovet av att äga saker har minskat eftersom man enkelt kan hyra dem med en musklickning. Det innebär också färre resurser som står outnyttjade , till exempel i form av bilar som normalt står parkerade nästan hela dagen eller rum som inte används i villor eller lägenheter. Entreprenörer är på jakt efter nya nischer med outnyttjade resurser och varor som kostar mycket, till exempel formella aftonklänningar eller borrmaskiner som bara används en eller två gånger varje år. De förändrar också hur efterfrågan på hushållstjänster uppfylls med hjälp av teknik som sparar tid och bland annat gör det lättare att handla matvaror, få städning utförd och skicka blommor.

[67] Heyman et al. (2013).

Sådana tjänster är naturligtvis inte nya, men de kan smidigt matcha tillgång och efterfrågan och erbjuder låga kostnader på ett sätt som har stor betydelse för ekonomin. En aktuell undersökning utförd av Freelancers Union fann att 34 procent av alla som arbetar i USA har deltagit i aktiviteter inom delningsekonomin. Den europeiska delningsmarknaden är inte lika utvecklad som den amerikanska, men blir allt viktigare, särskilt i Storbritannien. Europas rigida arbetsmarknader innebär att delningsekonomin på sikt kan få ännu starkare effekt, såvida inte utvecklingen stryps av nya regler.

En viktig faktor som kan påverka delningsekonomin är att motivet för ägande håller på att förändras. Varför äga en bil om man med ett enkelt klick kan beställa en transport när man behöver den? Varför köpa en festklänning om man bara ska använda den en eller två gånger? Varför inte hyra ut lediga rum i lägenheten? Incitamenten att utnyttja resurser effektivare finns överallt, men de håller på att få ett helt nytt genomslag på grund av betydligt lägre transaktionskostnader.

Digital renommé allt viktigare?

Nytt med delningsekonomin är också hur tekniken kan skapa *förtroende* för transaktioner. Att hyra ut sitt hem eller en plats i sin bil till en främling kräver ju en hel del förtroende när allt kommer omkring. Men delningsekonomin lyckas utvecklas ändå, precis som humlan trots sin storlek faktiskt kan flyga.[68] En kombination av affärssinne och teknik har skapat metoder att minska riskerna och utveckla förtroende i sådana transaktioner. Tekniken kan kontrollera kvaliteten och pålitligheten på olika sätt och låter båda parterna i en transaktion recensera och betygsätta varandra – en tvåvägskommunikation för att skapa förtroende. Digitala recensioner håller på att bli lika viktiga som digitala data och är sannolikt värdefullare/användbarare än analoga identifikationsmetoder. Ett körkort visar ju vem man är, men säger ingenting om hur pålitlig och förtroendeingivande man är. Det finns faktiskt uppgifter om människor som har svårt att få Uber-resor för att de har fått låg rating för tidigare resor.[69]

Digitala recensioner blir allt viktigare och är därmed ett sätt att etablera en förtroendeingivande renommé på nätet. Men frågan är om man bör kunna överföra historiken för en person som har god renommé på ett visst område till andra områden? Det kan tänkas att marknaden inte fungerar på det här området och ger upphov till ungefär samma problematik som gör det svårt att överföra pensionskonton mellan olika banker. Därför kan det behövas policyåtgärder som banar vägen för digitala recensioner. Ännu så länge har man i stort sett lämnat det här området i fred, sannolikt av goda skäl, men myndigheterna kan behöva anta en samordnande roll och leda arbetet med att skapa normer. Varför inte skapa en gemensam digital marknad för recensioner?

Digital teknik ger bättre kapitalutnyttjande

En annan viktig effekt av digitaliseringen, som inte är begränsad till delningsekonomin, är att det krävs mindre kapital för att starta ett företag. Tung industri kommer naturligtvis fortfarande att kräva omfattande investeringar och reklamkostnaderna kommer att förbli höga. Men många aktiviteter kan simuleras med datorer, finjusteras och förbättras. Idag kan entreprenörerna nå ut till sina kunder mycket enklare och till lägre kostnad med hjälp av en hygglig dator och en internetanslutning. Arkitekter har sedan länge ritat byggnader med hjälp av 3D-program, men nu för dagens kraftfulla datorer utvecklingen ännu ett steg framåt. En arkitekt kan till exempel få större kontroll över alla aspekterna på en konstruktion, från placeringen av elledningarna till rördragningen

[68] Jämförelsen mellan en humla och välfärdsstaten finns bland annat i Thakur m. fl. (2003).

[69] Se till exempel Streitfeld (2015b).

och beräkningen av all utrustning som krävs för produktionen. Estetiska förändringar (typ, färgsättning, osv.) kan införas på ett enhetligt sätt i hela konstruktionen, ungefär på samma sätt som formatering av text hanteras automatiskt i en ordbehandlare.

Distributionskostnaderna kommer sannolikt också att bli lägre i takt med att användningen av 3D-skrivare ökar och delningsekonomin blir allt populärare. Den sedan lång tid tillbaka pågående trenden att minska antalet mellanhänder för transaktioner – inom bankväsende, industri, logistik, bokutgivning, etc. – kommer att bli ännu starkare. Varför lagra och frakta kostsamma reservdelar när de kan skrivas ut på begäran? 3D-utskrifter ger lägre distributionskostnader och snabbar upp både konstruktion och leverans. De kan användas inom industrin och sjukvården och för konsumentprodukter. I Kina och i Nederländarna har man byggt fullskaliga hus med hjälp av 3D-skrivare.[70] Men det finns också tillämpningar för 3D-skrivare som ger bättre livskvalitet genom effektivare sjukvård. 3D-utskrifter bidrar exempelvis till lägre kostnader för specialkonstruerade arm- och benproteser. Det finns också exempel där kirurger skapar 3D-kopior innan komplicerade ingrepp utförs för att förutse komplikationer som kanske inte skulle kunna upptäckas förrän patienten låg på operationsbordet.[71]

Internet of Things (IoT) och big data ger möjlighet att få betydligt större kontroll över alla aspekter av produktionen. Detta och 3D-utskrifter är revolutionerande teknik som påverkar alla led i produktionen, men utvecklingen av IoT kan fördröjas av rättsliga hinder, främst frågor om konsumentsäkerhet, upphovs- och patenträtt (mer om detta nedan).

När det gäller efterfrågan håller tekniken på att förändra företagens metoder att nå ut till konsumenterna med information och reklam. Alla aktiviteter på internet genererar mängder med data och en del av dem är mycket värdefulla för företag som vill nå speciella målgrupper. Personuppgifterna har faktiskt kallats för en helt egen typ av tillgång (asset class) för att ange hur viktiga de håller på att bli jämte traditionella tillgångar som man handlar med på finansmarknaderna. Det har skapat många sekretessproblem. Telekomoperatörerna har enorma mängder med information om hur människor förflyttar sig och kan dra slutsatser om deras livsstilar och vanor med utgångspunkt från sådana data. [72] Konsumenterna skänker frivilligt bort många sådana data för att få tillgång till kostnadsfria tjänster – till exempel e-post, nätverk och kartor. Men det kan också vara så att människor faktiskt inte är medvetna om hur mycket information de faktiskt förmedlar genom att bara logga in och flytta muspekaren över skärmen.[73]

Den ekonomiska effekten av personuppgifterna är att företagen kan målinrikta kampanjer för specifika produkter på ett mycket träffsäkrare sätt. De kan också erbjuda olika priser till konsumenterna, lägre priser för konsumenter som just står i begrepp att lämna webbplatsen utan att köpa något och högre priser för konsumenter som är mindre priskänsliga. Omfattningen av prisdiskriminering ökar, men det är likväl en känslig fråga som företagen är varsamma med. Å ena sidan kan man öka effektiviteten om man med hjälp av tekniken kan hitta det högsta pris någon är beredd att betala. Å andra sidan kan detta reta upp konsumenterna, som naturligtvis har en känsla för rättvisa och lika behandling, och företagen måste lära sig att skapa balans

[70] Se till exempel Davison (2015).

[71] Se Weintraub (2015).

[72] Malte Spitz, en tysk riksdagsman, begärde och fick lagrade mobiluppgifter 2011 från Deutsche Telekom som gav mycket detaljerad information om hans förehavanden; i Sverige har Örstadius och Larsson (2015) gjort en liknande undersökning.

[73] Se till exempel Sveriges Konsumenter (2014) och Bylund (2013).

mellan den effektivitet som tekniken erbjuder och människornas reaktioner när de ser hur den används i praktiken. Det finns rapporter om konsumenter som blir arga när de utelämnas från kampanjer riktade till välbeställda personer. De här frågorna är inte nya, men tekniken vinklar dem på ett nytt sätt och gör det angeläget att hantera konsumenternas reaktioner, särskilt på områden där konsumenterna lätt kan byta till en annan leverantör.

Den mikroekonomiska revolution som digitaliseringen driver fram har makroekonomiska konsekvenser som beslutsfattarna ännu inte förstår

Förändringarna som vi diskuterat i avsnittet ovan kommer att få avgörande effekter för tillväxt och arbetstillfällen. Entreprenörer i delningsekonomin håller redan på att påverka det övergripande resursutnyttjandet och öka effektiviteten på vissa områden samtidigt som den hittar nya nischer med arbetsuppgifter som tidigare helt enkelt inte utfördes på grund av matchningsproblem och höga transaktionskostnader. Den tekniska förändringen blir allt snabbare om man jämför med tidigare perioder och effekterna kommer att bli märkbara inom breda sektorer i ekonomin.

De förändringar som diskuteras ovan kan komma att ha stor påverkan på hur vi bedömer läget i en konjunkturcykel och dess effekter på ekonomin, inte minst på sysselsättningen och inflationen. Mer konkret kommer mindre resurser i termer av arbete och kapital kunna ge samma output. De kvalitativa effekterna är självklara, men deras storleksordning och omfattning kommer att påverkas av flera faktorer och inte minst hur regelverken reformeras.

En implikation är att det kommer att bli svagare inflationsimpulser från en given resursnivå i ekonomin. En bil som mestadels står oanvänd under sin livstid kan användas i mycket högre utsträckning och en 3D-skrivare sänker kostnaderna för lagring och distribution. Man kan alltså få mer gjort med mindre kapital. Men resultatet kan blir mer än bara ett bättre utnyttjande av befintliga resurser och kan även komma att påverka produktivitetstillväxten.

Många OECD-länder har haft en dämpad produktivitetstillväxt under de senaste åren. Detta kan delvis bero på mätproblem i statistiken[74] och de långsiktiga cykliska effekterna av skuldnedväxlingen efter finanskrisen. Men professor Robert Gordon vid Northwestern University beskriver också en rad andra faktorer som hämmar tillväxten, bland annat åldrande befolkningar och höga statsskulder.[75] Det kan vara så att IoT, big data, 3D-skrivare och all annan ny teknik som är på gång kommer att förbättra tillväxtpotentialen över tid och balansera de motverkande faktorerna. Men detta är en process som kan ta lång tid. Hur fort det går kommer i hög grad att bero på hur myndigheterna anpassar regelverken.

På medellång sikt, kanske inom de närmast tio till tjugo åren, kommer fördelarna med digitaliseringen sannolikt att öka tillväxtpotentialen och därmed kommer de krafter som kan hålla tillbaka inflationen sannolikt att verka på ett eller annat sätt under en lång tidsperiod. Digitaliseringen är uppenbarligen inte den enda kraften som på medellång sikt påverkar inflationen, men den kan vara en av de mest missförstådda i regeringskanslier och centralbanker. Den direkta priseffekten för konsumentvaror, i synnerhet elektronik, är förstås tydlig. Men de indirekta effekterna av resursutnyttjandet i ekonomin kommer sannolikt att bli än mer signifikanta och varaktiga. Det

[74] Se till exempel Coyle (2015).
[75] Se Gordon (2014).

är en utmaning för centralbankerna och de politiska institutionerna att lära sig förstå vilka förhållanden för företagen som påverkar ekonomin, annars riskerar man att formulera en politik som står på skakig grund.

3. Ekonomiska utmaningar i en digital värld

När det gäller framtiden och effekterna av digitaliseringen kommer institutionernas förmåga att hantera chocker i Sverige att testas på ett annat sätt än under finanskrisen 2007 eller den inhemska krisen i början av 1990-talet. Händelserna ovan var visserligen mycket svåra och problematiska, men det starka fokus och den dramatik som de gav upphov till bidrog till att underlätta den politiska anpassningen. När det gäller digitaliseringen liknar effekterna på arbetsmarknaden i hög grad effekterna i samband med den åldrande befolkningen: de uppstår gradvis, från år till år, sannolikt utan någon avgörande händelse som förebådar en stor förändring. Det kan bli svårare för myndigheterna att ändra kurs, när förändringar inträder gradvis – trots att de slutliga effekterna på välfärden kan bli betydligt mer omfattande.

Utmaningar för myndigheterna – regelverk

Mot bakgrund av den långsamma produktivitetstillväxten i OECD-länderna är det angeläget att snarast genomföra strukturreformer i ekonomin så att tillväxten inte i onödan bromsas av åldrande befolkningar och höga privata och offentliga skulder. Dessvärre har takten på strukturreformer på produkt- och arbetsmarknader saktat ned i OECD-länderna, inklusive Sverige, på senare år.

Det är naturligtvis inte så att få regler alltid är bättre. Regler är nödvändiga för att skapa trygghet och förtroende på marknaderna. Utan adekvata regler och normer skulle marknadsekonomierna sannolikt begränsas av en brist på förtroende och högre transaktionskostnader. Men regelverken har utökats under årens lopp, sannolikt i *betydligt högre grad* än vad som krävs för att skydda konsumenterna. Europeiska unionen gör stora ansträngningar för att förbättra det fria utbytet av varor och tjänster. Och man har gjort viktiga framsteg, men språkliga och kulturella hinder inom EU gör merarbetet med de återstående reglerna, bland annat krav på momsredovisning och normer för säkerhet och information som varierar inom de 28 medlemsstaterna, mer betungande än vad motsvarande regler gör i USA.

Dessutom kvarstår protektionistiska krafter som gör det svårare att starta nya företag och minska regelbördorna. Det försvarar monopolvinster för etablerade företag när konkurrensen begränsas. De ständiga kraven på tillsynsmyndigheterna att standardisera och skärpa säkerhetskraven har i praktiken en tendens att väga över de intressen som strävar efter att inte öka komplexiteten. Det finns en benägenhet att skapa ännu fler regler vilket ytterligare spär på komplexiteten.

Digitaliseringen gör sitt intåg samtidigt som den redan snåriga och komplexa regelstriden pågår och den skapar nya frågor som tidigare inte tagits upp eller uppfattats som intressanta. Det är sant att patent och immateriell egendom är områden som har diskuterats under lång tid. Musik- och förlagsbranscherna var de första som kämpade emot digital teknik som gav möjlighet till enkel kopiering och distribution. Det har tagit lång tid att utveckla nya affärsmodeller som ger innehållsproducenterna möjlighet att ta betalt för sitt arbete, främst genom prenumerationstjänster för musik, dagstidningar och böcker på internet. Förändringen pågår fortfarande.

För lagstiftningen finns det två utmaningar som är viktigare än alla andra. För det första finns det regler som utgör ett stort hinder på den inre digitala marknaden och som måste undanröjas. De främsta fördelarna med den digitala tekniken i form av låga marginalkostnader och enkel distribution urholkas av att det finns 28 områden med olika regler inom EU. Det är egentligen inte främst de olika momssatserna som är problemet, utan redovisningskraven, begränsningarna för dataöverföring över gränserna och rutinerna. Reglerna för säkerhetsinformation varierar också, på samma sätt som reglerna för lagring och hantering av konsumentdata.

För det andra hämmas expansionen av delningsekonomin av osäkerhet om vilken modell för regelverken som ska tillämpas. Det kan räcka med en liten förändring av befintliga regler eller av tolkningen av dem för att en affärsmodell ska omintetgöras. Det finns entreprenörer inom hela ekonomin som är i färd med att fundera ut hur de ska kunna tjäna pengar och leverera värde till andra företag och konsumenter. De kommer sannolikt att uppmärksamma behandlingen av Uber och Airbnb, som är de ledande rebellerna inom delningsekonomin. Den skadligaste sidan av osäkra regler är den dimma av oberäknelighet som hindrar att nya idéer blir genomförda.

Det borde vara angeläget att klargöra den rättsliga ställningen för personer som arbetar i delningsekonomin och förbättra det sociala skyddsnätet för frilansare. I Sverige är hela ekonomin strukturerad för att behålla de omfattande avtalsförhandlingarna för heltidsanställda mellan fackföreningarna och arbetsgivarorganisationerna. Om antalet frilansare ökar kraftigt kan förutsättningarna för modellen försämras och dess legitimitet ifrågasättas. Det är en utmaning för våra institutioner att utforma avtal och system på ett sådant sätt att de hanterar hur risker påverkar olika individer och samtidigt befrämjar den flexibilitet på arbetsmarknaden som krävs för att minska arbetslösheten och behålla konkurrenskraften.

Sektorer där delningsekonomin börjar utvecklas står inför mängder av regelproblem som ännu är olösta. En vanlig fråga är om yrkesnormer ska tillämpas för mer amatörmässiga typer av aktiviteter och var man i så fall ska dra gränsen. Vilka säkerhetsnormer bör tillämpas för Airbnb-uthyrning jämfört med hotell? Bör skattesatserna för småskaliga verksamheter vara lika höga som för stora bolag? Vilket ansvar har innehavare av peer-to-peer- (P2P) eller peer-to-business (P2B)-företag i händelse av en konkurs? Varför har hushåll sämre skatteregler för P2P-lån än för noterade finansiella tillgångar placerade i investeringssparkonton (ISK) hos en bank?

Hinder för självkörande fordon är ett särskilt besvärande exempel på hur lagstiftning faktiskt kan motverka säkerheten. Många är övertygade om att självkörande bilar kommer att orsaka betydligt färre olyckor och minska antalet döda och skadade i trafiken. Men frågan om det juridiska ansvaret i händelse av en olycka hämmar utvecklingen av självkörande fordon.

Om myndigheterna försöker skapa separata digitala regler för varje marknad kommer arbetet att ta mycket lång tid. Dessutom utvecklas tekniken snabbt och nya företag kan hitta metoder att göra saker som kanske behöver omfattas av regler som fortfarande inte ännu finns på plats. Därför borde myndigheterna anstränga sig för att etablera regler i form av *grundprinciper* som kan tillämpas på alla områden. Specifika rekommendationer om sådana principer faller utanför ramen för den här rapporten, men några kommentarer kan vara på sin plats. För det första måste säkerhetskrav givetvis även fortsättningsvis beaktas, men vara rimliga i förhållande till förväntade utfall, vilket inte är fallet för självkörande fordon. För det andra bör varor och tjänster beskattas mer likformigt. Skillnaderna mellan böcker (en vara) och e-böcker (en tjänst) är alldeles för stor i nästan alla länder. I Sverige är moms-skillnaden nästan tjugo pro-

centenheter. Det är ett hinder som även påverkar många andra områden, bland annat 3D-skrivare. För det tredje bör ansvaret i händelse av fel eller personskada klarläggas i generella termer. För det fjärde bör lagar om byggnation och andra kommunala regler harmoniseras så att det möjliggör vinster med stordriftsfördelar.

Om principer av generell bäring infördes skulle utformningen av regler som tar hänsyn till heterogenitet på specifika områden kunna gå betydligt snabbare. Om varje sektor inom ekonomin istället får egna uppsättningar med regler som inte har mycket gemensamt med varandra är det uppenbart att fördelarna med den digitala tekniken inte kommer att kunna utnyttjas och produktivitetstillväxten kommer att hämmas. Det är naturligtvis viktigt att reglerna inte ger otillbörliga fördelar för skilda intressegrupper utan istället stöder innovation och bidrar till den 'kreativa förstörelse' som blev ett begrepp genom den berömda ekonomen Schumpeter.

Mer specifikt kan man säga att hur regeringen organiserar sitt arbete utgör en en utmaning för att undanröja hinder som håller tillbaka fördelarna från digitaliseringen. Ansvaret för digitala frågor vilar hos en bostads-, stadsutvecklings och it-minister som är anknuten till Näringsdepartementet. Men ansvaret för de flesta hindren och utmaningarna som kan fördröja utvecklingen av digitaliseringen ligger hos andra departement, främst Justitiedepartementet (dataskydd, rättsligt ansvar, patent och upphovsrätt), Finansdepartementet (skatter, finansregler) och Arbetsmarknadsdepartementet. Varje departement har stor makt inom sitt eget område och låter sig sannolikt ogärna rubbas från sina positioner. Vinsterna, kostnaderna och riskerna med digitalisering bör vägas strategiskt på högsta nivå. För att snabba upp översynen av regelverk som fördröjer digitaliseringen bör några it-frågor sannolikt samordnas inom statsministerns kansli, åtminstone under de år som arbetet med att reformera regelverken pågår.

Utmaningar för myndigheterna – livslångt lärande och digital kompetens

Människor lever längre än förr, men normen att man ska utbilda sig i unga år och därefter endast i liten omfattning behöver fylla på kunskap senare i livet är svår att bryta. Det finns visserligen mängder med utbildningskurser i alla tänkbara ämnen – från affärskommunikation till datorprogrammering och specialkunskaper i olika yrken, men den snabba tekniska utbildningen skapar ett behov av möjligheter till mer systematisk kunskapspåfyllning under hela vår livstid. Man också ställa frågan om en del högre utbildning har blivit för tidskrävande i relation till dess gångbarhet på arbetsmarknaden. Sådana frågor har blivit allt viktigare i takt med att befolkningarna åldras och digitaliseringen förstärker dem.

Tillgång till kvalificerad arbetskraft är en viktig fråga för företagen, men det är inte självklart att bara mer utbildning är den rätta lösningen. Professor Alison Wolf vid King's College hävdar faktiskt att vi investerar för mycket i utbildning samtidigt som kvaliteten är för låg på vissa områden.[76] Ett år i utbildning är också ett år då man inte arbetar, vilket ytterligare belastar finansieringen av de sociala välfärdssystemen som utvecklades i en tid då andelen av befolkningen som arbetade var större i relation till antalet pensionärer.

Vi skulle snarare behöva mer utbildning och kompetens som direkt efterfrågas på arbetsmarknaden för att få ett bättre förhållande mellan antalet lediga platser och antalet arbetssökande. Vi behöver också metoder att komplettera de inhämtade kunskaperna under hela livet -- inte bara för att hålla jämna steg med den tekniska utveck-

[76] Se Wolf (2011).

lingen utan också för att kunna byta karriär mitt i livet, en fråga som betonas i en rapport om demografin från Framtidskommissionen.[77] Vi behöver bättre kvalifikationer rent generellt – och i synnerhet mer digital kompetens, något som understryks i en aktuell rapport till regeringen från Digitaliseringskommissionen.[78] En aktuell undersökning från Eurostat visar att många medborgare inte har ens elementär itkunskap.[79] Till viss del handlar det om en generationsklyfta, men det illustrerar också behovet av kontinuerlig kompetensutveckling.

Det sagda reser två stora utmaningar. Den första är hur förbättringen av kompetensen ska åstadkommas för att bättre ta hänsyn till företagens behov. Den andra är hur detta ska finansieras. Incitamentet för företagen att finansiera utbildningen av sin personal försvagas av risken att de anställda ska lämna företaget och ta med sig sin kompetens till en annan arbetsgivare, men det är också den sortens rörlighet som krävs för att arbetsmarknaden ska fungera effektivt.

När det gäller hur inlärningen av digital kompetens ska anordnas är den statliga/privata modellen UK Tech Partnership en modell som kanske kan vara lämplig för Sverige. Dess verksamhet samfinansieras av staten och näringslivet och med en relativt liten personalstyrka samordnar den utbildningsbehoven hos befintliga företag. Den fokuserar också på att utveckla den digitala kompetensen i skolorna och i synnerhet på att få fler flickor att delta.

En särskild fråga gäller huruvida digital kompetens bör ingå i våra baskunskaper, på samma sätt som matematik och naturvetenskap. Vissa argument talar för att den offentliga sektorn bör stå för en del av finansieringen, särskilt av utbildning som är mer generell, men att utbildning som ger mer specifik kompetens i högre grad bör finansieras av företag eller privatpersoner. Var man bör dra gränsen är en svår fråga som behöver belysas.

Mer lärande i lämpliga doser under livet är sannolikt till nytta för produktivitetstillväxten och gör det mindre sannolikt att människor som behåller sina jobb under lång tid inte kommer att kunna hitta nya uppgifter om företag omstruktureras.

Utmaningar för företagen – regler, ny konkurrens och nya kompetenser

Perioder med snabba tekniska förändringar reser flera tydliga utmaningar för företagen: beredskap att förändra affärsmodell eller kärnprodukter om efterfrågan förändras, uppdatering av kompetens och personal . och anpassning till gällande regler,

Förändringsproblematiken ser till viss del ut som en spegelbild av diskussionen om myndigheterna ovan. Etablerade företag står inför helt andra utmaningar än digitala entreprenörer. Den mest grundläggande frågan för entreprenörer är om affärsmodellen fortfarande är hållbar, om reglerna skulle förändras eller tolkas på ett oväntat sätt. De mest skadliga verkningarna av myndigheternas utredning rörande Uber är de signaler som den sänder till alla andra aktörer som funderar på att starta företag – särskilt förstås inom delningsekonomin. En särskild fråga är om frilansare ska betraktas som anställda. Om så är fallet måste företagen betala socialförsäkringsavgifter och andra skatter. Men det finns också många andra osäkra faktorer, bland annat om de digitala plattformarnas ägare är juridiskt ansvariga för handlingar som utförs av personer som använder eller tillhandahåller tjänster, exempelvis för uthyrning av lokaler eller peer-to-peer lån.

[77] Se Blix (2013a).
[78] Se SOU (2015a).
[79] Se Figur 5.1 i kapitel 5 i denna rapport.

Det är svårt att ge något mått på hur den här osäkerheten påverkar entreprenörer som funderar på att starta företag inom delningsekonomin. Men den omfattande mediarapporteringen om utmaningarna för Uber är svår att missa. De små vinstmarginalerna – eller initiala förluster, som det oftast handlar om – för nystartade företag gör den sortens risker extra skadliga. Lägre risker för affärsmodellerna och enklare insteg i delningsekonomin kan rent generellt skapa stora fördelar för ekonomin som helhet: resurserna utnyttjas effektivare, miljöbelastningen minskar, arbetstagare på låg- och medelinkomstnivå kan minska sin konsumtion och sitt ägande och vid behov hyra resurser (särskilt bilar), och jobb inom delningsekonomin ger flexibla arbetstider. Och delningsekonomin kan slutligen också minska omställningssvårigheter som följer i kölvattnet av fortsatt automatisering av arbete.

Etablerade företag, särskilt företag inom mogna branscher, står inför helt andra utmaningar. På vissa områden kommer nya digitala företag att försöka ta sig in och konkurrera. Att ha ordet ”digital” i affärsmodellen innebär vanligen lägre kostnader, snabbare verksamhet och att företaget lättare kan experimentera och nå sina kunder. Att vara stor ger inget ogenomträngligt skydd mot konkurrens från digitala företag. Sony kämpar sedan lång tid för att förvandla sina produkter och tjänster och möta utmaningen från internet och söker sig fortfarande fram, och Microsoft överrumplades också på ett sätt som gör att deras kvasimonopol på operativsystem nu ser mycket sårbarare ut.

Framgångsrika industriföretag är inte lika sårbara som nystartade företag eftersom investeringskostnaderna är höga och att komma in på marknaden kräver ofta stora kapitaltillgångar och förmåga att acceptera relativt osäker avkastning från en sådan investering. Biltillverkarna hotas inte av nystartade företag, utan istället av stora företag som Google och Tesla. Bankerna utsätts för konkurrens från *fintech*-bolag, som nu i allt större utsträckning finansieras av institutionella placerare och banker. IBM har gjort insteg på sjukvårdsmarknaden genom sina senaste förvärv och stora advokatfirmor och förvaltningsbolag som normalt tar mycket bra betalt för sina tjänster börjar hotas av delningsekonomin och automatiseringen av kunskapsintensiva jobb. Många arbetsuppgifter kan idag automatiseras, särskilt för juridiska tjänster.

Erfarenheterna från vissa företag som misslyckats visar hur tekniska förändringar kan innebära strategiska utmaningar, något som på engelska brukar benämnas ”*incumbent's curse*”. I USA är Kodak ett utmärkt exempel på detta, men det finns också många andra. I Sverige hade både Hasselblad och Facit starka positioner på marknaden, men personalen hade specialistkompetens på föråldrad teknik och försäljningsorganisationerna fokuserade på att leverera tjänster som inte längre behövdes när den elektroniska tekniken infördes[80]. Ett av de största problemen med att förändra ett företag under ett teknikskifte är risken att redan etablerade intressen i företaget försöker skydda företagets befintliga produktutbud och endast fokuserar på utveckling. Att fråga kunderna är sannolikt ingen lösning eftersom de kanske inte vet hur tekniken kan förändra tjänsten eller produkten som de behöver. Och när förändringen kommer kan det hända att det inte längre finns tillräckligt med tid att förändras[81]. Detta händer gång på gång.

Företagsledningen kan inte eliminera de strategiska riskerna genom att enbart förlita sig på strukturer för befintliga produkter, när man beslutar vad man ska satsa på. Detta är en mycket svår omställning som försvåras ytterligare av att den nya tekniken inledningsvis kan innebära förluster och i ett senare skede även kan komma att äta

[80] Se Sandström (2011, 2013)

[81] Se Bower and Christensen (1995)

upp vinster från existerande produkter. Bilindustrin är ett utmärkt exempel på detta. Införandet av självkörande bilar innebär sannolikt att det totala antalet bilar som köps kommer att minska. Det gäller även andra aspekter på delningsekonomin, bland annat uthyrning av verktyg och högtidsdräkter, där den totala konsumtionen, åtminstone inledningsvis, kan komma att minska. Det finns en möjlighet att kunderna köper mer av samma varor, men det är lika sannolikt att de stoppar besparingarna i fickan eller spenderar dem på andra tjänster.

Slutligen återspeglas behovet av att hitta och behålla kompetens, i synnerhet digital kompetens, i diskussionen ovan om utmaningarna för politiken. Företagen kommer att ha en nyckelroll i arbetet med att informera utbildningssektorn om näringslivets krav och måste också engagera sig mera aktivt i frågorna kring livslångt lärande. Det snabba teknikskiftet innebär att personal som inte utvecklar sina digitala kunskaper kommer att hamna på efterkälken när det gäller produktivitet och löneutveckling. I länder med rigida regler på arbetsmarknaden och kollektivavtal med klausuler som följer principen om först in, sist ut kommer det att finnas ett ännu större behov av att säkerställa kontinuerlig kompetensutveckling. Att delta i utbildningskurser en eller att par dagar kommer inte att räcka utan kompetensen måste utvecklas på ett mera strategiskt sätt. Skattesystemet bör också förändras så att det blir fördelaktigare för företagen att betala för personalens kompetensutveckling.

Att förväxla korrelation med kausalitet kan leda till allvarliga misstag

Ytterligare en risk som kan komma att bli mer markerad är att förväxla korrelation med kausalitet när man fattar affärsbeslut eller analyserar policy. De enorma mängderna med data om konsumenttrender, livsstilar och nätvanor är värdefulla för företagen och ger tillgång till information som kan användas till att nå specifika grupper med reklam och försäljningsargument. När det gäller policy finns det mängder med värdefulla data om människors beteende som kan ge beslutsfattarna en bild av människors reaktioner på skattereformer eller andra förändringar. En oemotståndlig lockelse kan vara att låta de enorma datamängderna ge upphov till bedömningar som *förefaller* att vara mycket exakta. Stora datamängder innebär vanligen mindre osäkra mätningar och mätningar på hela populationen eliminerar all stickprovsosäkerhet. Allt fler företag har tillgång till big data eller säljer åtkomst till big data. Men den synbarliga precisionen från sådana analyser kan vara falsk och kanske inte tål en förändring av förutsättningarna.

De som utför kvantitativa studier behöver vara försiktiga med att inte tolka korrelationer som kausala samband. Erfarenheterna från Google, som förutsåg en influensaepidemi med hjälp av sökfrekvenser, är ett bra exempel på hur bräckliga korrelationer kan vara.[82] När förhållandena förändras kan konsumenternas beteende också förändras. Riskerna med vantolkning av korrelationer ökar om de är stabila under lång tid och sedan plötsligt förändras på grund av en oförutsedd händelse. Banker som tillhandahöll lån i USA före finanskrisen förutsåg framtida risker med hjälp av enorma mängder data om tidigare tvångsförsäljningar av fastigheter. Men de omfattande problemen med så kallade sub-prime lån, som visserligen var en en liten del av den totala marknaden, skapade sedan en dominoeffekt till resten av marknaden, och de historiska korrelationerna var som bortblåsta. Samma sak kan hända med konsumentundersökningar och andra analyser som baseras på big data.

[82] Se Lazer et al. (2014)

Konsekvenserna av att anta att det finns kausalitet, trots att den inte existerar, är inte bara ett rent akademiskt felsteg, det kan få allvarliga ekonomiska följdverkningar och även leda till felaktiga affärsbeslut. Ett exempel som visar var sådana risker finns är det nya fenomenet ”now-casting” (nutidsprognoser), som använder enorma mängder data från webben (bland annat om människors sökvanor) som indata för makroekonomiska prognoser. Ett exempel: är fler sökningar efter arbetslöshetsunderstöd på nätet ett tecken på att arbetslösheten kommer att öka? En sådan korrelation kan se trovärdig ut, men människors beteenden kan förändras över tid så att korrelationen blir svagare, som i exemplet med Google och influensaepidemin. Slutsatsen är inte att korrelationerna saknar värde men att de bör kombineras med andra typer av data och modeller för att stödja de slutsatser som dras.

4. Vad kan komma att hända?

Digitaliseringen är en kraft som inte går att stoppa, ungefär på samma sätt som globaliseringen. Men dess hastighet och effektivitet kan påverkas kraftigt beroende på hur reglerna förändras. Det kan vara på sin plats att visa vad som kan hända med hjälp av enkla scenarier. Sådana bör helst utföras i en makroekonomisk modell, men det är svårt eftersom frågan egentligen handlar om hur förändringar av policy-parametrar kan påverka beteenden. Men de tidigare modellerna är baserade på historiska mönster som kanske endast delvis är relevanta, särskilt makromodeller som aggregerar många olika beteenden. För att något begränsa frågorna fokuserar vi endast på tre centrala variabler: produktivitet, sysselsättning och inkomstskillnader.

I Ruta 2 diskuterar vi tre olika scenarier. De är inte avsedda att tolkas som prognoser utan som illustrationer. Utgångspunkten är att utfallen beror både på regelverken och hur samhället lyckas underlätta anpassningsperioden på arbetsmarknaden. Målet är främst att befrämja produktivitetstillväxten och incitamenten för arbete och samtidigt minska problemen med volatila hushållsinkomster. Som Digitaliseringskommissionens delrapport framhåller kommer kompetensutveckling, i synnerhet av digital kompetens, sannolikt att innebära en stor förbättring av möjligheterna till sysselsättning, produktivitetstillväxten och lönerna.[83]

I scenarierna behöver vi inte utgå ifrån dramatiska anpassningar på arbetsmarknaden som en reaktion på ytterligare automatisering. I takt med pensionsavgången kommer företagen istället att välja om de ska ersätta personal som går i pension eller automatisera arbetsuppgifterna. Och eftersom andelen personer i arbetsför ålder minskar i befolkningen kan automatiseringen också vara en reaktion på bristen på kvalificerad arbetskraft.

[83] Se SOU (2015a).

Ruta 2. Scenarier för Sverige

I den här rutan skisserar vi policy-effekterna på ekonomin genom. Det här tankeexperimentet motiveras av den forskningslitteratur som understryker hur avgörande de politiska institutionernas reaktion på den tekniska förändringen är.[84] Scenarierna har visserligen konstruerats med utgångspunkt från förhållandena i Sverige, men de är ändå relevanta för andra EU-länder med omfattande offentliga välfärdssystem.[85] Vi diskuterar effekterna av olika politiska åtgärder med utgångspunkt från dagens nivåer för produktivitet, sysselsättning och ojämlikhet. Vi använder ett tidsperspektiv på medellång till lång sikt, en tidsperiod på ca tjugo år.

Makroekonomiska antaganden för alla scenarier

- Den makroekonomiska motvinden fortsätter att hämma produktivitetstillväxten.
- Oförändrade strukturer för arbetsmarknader, inklusive starkt skydd för ordinarie anställningsavtal.
- De sociala skyddssystemen kvarstår oförändrade.

Scenario 1. Politik som vanligt: fortsatt svag produktivitetstillväxt, färre jobb skapas än de som försvinner

Detta är ett trampa-på scenario, där politiken förändras långsamt. Fragmentarisk förändring av regelverken ger sannolikt upphov till långsammare produktivitetstillväxt. Fördelarna med digitaliseringen uppstår i huvudsak långsammare än kostnaderna för anpassningen av arbetsmarknaden. De makroekonomiska motvindarna som Robert Gordon diskuterar uppvägs i så fall inte i tillräckligt hög grad av innovationsvinster och värdet som de skapar. De åldrande befolkningarna och de höga skuldsättningsnivåerna i OECD-länderna påverkar redan ekonomierna, samtidigt som fördelarna med den nya tekniken och hur snabbt den införs beror på regelverken. Om reglerna för olika områden åtgärdas separat – ansvarsfrågan för självkörande bilar, patent och intellektuell egendom i samband med 3D-skrivare och graden av ansvarsskyldighet som ägarna av digitala plattformar har för transaktionerna de förmedlar – kan utvecklingen sannolikt mätas i *minihertz* i stället för *megahertz*. Frågor som måste införas i lagstiftningen och avgöras genom avtalsförhandling brukar bli tidsödande – och det finns en god anledning till det eftersom trovärdigheten och förtroendet för systemet beror på faktorer som dess rättvisa (verklig och upplevd) och förutsägbarhet.

Fortsatt automatisering av industrier och tjänster innebär att fler jobb försvinner och strukturarbetslösheten kan bli högre under en övergångstid eftersom många sektorer påverkas samtidigt och med starkare kraft än tidigare. Automatiseringsprocessen underlättas av arbetstagare som går i pension och därmed ger företagen fortsatta möjligheter att sänka kostnaderna utan att aktivt behöva minska andelen anställda med sedvanliga anställningsavtal. Problemen med att hitta personer med rätt kvalifikationer kommer dock även fortsättningsvis att utgöra ett hinder för rekryteringen, särskilt för högt kvalificerade jobb. I Sverige kommer den stelbenta bostadsmarknaden, med brist på hyresbostäder, också att försvåra strukturanpassningen. Det är svårt för dem som arbetar att flytta till nya platser om det inte finns några bostäder där.

Nya jobb skapas naturligtvis hela tiden, men entreprenörerna hämmas av osäkra regelförändringar som kan påverka deras affärsmodeller. Frågan är om deras affärsmodeller kommer behöva anpassas till regelverk som underminerar själva grundidén eller, mindre dramatiskt, om förändringarna tillför en komponent som får kostnaderna att öka så att de överstiger kostnaderna i affärsplanen.

[84] Se till exempel Acemoglu et al. (2005).

[85] Mekanismerna som beskrivs är också relevanta för USA, men de politiska institutionerna och startpunkterna skiljer sig åt. EU-länderna och USA står inför liknande utmaningar när det gäller att undanröja hinder till förmån för digitaliseringen, men förhållandena på arbetsmarknaden i USA är såpass annorlunda att anpassningarna sannolikt kommer att vara av ett annat slag, och faller utanför ramen för den här rapporten. Noteras bör att i USA har inkomstskillnaderna redan ökat kraftigt.

Det scenariot kan komma att innebära en successiv, men kanske inte särskilt markant, ökning av inkomstskillnaderna. En del jobb kommer att ha långsammare löneutveckling och för en del människor kommer det att finnas regler som hindrar dem från att arbeta i delningsekonomin. Men vi kommer ändå att få se fler superstjärnor som blir vinnare, entreprenörer med förmåga att erövra stora marknadsandelar och sedan förbli dominanta med hjälp av välkända varumärken, men också på grund av hinder som gör det svårt för andra att ta sig in på marknaden och konkurrera.

Scenario 2. Protektionistisk motreaktion: betydligt lägre produktivitetstillväxt, högre arbetslöshet, större inkomstskillnader.

Man kan betrakta det här scenariot på samma sätt som Scenario 1, kombinerat med en ekonomisk politisk reaktion som understryker rättigheterna för insiders och etablerade företag där destruktiva otillbörliga fördelar dominerar på bekostnad av värdeskapandet. Etablerade företag kan med hjälp av regelverken skapa hinder som gör det svårare att ta sig in på marknaden och därmed begränsar konkurrensen. Det innebär att färre jobb skapas och att incitamentet att göra sig av med den mänskliga arbetskraften till förmån för automatisering blir starkare. Det ökar polariseringen på arbetsmarknaden, så att jobb på medelinkomstnivå hamnar längre ner på kompetensskalan samtidigt som den långsamma produktivitetstillväxten innebär en svag reallöneutveckling för stora grupper, dvs. en polarisering av både jobb och inkomster.

Scenario 3. Bejaka förändring: bättre produktivitetstillväxt, fler arbeten, oförändrade inkomstskillnader.

Om översynen av reglerna inleds strategiskt med några få ledande principer om konsumentsäkerhet och andra frågor, minskar behovet av att utarbeta nya regler för varje område som kan bli föremål för digitalisering. Om sådana principer tillämpas för varje enskild fråga inom alla sektorer kan översynen av regelverket snabbas upp samtidigt som egenheterna som finns inom varje område kan diskuteras igenom ordentligt. Till exempel principer och trösklar för hur och med vilka skattesatser frilansare bör betala skatt i delningsekonomin och vilka regler som bör gälla för att garantera rimlig konsumentsäkerhet.

Vissa befintliga regler kan granskas för att avgöra om kraven är onödigt stränga när det gäller risker och utfall. Självkörande fordon kommer till exempel sannolikt att rädda många liv eftersom antalet trafikolyckor minskar, men lanseringen av dem dröjer ändå på grund av osäkerheten, särskilt vad avser ansvarsfrågan. Reglerna bör sträva efter *neutralitet* mellan olika alternativ, men utfallen bör sikta på att *främst lätta på onödiga regler istället för att höja ribban för nya potentiella aktörer.* Att höja ribban för tillträde kan hindra konkurrens och leda till monopolartad prissättning som drabbar konsumenterna.

Det här scenariot kommer att skapa betydligt fler tjänster inom delningsekonomin så att antalet befintliga jobb kan hålla jämna steg med antalet arbeten som försvinner. Genom att kombinera enkel anpassning mellan sektorerna med förbättrad yrkeskompetens, i synnerhet digital kompetens, underlättas förändringarna så att välfärden blir stabilare för stora grupper.

Införandet av delningsekonomin som en väsentlig del av arbetsmarknaden innebär att skillnaden i rättigheter som tillkommer insiders jämfört med outsiders med osäkra jobb måste åtgärdas. För att upprätthålla välfärdssystemets legitimitet måste socialförsäkringssystemens trygghetsnät erbjuda ett effektivare generellt skydd även för frilansare. Skyddsnäten måste kalibreras så att de jämnar ut inkomsterna över tid, men får inte vara så generösa att de minskar viljan att arbeta.

Sammanfattning av effekterna på medellång till lång sikt (de närmaste 20 åren)

	Produktivitet	Sysselsättning	Inkomstfördelning
Scenario 1. Sedvanlig politik	0	-	-
Scenario 2. Protektionistisk motreaktion	-	--	--
Scenario 3. Bejaka förändring	+	+	0

OBS: Scenarierna som beskrivs i den här rutan är stiliserade. Ett plustecken indikerar en förbättring, en nolla oförändrade förhållanden och ett minustecken anger en försämring. Ett dubbelt minustecken indikerar kraftigare försämring.

5. Några avslutande ord

Hur bra det kommer att gå för olika länder i tider av teknologisk förändring beror i hög grad på deras institutioner. Mycket stelbenta institutioner kan komma att trycka in digitaliseringens möjligheter i redan etablerade analoga regelfack på ett sätt som hindrar utvecklingen och gör anpassningen onödigt svår. Regeringar och myndigheter som inte lyckas hitta rätt balans mellan ledarskap och samarbete med näringslivet kan också komma att misslyckas. Priset för detta blir högre arbetslöshet och långsammare produktivitetstillväxt. I tider av förändring är det mycket viktigt att föra en politik som i grova drag är rätt. Misstagen får betydligt allvarligare konsekvenser än i normala tider. Felen kan vara resultat av aktiv politik eller av avsaknad av sådan politik. Avsaknaden av tydliga rättsliga regler för delningsekonomins affärsmodeller, 3D-skrivare, big data och andra tekniska framsteg hämmar utvecklingen och hindrar entreprenörerna från att utveckla och förbättra sina verksamheter och få nöjda kunder.

Men det finns åtgärder som kan underlätta en smidigare anpassning på arbetsmarknaden och bidra till att man tillgodogör sig fördelarna med digitaliseringen

- Att ta ut lägre skatt på (mänskligt) arbete. Hög skatt på arbete i Sverige stärker det redan starka incitamentet att automatisera arbetsuppgifter ytterligare. Skatteavdragen för hushållstjänster bör utökas, inte minskas.
- Att minska osäkerheten kring de regler som påverkar delningsekonomin. Det ger flexibla möjligheter till justeringar och lägre risk för högre strukturell arbetslöshet.
- Att skapa större möjligheter för livslångt lärande. Ett längre yrkesliv och snabba tekniska förändringar ökar risken att vissa kompetenser blir föråldrade tidigare i våra yrkeskarriärer. Uppdatering av yrkeskompetens kommer att bli av stor betydelse för att minska risken för ofördelaktiga framtidsutsikter på arbetsmarknaden.
- Att minska skillnaderna i socialförsäkringsskydd mellan anställda och egenföretagare.
- Att införa principer för reglering av den digitala ekonomin som kan användas till att snabba upp reformerna på många skilda områden, och därmed minska behovet av att utarbeta särskilda regler för varje område. Detta kräver ett nära, smidigt och kontinuerligt samarbete mellan jurister och ekonomer. Får vi inte det, kan den låga produktivitetstillväxten bli seglivad och demografins och statsskuldens makroekonomiska motvindar fortsätta att dämpa tillväxten.

Den digitala revolutionen kommer sannolikt att förbättra såväl livskvaliteten som effektiviteten på arbetsplatsen och fortsätta att förbättra vår fritid. Men ingenting är självklart när det gäller hur smärtfri förändringen kommer att bli. Institutionernas reaktion är en nyckelfaktor för ökad produktivitetstillväxt utan risk för högre arbetslöshet och växande klyftor.

1. Creative destruction in a digital world

"Thou aimest high, Mister Lee... Consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars." Queen Elizabeth I, 1589, on rejecting the request of William Lee for a patent on a knitting machine, quoted in Acemoglu and Robinson (2013).

1.1 Introduction

Digital techniques, advances in robotics and neuroscience are increasing opportunities and in some cases improving quality of life for many people. Self-driving cars, already old technology, are navigating through government regulatory obstacles. Autonomous cars have the potential to vastly reduce the number of accidents, improve mobility for everyone who either cannot drive or prefers not to, and to help commuters and travelers spend time more productively or pleasurably.

But technological advancements are also bringing major disruptions to the economy within a *compressed* time period. While the disruptions are not unprecedented – the changes during the Industrial Revolution were undoubtedly more significant – they are occurring in a time of *higher expectations* for the level of welfare that society should provide its citizens. In the aftermath of the financial crisis, unemployment and public debt are significantly higher in many OECD countries and productivity growth has slowed. Many European countries have seen the rise of populist extreme left and right-wing parties. Long-term trends of aging populations are affecting the outlook for growth. Might digitalization[86] be the succor that boosts growth and improves prosperity?

Digitalization presents both opportunities and challenges. It will be a balancing act to harness the benefits of digitalization while mitigating the downsides. In *Why Nations Fail*, Acemoglu and Robinson (2013) discuss the institutional features that support growth and can explain why some nations become rich while others remain poor.[87] Notably, it is important to have political institutions that balance the interests of various groups, the rule of law, protection of property rights, and predictability so that people and firms can expect to reap the benefits of long-term plans or investments.

What does this imply looking forward? How well we cope with the effects of digitalization will depend on striking a balance among institutional features conducive to stability and openness to recasting policies that get in the way of growth.

While this may sound easy, it is not. In essence, it is a clash between old and new. While the "old" will have to change in some ways, it is not superfluous to note that that the "new" is not always right. Those who argue that digitalization changes everything tend to underestimate the importance of norms and traditions (Chapter 3) and the role of regulation (Chapter 4). Although the impact of technology depends on how institutions react by adapting rules and regulations for goods and services, other trends and changes may matter as much – and sometimes more.

[86] Digitalization is typically defined as the representation of objects into zeroes and ones that can be stored on computers. We use the term more broadly for the ways that computers affect work, consumption and leisure.

[87] It is beyond the scope of this report to discuss these issues in detail. For a reference to the academic literature see Acemoglu (2005). For an overview of economic growth, see for example Aghion and Howitt (2006).

It is a mistake to underestimate how technology may have political and economic impact, for example, with respect to how social security and labor law affect the distribution of risk in society, such as that between insiders and outsiders (Chapter 5). Moreover, aging populations will make it more difficult to find new workers in some sectors and regions, thereby strengthening the case for increased automation. Germany is already beginning to experience this challenge in some sectors, notably the auto industry. But the challenge may also be felt keenly in sparsely populated regions in Sweden, for example in the need for health care and elder care.

Challenges from digitalization and inertia in institutions

Digitalization has a number of major implications for:

- Individuals as workers and consumers.
- Firms competing in the global economy.
- Governments regulating firms and setting the rules for competition, public welfare and social security.

Our institutions and habits produce considerable inertia to change and that is as it should be – up to a point. Rules and regulations are there to protect us, but the situation becomes somewhat incongruous when, in some instances, digital alternatives are likely to save a lot of lives. For example, self-driving vehicles are widely thought to be less prone to accidents, because, unlike humans, they are not impaired by lack of sleep, overconfidence or intoxication. Indeed, one of the technical challenges for self-driving vehicles is that they obey traffic rules, which becomes more of an issue when interacting with the average driver.

There is a disconcerting tendency to underestimate the challenges involved, especially by governments in Sweden and elsewhere, as if the myriad of small changes underway somehow might gel into a coherent whole. In the Swedish government, there is also a tendency to put the legal aspects above all other matters, such as economic efficiency, when it comes to adapting rules that allow us to benefit from digital technologies (Chapter 4). Perhaps some of this insouciance about the impact of digitalization comes from the dotcom crash of 2000. Things were blown out of proportion then, so surely they are again?

There are several sobering reasons why things are different now. With the ubiquitous use of the smart phone, digital technology is making inroads in most aspects of our lives. Many of the fastest changes underway are *consumer driven*. A large share of the population uses smart phones and tablets in their daily lives, for work and for leisure. Consumers making choices via digital media are changing the conditions for firms. Consumers are becoming more powerful as a collective through the use of rating systems for services combined with the ease of switching providers.

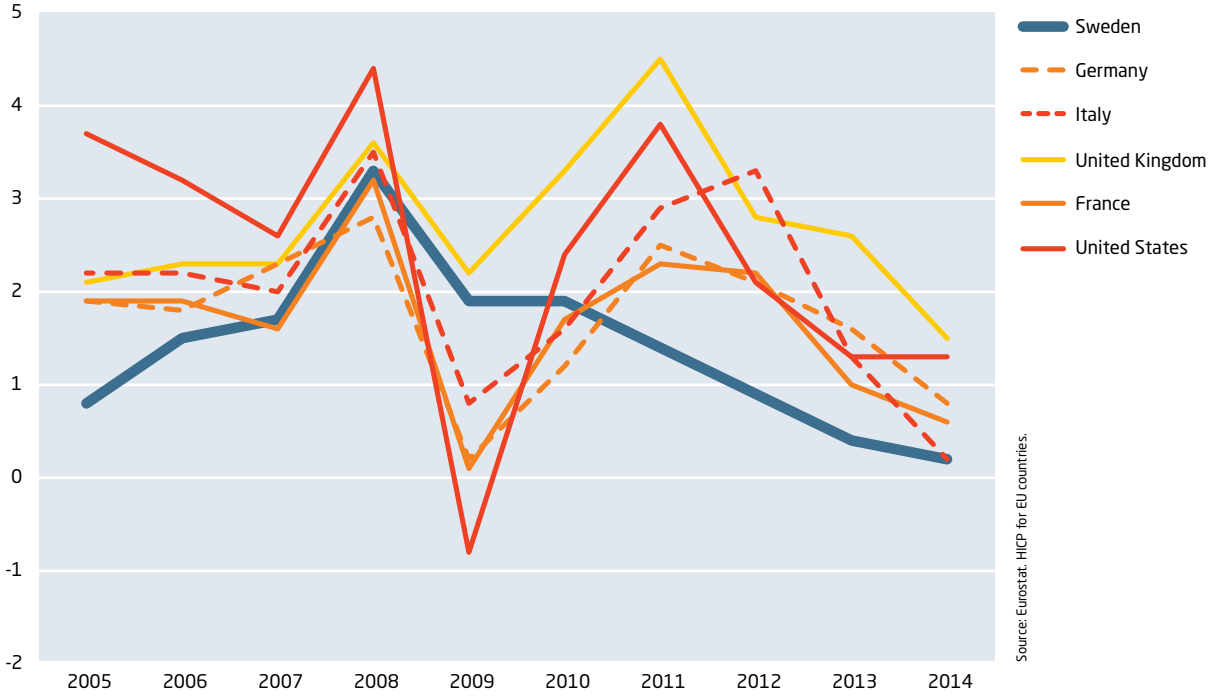
Markets are also becoming more mature and payment systems for digital transactions are available that people are beginning to trust. Digital technology is providing network effects, speed, and buyers and sellers matching services at low or zero marginal cost. A lot of business models are being disrupted – or *ubered* in the digital parlance – everything from taxis to education and financial institutions and media.

Economists on the other hand, borrowing some jargon from finance, have a tendency to look at digitalization as a *plain vanilla* structural change, no different from what is always in progress. Somewhat unhelpfully, the impacts of digitalization are becoming more significant just when the economics profession is still trying to recover from being blindsided by the financial crisis. The new research being conducted is primarily in microeconomics, on understanding network effects, competition and different markets in isolation. There is an urgent research agenda to draw insights from the microeconomic literature as to what this may imply for the economy as a whole, the macroeconomy.

Policy institutions and central banks may overestimate inflation pressures

Digitalization may lead policy institutions, such as government agencies, ministries and central banks to misjudge the state of the economy. One reason for this is related to how economists measure the degree of unused resources in the economy and inflation pressures. In particular, digitalization may improve the efficiency of the economy, leading to better use of existing resources, and may imply higher degrees of price competition than before. Wage competition, especially for low-skilled jobs, may also increase with the use of digital platforms. Inflation has already been subdued in many countries for several years; see Figure 1.1. Although many other developments have impact on inflation, part of the explanation may well be digitalization. This is discussed further in Chapter 2.

Figure 1.1. Inflation in selected countries, annual average change in percent.



Job creation may be slower than job destruction during a transition period

While the change in inflation pressures on its own is a significant development, the risks and issues for the labor market as a whole are more multifaceted. Although the changes are not coming overnight, ignoring the possibility of major upheaval may be risky; small policy errors can easily compound over time with unnecessarily onerous effects on social welfare, especially since short bouts of unemployment all too easily can become long ones, or even permanent, when skills are lost or self-confidence erodes. In recent decades, technology and humans have been largely complementary; see Autor (2014). While some jobs are lost, machines have by and large enabled people to work more efficiently, which has been accompanied by a need for higher skills. The effect has been productivity and real wage growth, improving disposable income and raising living standards for broad groups over time.

But even assuming that the long-run effect of digitalization on employment is neutral, which we believe, it may still be the case that new jobs are created at a slower pace than old ones are destroyed. Aging populations and shrinking workforces will make the transition somewhat easier at the overall level, but in some sectors we may see an increased challenge in matching available jobs to the skill sets of people entering the labor market. During a transition period, probably counted in decades rather than in years, it will be a challenge to help smooth adjustment in the labor market and mitigate the downsides in terms of increased inequality while not putting shackles on the impetus for growth.

Job polarization set to increase further

There is strong evidence today of widespread job polarization, in which middle income earners are being squeezed; see for example Goos et al. (2014) for an examination of several countries. Essentially, the middle class is becoming thinner. This has also occurred in Sweden, but only on the positive side with an increase in high income earners; see Adermon and Gustavsson (2015). Job polarization is likely to increase further because digital technology is beginning to also replace highly skilled workers. The effect may be either low wage growth for large groups and/or increased risk of unemployment, topics that we explore further in Chapter 3. Low wage growth for broad groups may in turn risk further political polarization and social unease. The US has already experienced significant wage polarization for broad groups that have received little real wage growth. By contrast, real wage growth in Sweden has been strong for the last two decades.

Secular stagnation and digitalization are different mechanisms

The notion of secular stagnation has been raised recently by Summers (2014). This hypothesis contends that we have entered a new era in which demand remains below potential but that due to excess savings, interest rates have to be more negative to boost the economy. This idea is somewhat controversial, see for example Dolan (2015), Sandbu (2015a) and Wolf (2015), but it is undoubtedly so that economists need to adjust their models and estimates in an era of negative interest rates. It should be noted that digitalization and secular stagnation are different mechanisms; digitalization in this regard concerns mainly microeconomic efficiency that leads to more price competition and better use of resources in the economy, while secular stagnation is an explanation of the macroeconomic effects of a savings glut. Thus even though they both ultimately concern output, the issues and channels differ.

If the nature of work changes, there may be pressures on social welfare institutions

The legitimacy of the modern welfare state, such as in Sweden, hinges on people's acceptance of the tax burden in order to enjoy a high level of universal public welfare, such as schooling, health care and infrastructure. Looking ahead, the combined forces of digitalization and aging populations imply challenges for how to maintain the trust and legitimacy underpinning the welfare state.

Though challenges from an aging population are by now fairly well understood, see for example Blix (2013a,b), the effects of digitalization remain relatively unexplored. Admittedly, there has been considerable discussion about artificial intelligence (AI), not least the question of people being replaced by robots. While AI might be possible some time in the future, robots are far from exhibiting the versatility of humans. The famous DARPA challenge in the US has teams of robots competing in an obstacle course. While there have been tremendous improvements in recent years, self-driving cars not least, robots need a lot of help to operate. Robots tend to be bad at things that humans are good at, such as dexterity and cognitive skills. Even the huge developments in self-driving vehicles, while very impressive, are not evidence of human cognitive skills. Self-driving cars do not drive on roads so much as they drive on digital maps, a point emphasized by MIT professor David Autor.

In the most recent DARPA competition, robots had to perform an obstacle course akin to performing salvaging operations inspired by measures that might have saved lives during the Japanese Fukushima Daiichi nuclear meltdown. The performance of the robots is still substantially subpar to that of humans on the obstacle course, but descriptions of performance were upgraded from "watching grass grow" in previous competitions to "watching golf, " see Markoff (2015a, b).

However, the lackluster performance of these robots should not provide false comfort for what may happen to labor. The idea of a robot sitting a desk (possibly with a coffee mug) perhaps serves to make them more human and less threatening. But in practice, jobs can be divided into parts and some of those can be outsourced to cloud computing or to the sharing economy with on-demand labor, see for example O'Connor (2015b). The extent to which this is possible is already considerable and on the increase, a topic discussed further in chapter 3.

In this report, we will focus on the economic and social consequences of advances that have already been made or are in the pipeline in the medium term. Arguably, the idea of robots taking over at some future point tends to distract from the more pressing issues that have not yet received enough attention in the public debate. What regulations are barriers to benefiting from technological change? Do we need to make changes to improve the labor market and reduce the risks of further job polarization and increased unemployment induced by technology?

One salient issue is that digitalization may lead to more freelance work compared to the situation today, especially in relatively rigid European labor markets with strong rights for insiders, see for example O'Connor (2015a). More freelance work and an on-demand economy will help provide flexibility that will make structural change easier. In the so-called "sharing economy," the owners of digital platforms typically do not see themselves as employers – only as conduits between those who want to buy and sell through digital platforms. Thus, these employers mostly do not provide health insurance and other benefits. Are government institutions and labor market partners prepared for such an economy if it becomes much larger than today? Since the norm is designed around full-time work for a single employer, this may lead to

more people unable to fully qualify for social security benefits or unable to draw on those benefits because of time constraints and the loss of business that absence might imply for the self-employed. The sharing economy will be discussed in various contexts in Chapters 2, 3 and 5.

The challenge ahead

Adaptability has long been a hallmark among humans and there are good reasons for thinking we will be able to cope with the changes brought by digitalization. But coping can come in different forms, all from muddling through to actively and strategically making informed choices about the direction of change and how we might best go about it. One could be forgiven for thinking that Europe has had quite enough of muddling through during the years of the financial crisis. Alas, many institutions do not seem sufficiently prepared for the changes underway.

But what exactly is the alternative to muddling through? In this report we will outline the challenges and indicate policies that would make the structural change easier in terms of employment and welfare while contributing to improving productivity growth (outlined in "Box 2. Scenarios for Sweden" in the Extended Summary). There is some urgency in addressing the challenges as bad policies can have especially onerous effects in times of rapid change. The changes from digitalization are broad, affecting social behavior, leisure and politics, but we will primarily focus on economic effects of digitalization.

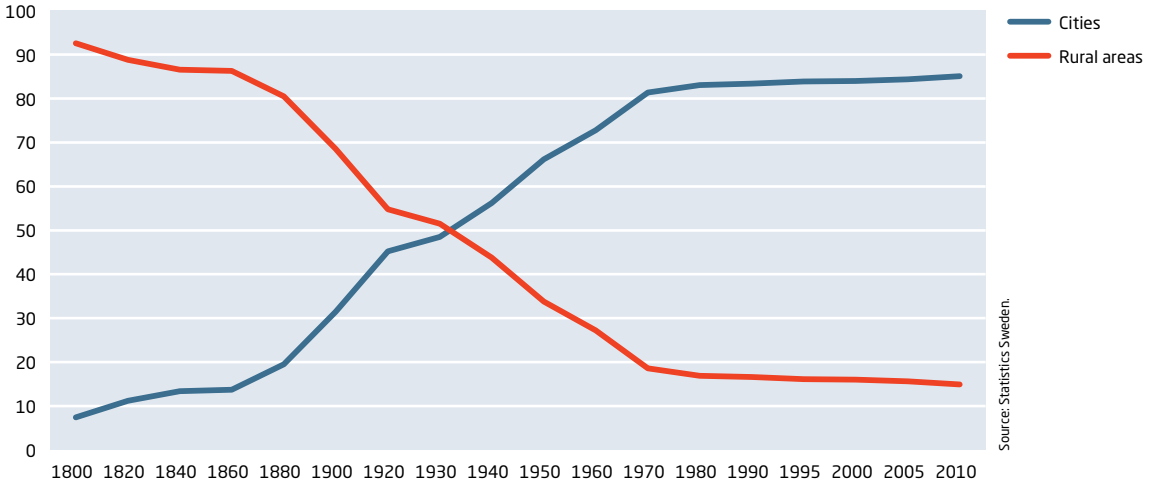
Even if governments were to choose a muddling-through policy, people will still cope. But the social costs may be higher. The starting point for adjusting to vast technological challenges is far from ideal for many European countries: public debt and youth unemployment are high; refugees from sectarian violence and civil war are coming in great numbers. It should be high on the policy agenda to make the utmost effort to benefit from digitalization while smoothing the worst downside risks.

1.2 Speed and scope of structural change

There is an implicit view in policy circles, especially in central banks and ministries of finance, that digitalization is similar to previous structural change. This view implies a risk of underestimating the broad scope of changes and the speed of adjustment. Societies have a long tradition of adapting to change. The advance of electricity with all its benefits and improvements for households and firms is a case in point. It was a very broad change, affecting the whole economy, but its effects took a long time to materialize (see Chapter 2). Grids had to be built, machines invented and so on. There was plenty of time to adjust, even if some people were surely caught unawares in the process.

If we take an even broader view, urbanization and the Industrial Revolution provide a more dramatic transformative change. In Sweden, about 95 percent of the population worked on farms or lived in rural regions around 1800, see Figure 1.2; now, the situation is virtually reversed. This is a massive change, but it occurred over a period of two hundred years, thus allowing people and institutions time to adjust. From the 1970s on, urbanization has continued unfettered but changed character. In the last few decades, people have been moving from smaller cities to major cities and so, if anything, Figure 1.2 understates the continued increase in major metropolitan areas.

Figure 1.2. Urbanization, share of population in cities and rural areas, Sweden



By contrast, a swift change that affects a specific area is difficult but as long as the rest of the economy is unaffected, there are many opportunities for the people involved to adapt and find new jobs and opportunities in other areas. In Sweden, major changes occurred in the textile industry with the onset of a steady decline starting in the 1950s and even more dramatically in the shipbuilding industry in the late 1970s. We will discuss these and draw some lessons from them in Chapter 3.

In recent times, some large Swedish companies have cut their workforces rather dramatically. Ericsson, for example, implemented mass layoffs after the dotcom bubble burst and in response to fierce competition from other network operators, such as Nokia in Finland and Blackberry in Canada. Sometimes the reasons for the lack of competitiveness are long in coming, but the fallout can be fast once the tipping point is reached.

While these changes have been significant for specific sectors or locations, the possibilities for new jobs within an industry or elsewhere often work out relatively well over time. When Astra Zeneca decided to close its research department with about 1,200 employees in the Swedish town of Södertälje, population about 90,000, this was a major event. The people affected were highly skilled workers performing non-routine and creative tasks. Although a major upheaval, the final tally turned out rather well. A report from TRR (2015) shows that almost 95 percent of those affected found new employment or became self-employed within a two-year period of turbulence and adjustment.

How will digitalization affect highly skilled workers in other areas if several sectors are affected simultaneously? The impetus to change will not be as fast as it was for Ericsson, Astra Zeneca or Nokia – but probably faster than what we are used to compared, for example, to the introduction of electricity. In contrast to the researchers at Astra Zeneca, most of whom found other jobs elsewhere, what if all researchers were affected at the same time? This is what digitalization could bring.

The changes that have been underway in music, news and video are instructive. The music industry has seen its business model uprooted with the advent of digital technology; journalism is still battling strong cost pressures and video streaming is replacing physical discs sold in shops and available for rent.

Perhaps the likeliest scenario for other skilled workers would be similar to the process in journalism: unlike the closing of a factory or industry, there will be no dramatic event that heralds a new age. But cost pressures and changing production processes will bring gradual changes every year. Firms that fail to adapt the business model may find a gradual erosion of profits. Such a process may thus increase the tendency towards job polarization that is already under way.

1.3 Long-run trends

To assess the effects of digitalization, we will argue that it is necessary to combine the evidence from established long-run trends, economic models, and anecdotal evidence. Using *only* economic models would risk missing the specter of a structural shift, while using only anecdotes risks over-interpreting a noisy signal. The long-run trends in the economy help us link the anecdotes to economic theory and make better sense of the changes underway. Apart from technological progress, the most relevant ongoing trends in this context are:

- Aging populations
- Continued globalization and increased trade
- Further urbanization
- Further growth of the service sector compared to industry
- Slowdown in productivity growth

The slowdown in productivity growth may or may not be a long term trend. This is a key topic for assessing the impact of digitalization and we will discuss it more thoroughly in the next section.

Aging populations

The age structure of societies affects everything from the available work pool to the size of preschool classes and demand for health care services and funding of pensions is a big topic in most countries. One issue in particular is a challenge for welfare states, that of sustaining growth in tax-financed public welfare services when the working populations aligned with existing norms are shrinking. While an enormous literature is devoted to aging from a policy perspective it is hard to muster political impetus for appropriate policies because the changes occur slowly from year to year without drama; see for example Blix (2013a,b). But the cumulative demands of digital skills are a challenge for many older people unaccustomed to using computers, smart phones and tablets.

But there are actually some similarities in the challenges stemming from aging populations and digitalization. Most obviously, digital technologies are making substantial improvements in the lives of older people in areas ranging from health care to self-driving cars. For the German auto industry, the lack of new workers as older ones retire has led to robots taking over even more functions; see Bryant (2015).

There are also other similarities. While digitalization has an image of being fast moving, its effect on the economy takes time to materialize: in 1987, for example Robert Solow famously quipped, "You can see the computer age everywhere but in the productivity statistics." This issue is arguably still relevant today, as discussed in Section 1.4 below. Moreover, just as life-long learning is key to a longer productive working life, learning

and retraining are key to employment and wage growth as the economy becomes more digital (Chapter 5). People have to continue to learn new software and how to operate it or risk wage stagnation or – worse – unemployment. Employees who do not update their skills can survive for a few iterations, but with big technological leaps, the skills mismatch may become more pressing, as artisans discovered with the invention of machines at the beginning of the Industrial Revolution.

The lack of workers in the German auto industry has increased demand for automating work. This experience is likely to hold true for broad sectors of the economy. Many OECD countries, including Sweden, have aging populations. In some sectors, finding workers – especially skilled workers – will be hard. Thus, demography is increasing the demand for automating work. In Chapter 3 we will explore this topic further and argue that the challenge is not that work is disappearing but rather that the skills mismatch is problematic and the risks of technology-induced unemployment for those with inadequate skills will increase. Thus, the main concern is that income inequality may rise further and increase tensions in the labor market.

Globalization

Globalization and continued increases in world trade have brought higher standards of living and improved conditions, but also increased competition and pressure to specialize, particularly for small, open economies. There are many parallels between the effects of globalization and digitalization. Indeed, some of the literature on globalization that discusses how some jobs in industrialized countries were outsourced to countries with lower wages are very similar to current arguments about which jobs are at risk of being automated; see Autor (2014), Blinder (2009), and Frey and Osborne (2013). Simple assembly jobs and technical support are among the jobs that have been outsourced, notably to Asian countries. This process has led to lower cost of production in industrialized countries and development in the countries to which tasks have been outsourced.

For some years, the trend to outsource continued. Though most of the high-end development of technology is retained in corporate headquarters in OECD countries, wages have been pushed up in some Asian countries. With the advent of further digitalization and reprogrammable robots, the nature of the outsourcing trend may change, although it is too early to draw definite conclusions.

One possible shift is a change in outsourcing from Asian countries to other regions where wage costs are still low, such as Africa or South America. But political instability and barriers to trade may be an obstacle to this development. Another possible shift is "home-sourcing," a process in which previously outsourced tasks return to industrialized countries but are performed by robots instead of manual labor and which could lead to especially challenging welfare implications for Asian countries. For example, some countries may lose their manufacturing base before highly skilled services evolve, leading to so called "premature deindustrialization," see "Box 3.4. Labor market disruptions" in chapter 3.

The effects of digitalization would likely be much less if the world was not already highly interconnected through foreign trade and investment. Globalization has thus paved the way for the network effects and increasing returns to scale that digital technology thrives on. A digital revolution without global reach would not generate the leverage that is the elixir of life to digital platforms.

Urbanization and the rise of the cities

There are two somewhat contradictory trends that concern urbanization and digitalization. Urbanization was a key ingredient in the Industrial Revolution; the influx of people from farms to cities made for a climate of innovation. The literature on growth emphasizes the role of cities as magnets for talent; see for example Glaeser and Gottlieb (2009). Ambitious people are more likely to meet in cities and be stimulated by interacting with other talented people. Also, there are larger pools of workers available for employers looking to hire.

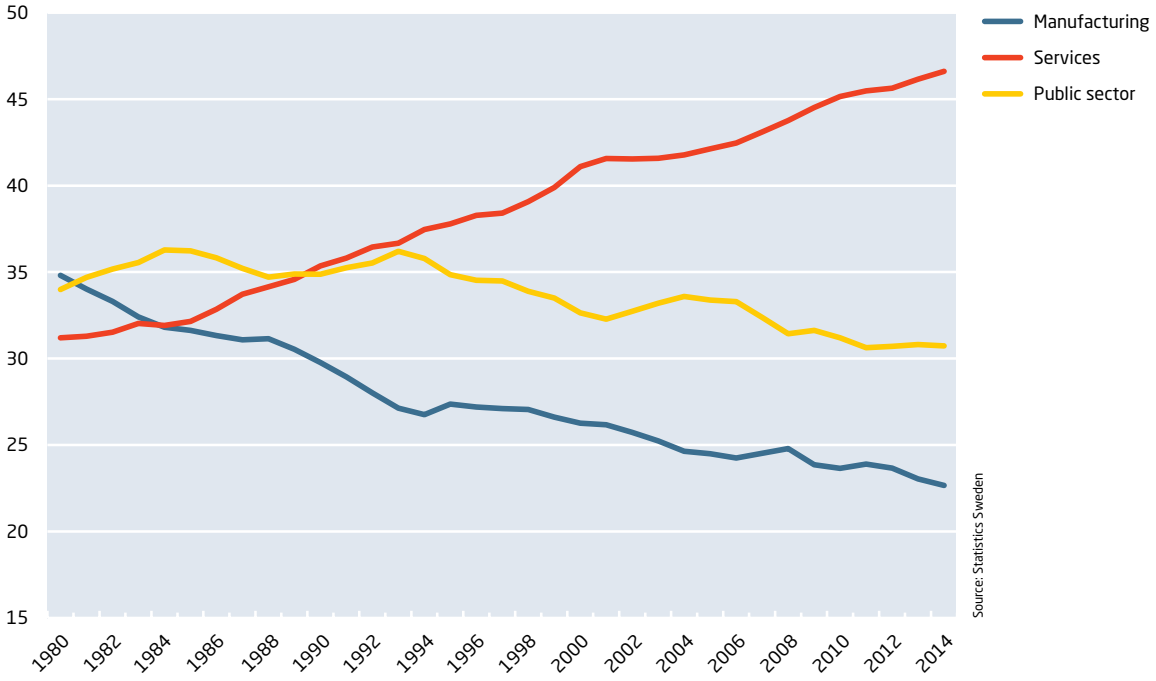
The dynamic cocktail of people with "'good ideas colliding" – to make something even better – is an ingredient in tech clusters. Arguably, however, it is really the same mechanism as the advantages of having a city in the first place, but more focused on technology.

While urbanization is thus part of the progress that has made technological innovation possible, it may also, paradoxically, reduce the need for people to move to cities. With the capacity to work remotely, more tasks can be performed off site. For example, some aspects of education and simple interactions with doctors might be accomplished with digital technologies. Machines in connected mines can also be controlled remotely; see Ek (2014).

Service sector growth

Productivity gains in industry have driven overall productivity for the whole economy; for a long time, industry has been able to increase output while decreasing employment. Correspondingly, the service sector has increased in size and represents three out four jobs in many OECD countries, if both private and public sectors are included. The private service sector accounts for almost half of employment and has increased steadily over time; see Figure 1.3. By contrast, manufacturing has been declining in terms of employment while maintaining strong productivity growth.

Figure 1.3. Employment in different sectors, Sweden



At a cursory glance, industry seems very efficient and service sector productivity growth somewhat lackluster. But it may very well be the case that part of the productivity gain in industry is due to outsourcing functions that were previously done in-house to the service sector. For example, clerical services, food catering, administration, and sanitation might be turned over to outside contractors, enabling industry to focus more on core functions.

In terms of the effect of digitalization, the feature to highlight is that manufacturing has continued to improve efficiency for a long period of time and digitalization is now making inroads towards improving efficiency in services as well. Looking ahead, much of the hope for future productivity resides in improved services. We will return to this point in Chapter 2 when we discuss the sharing economy, but first we turn to an overall view of where productivity is headed.

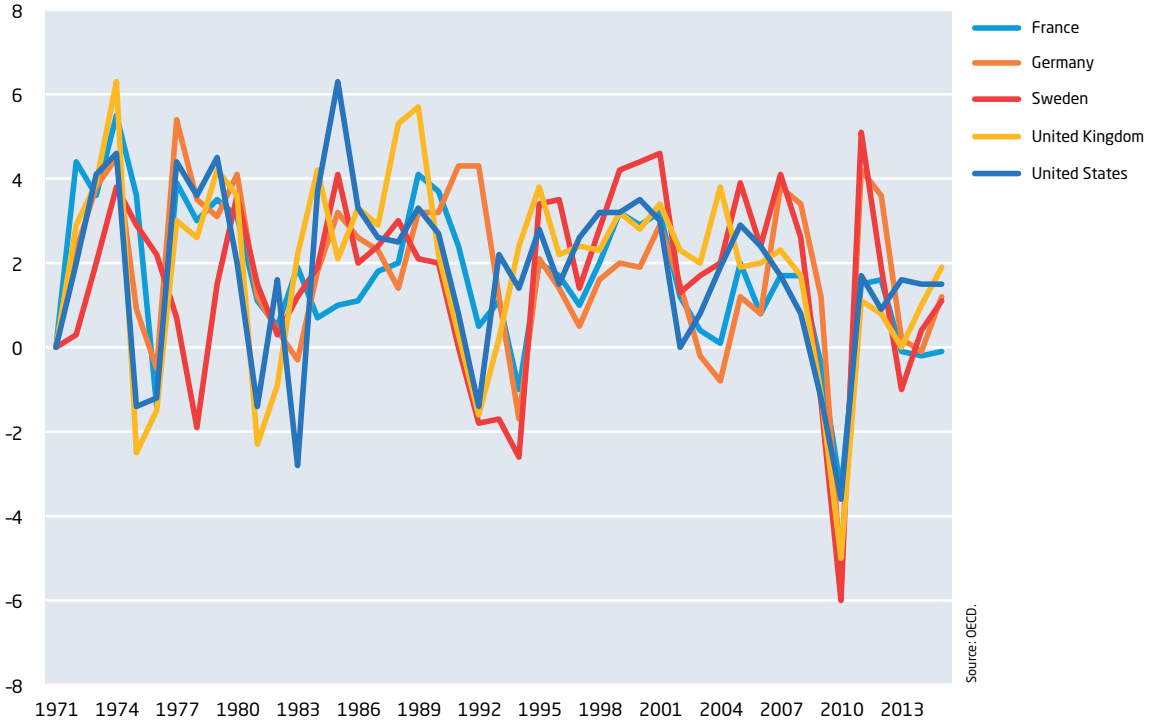
1.4 Productivity growth

Productivity growth now and in a historical context

Productivity growth has slowed in major industrialized countries. The slowdown occurred even before the financial crisis (see Figure 1.4). This compares to historical GDP per capita growth, which was around 2 percent per year in Sweden during 1820–2000, a number on the same order in magnitude as many other industrialized countries.

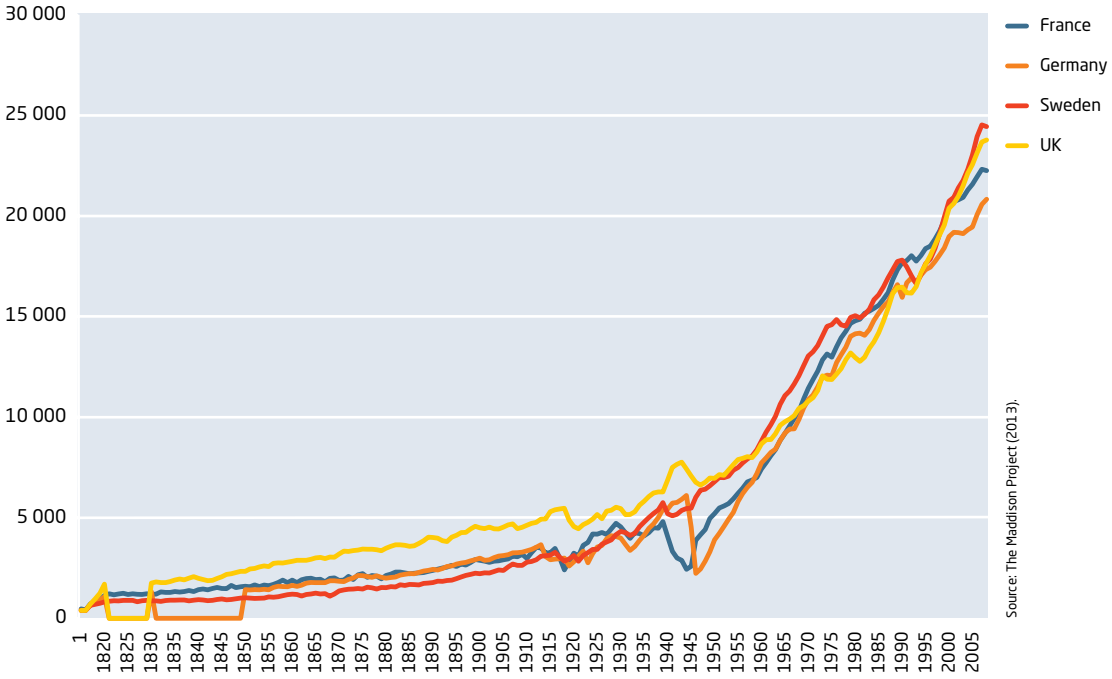
Research from Angus Maddison shows that historical growth prior to the Industrial Revolution was virtually non-existent and hence a growth rate of 2 percent is still rather good. Using the "Geary-Khamis dollar" (see Figure 1.5) we see that growth only became significantly positive at the beginning of the Industrial Revolution. Starting in the mid 19th century, growth picked up with a steady positive trend.[88]

Figure 1.4. Productivity growth in Sweden, Germany, France, UK, US



[88] Some BRIC countries, such as China, have managed to sustain even higher growth in the last decades by leapfrogging, thereby skipping some steps on the development ladder by adopting the latest technology from OECD countries.

Figure 1.5. GDP per capita growth in Geary-Khamis dollars



Note: The Geary-Khamis dollar is a hypothetical currency with the same purchasing power as the US dollar and is often used to compare countries over longer time periods. For comparisons in the last few decades, the OECD publishes GDP per capita corrected for purchasing power that accounts for changes in exchange rates and inflation rates.

Slowdown in productivity: temporary or permanent?

Is the recent slowdown in productivity growth a temporary setback or a return to a norm that held prior to the Industrial Revolution? Robert Gordon of Northwestern University argues that it is permanent or at least long-lasting. In a series of papers, see for example Gordon (2014), he discusses headwinds for growth stemming from aging populations, high public debt, diminished returns on education and outsourcing as well as environmental factors. Using simple calculations, Gordon argues that most of the productivity growth dwindles down to pre-Industrial Revolution levels of around zero.

That this is controversial is a bit of an understatement; see for example Bartelsman (2013). While Gordon has evidence in the form of the recent slowdown to support his case, many others contend his findings; see for example Brynjolfsson and McAfee (2014), Ford (2009, 2015a), and in a Swedish context, see Blix (2015) and Boumediene and Grahn (2015). Joel Mokyr, a colleague of Gordon's at Northwestern University, has for many years argued the opposite case; see for example Mokyr (2013). Gordon essentially contends that recent advancements in digital technologies are much less significant to productivity growth than the major discoveries of the last century, such as electricity, cars, and airplanes. Further, he argues that the gains from digitalization have already largely been realized, such as electronic banking, word processing, and so on.

Ultimately, the validity of these arguments rests on data. Alas, the difficulties of measuring quality and its implications have likely become more serious in recent years; see Feldstein (2015) and Coyle (2015). Current GDP and inflation figures might underestimate productivity and quality improvements. As physical goods are transformed into digital services, the shift in consumption bundles in indices becomes more problematic. Even with modern statistical techniques, it is difficult to adjust goods, and especially services, for the improvements that occur over periods of time.

For example, a car with ABS brakes and modern safety features is a much different product than a car made only a decades ago; likewise, self-driving cars of the future will be of higher quality than cars today. Statisticians try to account for these differences but the methodological questions are difficult.

Gordon's case rests on clearly identifiable macroeconomic factors that are likely to impact industrialized countries in the years to come. Although not all countries have high debt, the overall debt burden is high and may be a drag on the world economy for quite some time; likewise, aging populations are common to most OECD countries and regions of Asia, whereas countries in Africa tend to have younger populations.

The key question is whether the microeconomic innovations from digitalization and other technology can outweigh the headwinds identified by Gordon. We do not have a complete answer to this, of course, but a few points in Gordon's favor deserve to be highlighted. First, the recent productivity slowdown has to be explained in some other way (such as secular stagnation or measurement problems as mentioned above); while lingering uncertainty from the financial crisis may surely delay recovery: the slowdown occurred even before the crisis. Second, as the historical account above shows, a high level of growth is not a law of nature. We cannot simply presume that all things will return to high growth.

At first, it may seem that those who proclaim the fantastic new effects of new technology and Gordon's pessimistic view are diametrically opposed but (with some effort) they can be reconciled. If it takes a long time for digitalization to have broad effects on the economy, productivity growth may be sluggish for some time. The productivity boost from technology may be slower and weaker unless regulation removes the obstacles standing in the way (see Chapter 4). A few highly efficient firms and innovative firms may not be enough to carry the whole economy. Without broad diffusion of technology, the effects on the economy may be limited; OECD (2015a).

New technology that may boost productivity

What is the effect of new digital technologies like smart phones, 3D printers, and new services with digital platforms that can transform work and leisure? This report is in large part motivated by the potential of such innovations. For example, 3D printers are now capable of building large buildings and bridges, see Davison (2015) and the Economist (2015i), replace limbs, see Mrozfeb (2015), and enable doctors to practice before performing complex surgery, see Weintraub (2015). The costs of such replication were previously either too high or simply impossible. For example, when an astronaut needed to repair the spaceship, the requisite tool could simply be sent to the 3D printer on board. Other examples of digital technologies that save time or improve efficiency are:

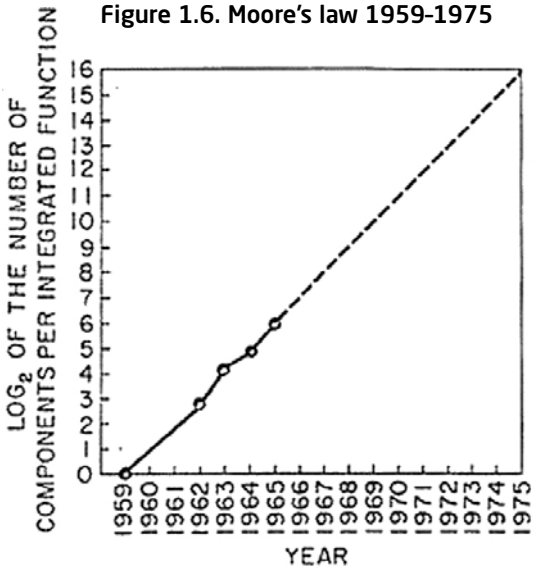
- Swifter communication
- Helping navigation with maps
- Remote work
- The sharing economy (see Chapters 2 and 3).

Technology is already improving the quality of life for people with disabilities, wounded veterans, and senior citizens by helping them remain active. Most people will agree that there are great innovations around the corner – the question is when they will have effect on the broader economy. And will they be in time to reduce the dampening effects of aging populations etc. identified by Gordon?

Moore's law and productivity growth

Productivity growth is a broad topic, see for example Syverson (2011) and Jones (2015), and we will cover only the discussion of digitalization. It is instructive to recapitulate Moore's law, which in many ways has come to symbolize the optimism about all things digital. The original chart from Moore's paper is depicted in Figure 1.6, reproduced from Poeter (2015). Essentially, it holds that the speed of microchips doubles every year – or every 1½ years. So far Moore's law has held true.

Figure 1.6. Moore's law 1959-1975



A doubling in speed – or some measure thereof – implies a growth rate of one hundred percent every year compared to the paltry 2 percent post-Industrial Revolution average or the even more lackluster 0.2 percent in Sweden between 2007–2012 (see Figure 1.4).

If the speed of computer chips increases so much, why is productivity growth still so slow? Even asking this question might seem a bit unfair, but the difference between one *input* factor, the microchip, in parts of the economy does not automatically translate to enormous *output* growth in the whole economy. Not even if the microchip indeed was a key input into all products and services would the output growth automatically be high. Supposing the speed of microprocessors were to grow by 1,000 percent, the effect on productivity growth might still not increase by much in the short run.

The reason, of course, is that there are other input factors, notably human labor, other factors of production etc. that only benefit from increased speed up to a point. Nordhaus (2007) makes a similar point in noting that computers represented about 2.3 percent of total capital stock in 2000. An analogy might be a Ferrari: it can go very fast on the roads, but if it has to cross a lake or river, it will have to slow down like other cars. Productivity growth in the economy as a whole is likely constrained by a variety of factors unrelated to technology:

- High public debt or inflation.
- Corruption, red tape and inefficiencies in legal institutions.
- Poor education and lack of human capital.
- Poor infrastructure, roads, communications and internet infrastructure etc.

Recent research has tried to go beyond these factors. "Knowledge-based capital" (KBC) concerns various forms of soft knowledge, management and organizational skills; see OECD (2013). When it comes to digitalization, one key factor concerns how IT technology is used in the firm. Bloom et al. (2012a, b) have shown that American multinationals tend to have higher gains from IT investments than other firms due to better people management. They are better able to integrate IT into the work process and management can use the technology as a tool to improve efficiency. Experiences from India with control groups have illustrated the key importance of how management works in order to derive benefits from using IT. Having a fast computer in an otherwise disorganized operation does little for productivity or efficiency; the benefits of technology can be held back by the physical environment and poor work procedures.

1.5 Structure of this report

This report is organized as follows. The next chapter is devoted to discussing how digitalization may change the way economists look at the economy. Chapter 3 is devoted to the labor market, and in particular the creation and destruction of jobs. Chapter 4 covers challenges for firms and regulatory issues. Finally, Chapter 5 discusses Sweden's standing as an IT nation and in terms of, education and inequality. It concludes with some reflections on how policy can smooth structural change. In particular, what policies are conducive to productivity growth while limiting the increase in inequality? The Extended Summary of the report contains some scenarios that illustrate the effects that different policy choices may have on productivity, unemployment, and inequality.

2. Economics of digitalization

"...digitalization has some features that suggest that many well studied economic models may not apply..." Goldfarb et al. (2015)

2.1 Introduction

Economics at its core is about understanding incentives and tradeoffs between different choices and their implications for the economy and welfare. Digitalization has not changed this but many other aspects of economics may be affected, a topic we will explore in this chapter.

We will argue that digitalization brings many of the stylized features of basic economic models closer to reality, making models based on competition and instantaneous and frictionless market clearing *more* relevant than before. Essentially, digitalization implies improved efficiency in a number of dimensions. But in bringing economic models closer to the real world, paradoxically, some of the relationships estimated in historical data may need to be reevaluated and may lead to misleading policy conclusions.

In this chapter we organize the effects of digitalization on the economy into demand and supply side effects at the micro level: that of the firm or the individual. On the supply side, network effects, increasing returns to scale, and 3D printers are among the factors leading to faster, cheaper production. It is well known that not all these improvements are accounted for in official statistics. It is especially hard to measure quality improvements, which has long been a challenge for statistical agencies. But the mismeasurement may be more serious and systemic today than before, with the consequence that it is harder to assess the growth rate of the economy; see for example Byrne and Pinto (2015), Coyle (2015), and Feldstein (2015). On the demand side, increased price transparency and more global access are improving efficiency and competition. Digital platforms may be thought of as combining the elements of *both* improved supply and demand: by smoother matching of buyers and sellers they are creating markets and opportunities even for goods and services for which transaction costs and frictions were hitherto prohibitively expensive.

All of these *microeconomic* improvements have a variety of indirect effects on the *macroeconomy,* total output (GDP), employment, inflation, etc., but these effects are hard to measure. More importantly, we argue that they may confound models currently used for policy analysis at fiscal institutions and central banks. Admittedly, some conservatism in not changing models too often is advisable. Moreover, it may be especially difficult to separate the effects of digitalization from other factors in the aftermath of the financial crisis. However, the improvements are gradual and therefore those who want solid econometric evidence may have to wait for many years, by which time policy errors may have accumulated and done untold harm to the economy.

What might these errors be? At the end of this chapter, we discuss the policy implications of issues primarily related to the measurement of capacity utilization (the "output gap"), whereas we discuss matters related to employment in Chapter 3 and those related to firms and regulation in Chapter 4. Although this chapter focuses on the somewhat narrow topic of capacity utilization, this in itself brings central economic policy issues to the fore.

Digitalization is set to bring faster structural change at the microeconomic level compared with recent decades, moving models in use – especially macro models – onto shakier ground. First, digitalization will bring about more efficient use of existing resources – both capital and labor. We are probably experiencing this effect already and it is likely to grow in importance in the years ahead. The explanation is partly related to the "sharing economy" exemplified by more efficient use of the existing total vehicle fleet. But it is also related to little or zero marginal costs and network effects of expansion in several digital areas. Secondly, new technologies will also help us make better use of existing resources. They may also be a countervailing force on productivity growth weighed down by the macroeconomic headwinds discussed in Chapter 1 (demography, public debt, etc.). But the strength and timing of productivity improvements will depend on several factors, most notably on government regulation.

Even if – as we believe – digitalization will be employment-neutral in the long run, it is likely that more jobs will be destroyed than created during a period of adjustment; see Chapter 3. This would imply that medium-term equilibrium unemployment might be higher than accounted for in current models that assume a largely unchanged rate of structural change.

It is worthwhile to stress that digitalization may affect estimates of economic behavior, output gaps, and medium-term equilibrium employment regardless of whether or not preferences for work, leisure, and consumption change. The way firms produce output, the way consumers select goods and how jobs are found may be altered because technology is changing the overall environment for work and transactions.

Of course, we cannot know how serious this issue is. As discussed in Chapter 1, productivity growth is currently low in most developed countries, which may be partly due to persistent effects of the financial crisis, partly cyclical, partly related to uncertainty about future financial regulation, fiscal consolidation, or secular stagnation. As discussed in Chapter 1, the effects of digitalization cannot easily be separated from existing long run trends of ageing populations, globalization, and the increasing employment share of the service sector.

But whatever the contribution of digitalization, it is likely to act as an accelerator for other changes already underway. For example, when robots become even more versatile than today, reprogrammable, or closer to artificial intelligence (AI), they will be able to replace even more jobs than before, an issue we will touch on in the next chapter. But before discussing how digitalization may be changing the economy, it is worthwhile to review the basic economic assumptions that underpin many models.

2.2 Foundations of economic models

Let us briefly discuss the standard models used in economics as a starting point to the way digitalization may affect behavior and what it may mean for the models. This is of course a very broad topic, but the ambition is to sketch some arguments that may be useful when thinking about the broader effects of digitalization.

The standard microeconomic model taught in basic economics makes a number of assumptions that are used to understand how incentives and actions can lead to different outcomes depending on preferences, attitudes to risk, and other factors.

For the individual, the workhorse model assumes some form of utility maximization, typically involving a tradeoff between work, leisure, and consumption. We work in

order to be able to consume, but there is assumed to be some disutility to working and in equilibrium the marginal disutility from work relative to that of consumption is directly related to the real wage. Of course, the set-up is highly stylized and modern research has developed more realistic assumptions and investigated various ways of relaxing these assumptions. But the fundamental idea behind the individual's utility maximization remains one of the core principles of economics. Digitalization does not change or alter the value of using the utility-maximization framework, but in some dimensions, further discussed below, it makes the workhorse model *less unrealistic* – or more realistic – depending on one's perspective.

For firms, the standard model assumes cost minimization of production and that prices of goods and services are set at marginal cost when the market features perfect competition and at marginal revenue when the firm is a monopolist. Between the extremes of perfect competition and a monopoly, models explore various forms of imperfect competition and price behavior with different outcomes depending on factors such as market structure, demand elasticity, brand names, advertising, and research and development.

2.3 Features of the workhorse model that are changing: production

There are several aspects of the economic workhorse model that may be affected by digitalization. At the most basic level, it seems reasonable that people's preferences and attitudes to risk will not change due to digitalization though they may change for other reasons over time.[89] But digitalization may be changing the exogenous factors that affect economic agents' decisions about work, leisure, trade, and so on. In this section, we discuss how digitalization may change parts of the production function compared to the standard model with regard to how goods are produced and distributed. A stylized summary of all the potential ways that digitalization can affect the economy is given in Box 2.1.

2.3.1 Increasing returns to scale due to network effects

Economists have long discussed increasing returns of scale due to network effects but these have only been a minor part of the toolkit, mainly a theoretical curiosity: most models are based on decreasing returns or constant returns to scale.[90] For most of physical production, this assumption is often a good starting point, but not so for digital technologies. With increasing returns to scale, the fixed costs, such as investments, quickly become relatively small when more units or services are sold.

Increasing returns to scale are perhaps most easily understood in the context of telephone services, where the parallel to digital technologies is informative. When there are only two telephone users, they can only call each other; with three or more users, the combinations rise very fast – and so does the usefulness of the service. Compared to telephone services with digital services such an effect is magnified because once the computers are connected, *each* activity benefits from the network. Telephones, instead, allow only one activity. It is as if the telephone network is only one slice from an infinite number of activities enabled by digital technology.

[89] Research has indicated, for example, that values tend to changes as societies become richer; for example, richer countries in the OECD region may ascribe greater value to safety than do developing countries.

[90] Increasing returns to scale may also give rise to explosive solutions that are awkward in mathematical models.

Box 2.1. How digitalization can affect the economy

Output (GDP)
- Lower transaction costs
- Network effects and increasing returns to scale for digital goods and services
- Improved matching: digital platforms also enable minor transactions in goods and services
- Speed of technical diffusion increasing in some dimensions
- Non-exclusive nature of digital goods
- Lower cost of tweaking production/innovation.

Capital
- Many free digital tools available
- Cutting out the middleman reduces cost
- Cloud computing, vast processing power available
- Easier available capital with peer-to-peer (P2P) and peer-to-business (P2B) financing
- New payment systems; bitcoin, apple pay, swish, etc.
- More efficient use of existing capital stock (cars, apartments, tools etc.), sharing economy
- More seamless information

Pricing power
- Easier price comparisons and transparency
- Younger generations more prone to price comparisons online
- Easier entry
- Increased global competition in value chains
- More information about consumers and targeted advertising, price discrimination
- Brand names established faster but also higher risk of negatives

Wages
- Online labor markets services more global
- On demand economy and self-employment increase competition
- More self-employment may change wage-bargaining processes in the economy

This feature of digital technology is probably the best understood aspect and the one that has the most dramatic impact, notably in terms of accelerating how the economy works. Whatever service can be delivered to 10 people may in theory be as easily delivered to 10 million or 10 billion. In practice, there are regulatory obstacles, issues of taxation and language barriers that prevent the scaling from being entirely seamless from local, to city, to country or global, discussed further in Chapter 4.

The importance of network effects hinges on how prevalent they are in the economy and the magnitude of the effects. There is a small but growing empirical literature that investigates specific markets; for an overview see Belleflamme and Peitz (2015, pp. 581–583). For example, for spreadsheet packages, consumers were willing to pay almost 50 percent more for software compatible with a well-known standard; for direct network effects, it has been found that without network effects, German mobile penetration might be 50 percent lower with observed prices.

Better knowledge about the size and scope of network effects in the economy would be a useful research agenda. How much of network effects from digital firms spill over to industry and what is the rate of change? This information could be used to better understand potential GDP in the economy. For example, if network effects are increasingly prevalent, potential GDP might increase compared to a less digital economy.

2.3.2 Speed of technological diffusion and the digital shift

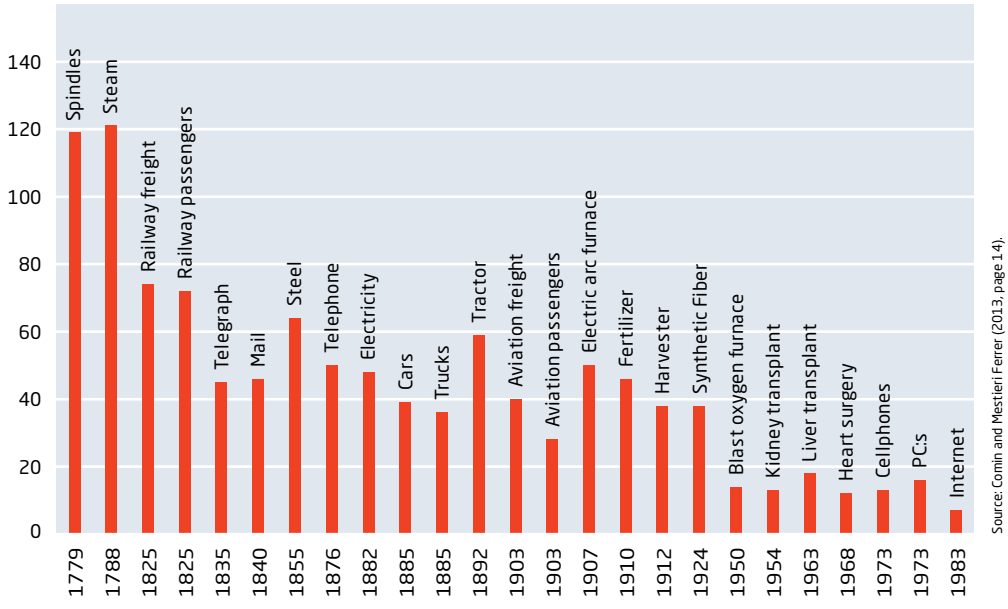
Innovations used to take a long time from conception to commercial use. Steven Johnson in *How We Got to Now: Six Innovations That Made the Modern World* describes the path of progress for technologies that irrevocably changed welfare across the world; see Johnson (2014). For example, Angel Barovier discovered how to make crystal on Murano Island, Venice around 1450, but the understanding of why it worked took another half millennium and led to the discovery of the mirror and later to fiber optic cables used for fast internet transmissions. Likewise, William Carrier invented air conditioning in 1902, but its commercial use took another half century to take hold.

In the last three centuries, the speed at which innovations spread throughout the world economy has vastly increased; see for example Comin and Mestieri Ferrer (2013). As shown in Figure 2.1, the average number of years for technological diffusion has more or less decreased continuously, with the introduction of spindles taking on average 119 years to spread compared to seven years for the internet.

With the advent of smart phones and the web, the speed of diffusion is likely increasing yet again. It is now much easier to seamlessly reach many users, for example, through the web, via the Apple app store or Google's android. Exactly how much faster digital technologies are spreading is not easy to determine. Reports have been circulating comparing the number of days that the game "Angry Birds" needed to reach 50 million users (35 days) compared with television, for example (75 years), but the veracity and origin of such numbers have been questioned; see Aeppel (2015) and Hannemyr (2003). The comparisons are not straightforward, because while games may spread like wildfire, the time these games are played may have a half-life considerably shorter than other technologies in the 20th century.

What is undoubtedly true is that technological dispersion has increased manyfold over the centuries. The speed and scaling of digital services means that some companies that become successful can grab an enormous share of the market, including the recent notable examples of Amazon, Facebook, and Google, as illustrated in Figure 2.2.

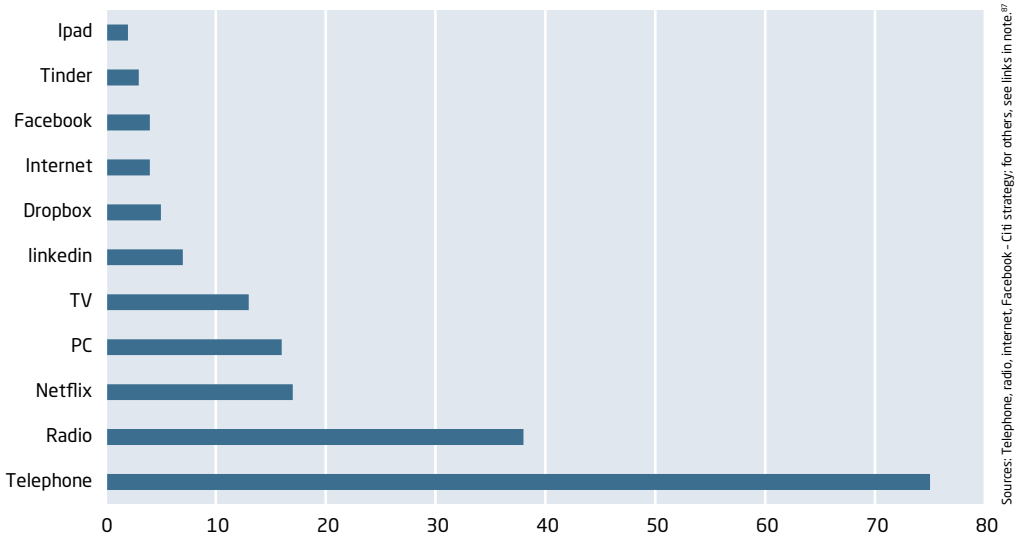
Figure 2.1. Technology is spreading faster, mean time of adoption in years



Source: Comin and Mestieri Ferrer (2013, page 14).

Note: The time to adoption is the mean number of years for a large sample of countries; for details see the explanation in the paper.

Figure 2.2. Years needed to reach 50 million users



The network effect and the possibility of fast scaling are the fundamental aspects underlying digital effects on the economy. Almost everything stems from these features. The effects of scaling are evident from the number of companies that go from startup to global in a few short years. Indeed, it has given name to a new term – unicorns – coined by the venture capitalist Aileen Lee; see Manjoo (2015a). The appellation denotes a company that reaches $1 billion in sales in just a few years. There are five companies with Swedish origins among the unicorns, notably King, Klarna, Mojang, Skype, and Spotify. While some digital companies clearly have reached extraordinary market value in very short periods of time, there is concern that some of this may be exaggerated due to accounting treatments and the terms of private investments set before initial public offerings; see Smith (2015).

What do the network effect and increasing returns imply for how the economy is working? For all areas where services are delivered digitally, the benefits are huge. Though digital services are growing rapidly, they are still a small part of the economy and much of the benefits come from finding and addressing inefficiencies in existing business models. Most of the economy is using the computer in one way or another, but so far *only a fraction* can claim to enjoy the *pure network* effects discussed above. This may change over time, but is still likely to be a gradual process.

For example, hairdressers use websites to allow customers to make electronic appointments and perhaps include texting to send reminders, thus making the business cheaper and less time consuming to interact with customers before the service is provided. But the actual haircut does not enjoy low marginal cost, increasing returns, or network effects. Similarly, the physical production of cars or appliances can benefit from digital designs and experimentation; spare parts can be produced with 3D printers and cars can be ordered online. But most of the production is still subject to physical limitations and hence deceasing returns to scale; it is really only largely digital services, such as games, newspapers, books, music, and video streaming that enjoy full network effects and increasing returns to scale.

[91] iPad – www.quora.com/How-long-time-did-it-take-Apple-to-reach-50-million-iPad-users; Tinder – http://mobile.nytimes.com/2014/10/30/fashion/tinder-the-fast-growing-dating-app-taps-an-age-old-truth.html?referrer=&_r=1; Dropbox – http://www.fastcompany.com/3029699/bottom-line/lessons-in-hyper-growth-from-the-man-who-scaled-engineering-at-dropbox-and-faceb; linkedin – https://ourstory.linkedin.com/#year-2003; netflix – http://money.cnn.com/2014/07/21/technology/netflix-subscribers/.

2.3.3 Lower marginal cost, non-exclusiveness

If we consider the parts of the economy that are mostly non-digital, such as manufacturing, they typically include machinery, inventory, sales, etc. All features of production are benefiting to some extent from digital technology, which has some dampening effect on the marginal cost of production. The larger the digital content, the more significant the effect. Newspapers and journalism are especially illustrative examples. Delivery of newspapers via digital services (pressreader, etc.) is seamless and enjoys near-zero marginal cost but the production of news does not. Having journalists in different countries to report events is expensive, especially in war or conflict zones, when risk premiums have to be paid. But the larger the distribution of newspapers, the lower the marginal cost: the fixed component of the firm's costs becomes a smaller share of overall costs if distribution is digital. The same argument applies to many other activities that involve physical production but digital delivery, such as movies and music. Notably, for digital books most of the costs of production remain the same for publishers: the physical printing of the books is a fairly small share of total costs.

All things that can be delivered by digital means share another important feature that distinguishes them from the rest of the economy: the non-exclusive nature of consumption. When you buy a product in a supermarket or a book in a store, no one else can use it at the same time. With digital delivery, the consumption of one person does not restrict that of another. This is essentially the other side of the network effect discussed above. It has especially important implications for the distribution of knowledge and it is instructive to discuss why. Before written language, knowledge had to be passed down orally, which was slow and prone to error/misinterpretation. With printed media, knowledge is passed much more easily from generation to generation, but only with digital media and the internet has *virtually* all information become available to *everyone*. Libraries with classical works can burn down and unique works destroyed but if the works are stored digitally, there may be backups available. But while digital knowledge does not burn down, there are other issues instead.

When all information is available digitally, the amount of "noise" also increases and without strategies for dealing with this, some efficiency gains may be held back. Moreover, for information and knowledge to become seamless, there is also an issue of *backward compatibility*. As standards are changing, retaining the ability to read old documents and pictures may be low down on the priority list of firms that are looking to be profitable. Indeed, for many people, accessing their own personal files, pictures, and videos from many years ago might not be seamless with the latest software.

There are also physical limitations to digital storage of media, as deterioration of hard drives, etc. may occur over time. With the upgrade logic of changing phones and computers every few years, the degradation of hardware may not be a big issue but for the stuff on our desks or in our pockets, for tape and hard drives, degradation of data may be an issue – perhaps not the same order of magnitude as books being destroyed by wars, fire, or simply old age. Admittedly, digital storage in the cloud may be more secure than previous storage methods, but while books can be destroyed they cannot be corrupted the same way data can. Overall, backward compatibility remains an issue with unclear ramifications.

2.3.4 Information becomes more seamless in capital markets

The standard model assumes that all relevant information is reflected in the price of assets and that new information instantaneously translates into price changes when conditions change. Much research in the field of behavioral finance, see for example

De Grauwe and Grimaldi (2006), is devoted to relaxing the assumption that information is infinitely available and that individuals are able to process it seamlessly to compute complicated optimization problems and reallocate portfolios.

While digital information processing has been available for decades, automated high-speed trading has become possible only with the advent of fast computers, digital infrastructure, and high-speed internet. With sophisticated algorithms, high frequency trading finds arbitrage opportunities in the smallest price movements. Indeed, it may no longer be possible for traders to find arbitrage opportunities without using high-speed computers. In this way, information processing and trading has gradually moved closer to the workhorse models of finance. To the extent that deviations from the workhorse model also implied imperfections and inefficiencies, digitalization has improved the price mechanism of financial instruments and hence, at least from this perspective, contributed to making financial markets operate more efficiently.[92]

The efficiency gains may not be easy to measure, but digitalization has arguably brought a different type of vulnerability to the financial system. First, the financial crisis of 2007-09 showed how the vast complex interdependencies made the financial system vulnerable. Second, technical mishaps can cause serious problems. Third, the systems may also be sensitive to manipulation. While insider trading and rumors have long been part of illegal activity in financial markets, the manipulation of trading aimed at nudging automated trading algorithms in one direction or another is a new form of vulnerability, exemplified by the "flash crash" of May 2010. It is contended that a single day-trader based in London on his own wreaked havoc on the Chicago exchange by first placing a large batch of orders to nudge algorithms in one direction only to cancel those orders in the next instant.

2.3.5 Capital investment – less required to start "digital" companies

Some of the first benefits of the Industrial Revolution lay in replacing manual labor by machines, known as "capital deepening." But once the major shift from a labor-intensive economy is made, productivity improvements from capital deepening become lower; that is, the marginal return from an additional unit of capital decreases over time. For OECD countries, most of the growth differentials in recent decades are explained by how well the productivity factors interact together in "total" or "multi-factor" productivity.

Does digitalization change the economic logic of the current shares of labor and capital? For some parts of the economy, notably manufacturing, digitalization has involved a gradual shift over long periods of time. Fewer people have been needed to perform the same functions. But for those sectors involved in "digital production" the shifts are more dramatic.

First, by using existing ICT platforms, "digital" firms can implement new business ideas and spread them very widely at low cost. For instance, Apple's *app store* is an example of an ecosystem where, with a modest amount of programming, it is possible to reach almost the whole world.

Second, the amount of capital needed to start a digital firm is often much less than that of physical production. A moderately fast computer and an internet connection may be all that is needed. Platforms, software, storage, and computing power are free

[92] Such efficiency gains may well be dwarfed by other problems with how financial markets operate, an issue outside the scope of this report.

or can be rented at low cost. Powerful and sophisticated tools are available through cloud computing. One effect of this is that even small startup firms can swiftly become large based on very little capital.

2.3.6 Quicker production, tweaking, innovation, and cutting out the middleman

Digital technologies make it possible to speed up production and improve quality. The initial stages of the Industrial Revolution entailed building specialized machines that performed one task – and one task only. New products typically involved costly changes to existing machines or, indeed, the need to build new machines. As a result, product cycles tended to last longer than they do now.

Firms that have not updated their IT systems for a long time may find themselves suddenly facing intense competition from those that have modern platforms and are able to more clearly discern customer demand and adjust production accordingly. Banks are especially vulnerable in this regard with old IT platforms stemming from a combination of conservative upgrade cycles, legacy systems, and mergers. One consequence for banks is that some of them may not have a complete picture of their client base in contrast to competition from new firms that use digital platforms, which is further discussed below in "Box 2.3. What is fintech?" The same may hold true for shops and chain stores that use outdated IT systems, with vast potential for improvement.

With advances in robotics, see for example Bryant (2014), Harding (2015), and Markoff (2012, 2015a, b), machines are becoming more versatile and reprogrammable, even in areas where highly skilled labor interacts with physical development – and so has broader relevance for the manufacturing sector. We are not yet at the point where machines can replicate the full range of human physical and cognitive skills, but in many sub-areas, computers consistently outperform people (see Chapter 3). Some of the work in building electronic components that was previously outsourced to Asian countries may even return to OECD countries, though probably in the form of robot fleets rather than manual labor, see the Economist (2012b).

As robots become more programmable, the fixed costs become smaller and their uses increase. Architects are working on ways to send their drawings directly to industrial robots for production. Even sewing of garments may soon be performed by robots and may in a few years lead to the reshoring of production from low-wage countries; see for example the Economist (2015c). When design can be sent directly to industrial robots, another intermediate function of production is removed, thus speeding up production and making it economically feasible to have smaller production lines, retooling more frequently, and making goods more personalized, similar to the advantages of 3D printers.

3D printers are being used to build bridges and houses; see the Economist (2015i). With complete design of a bridge in the computer, it is possible to reduce the amount of material used. In the example of the bridge, this resulted in 75 percent reduction in weight, which is a major cost saving only possible through software integration of design with the printer.

It is difficult to assess how far digitalization has cut out layers of production and streamlined processes. The changes are occurring in broad sectors of the economy, including in areas hitherto largely unaffected. For example, restaurants are now able to use software such as table 8, Zurvu and SeatMe to improve efficiency and reduce the number of "no-show" reservations that can amount to 5–10 percent of all reservations; see Buchanan (2014). But even if the magnitude is so far unclear, the direction is not. During the Industrial Revolution, machines were replacing workers; today all sorts of functions,

but especially those that are primarily rule-based are being increasingly automated. In the years to come. advanced services such as legal analysis, design, and writing may also increasingly be subject to automation, a topic we will return to in Chapter 3.

Indeed, eliminating the intermediary has been a trend in many areas: word processing reduced the need for secretaries; online booking, the need for travel agents; and online banking the need for bank tellers. A recent example is *InShared*, a Dutch insurance company, that has recently made the whole claims process digital, thus eliminating several layers of human interaction.[93] This overall trend has consequences for the individuals who are the recipients of those services, notably in that households need to do more of the work; see, for example, Lindbeck and Wikström (2003).

But reducing the need for the intermediary has other effects as well. A digital design can be changed more easily than a physical one. With few strokes on the keyboard, the initial design can be easily improved and production processes quickly updated. This is good news for innovations. The possibility to experiment and explore becomes cheaper and easier; with 3D printers, designs can be shown not just in concept but also physically, which cuts costs in the sensitive start-up phase for companies.

We are not aware of any research that systematically analyzes how far intermediary services have been squeezed. Thus, it is also hard to say how much of efficiency and productive growth comes from this trend. But looking ahead, it stands to reason that digitalization may bring further efficiency gains, especially in areas that have hitherto been less affected, especially in services, including highly skilled services in the professions (more on this in Chapter 3).

2.3.7 Business model disruption, subscriptions becoming more common

Digitalization is changing the calculus for how firms can charge money, notably in choosing between subscription-type services or payment per good or service. While it is hard to generalize, subscription services are associated with loyalty and steady revenues and are thus attractive for firms whenever possible. For example, newspapers and gyms traditionally offer both, but in rapid changing markets, businesses that are firmly entrenched in either model may also have to rethink their strategy or risk being left at the station as consumers jump onboard. Digital companies that initially provided a lot of content free of charge are tweaking their payment models in a variety of ways. This will affect traditional businesses in a lot of different areas.

Digital media – music, film, newspapers, books, and magazines are in this category. Subscriptions for music via Spotify vie to attract customers with free offers combined with advertising or ask customers to pay a monthly fee for virtually unlimited access. Other streaming services provide free trial periods, similar to apps and software. Netflix used to be a content provider only but has now shifted into content creation, thus becoming a slightly different kind of business. Apple has until now been a platform to buy media but is now going into competition with Spotify and offering streaming music.

Some businesses are facing strategic choices about where they want their revenues to grow or how to find new ways to make money. Publishers that offer subscription services for books, music, and the like may be squeezed between consumers and content creators. Content creators want to be paid for each time their work is accessed, be it a song or a book. Thus, the more times a customer accesses a particular work, the less profit for the subscription service that charges a fixed fee.

[93] The whole claims process is done online. The customers report the claim on a web page, where they are even able to book contractors.

What this development will mean in the longer term is unclear. What is clear is that the relationship between content provider and content creator is changing in complex ways and so are their relative bargaining positions. Much of the bargaining strength traditionally resides with the content providers but this is also changing, most prominently recently when a tweet from Taylor Swift made Apple reverse its position that artists would not be paid for songs played during the free three-month trial music subscription.

Payments are also changing in other areas. For example, Dollar Shave Club ships razor blades to customers every month, thus competing against Gillette; see Hill (2015). Car rental firms are having to compete with providers such as Car2go that charge per use, which in turn may be competing with leasing alternatives and ownership. Apple and Facebook are beginning to provide newspaper content directly in their feed rather than sending customers to news sites via links. Netflix used to distribute content but is now successfully producing original material. Google used to be an internet-search company until it designed Android, its own operating system for smart phones and is now exploring venturing into cars, smart homes, and other areas. Overall, digitalization has blurred the line between content creation and distribution. Several companies are in the throes of deciding exactly what kind of business they are doing.

For businesses that are locked into a particular way of interacting with customers, it will be important to be able to change how it charges money in response to shifting consumer preferences and behavior. For example, some newspapers have opted in to the new Facebook and Apple services, while others remain out; see Garrahan and Kuchler (2015). While the choice is complex, at least two factors stand against each other: by providing content to digital platforms with many visitors, newspapers can potentially broaden their market and reach more customers. But at the same time, there is a risk that the brand name will be eroded and that loyal subscribers will leave to instead enjoy lower cost access via the digital platforms. Overall, it seems the digital disruption in media is only beginning and spreading to other areas as well.

2.3.8 Working hours – divided into small pieces and more self-employment

Digitalization increases possibilities of moving employment contracts more towards small pieces of time rather than the full time-part time-unemployed spectrum. For example, someone might work part-time in an office, drive a car-share in the evenings, and rent out an unused room, thus being employed and self-employed simultaneously and to varying extents. When this choice is involuntary, however, it may have negative consequences, some of which have already been observed in the US. For example, some low-paid workers in fast food chains in the US have seen their working hours become more unpredictable when their firms optimize schedules according to demand. One effect of this is that it becomes harder for people to plan their lives for second (or third) jobs, studies, child care, and free time; see Kantor (2014) and Singer (2014). Recent strikes for better conditions in some fast food chains in the US could be a sign of such frictions in conjunctions with issues related to low pay.

Wages in the US have not increased much for median workers in recent decades; instead, many households may have perceived their wealth going up due to increasing house prices; see for example Rajan (2010). Many less skilled workers have also had low wage growth, as the pool of available workers to fill positions is substantial; see, for example, Leubsdorf and Hilsenrath (2015). Although the explanations may be several, digitalization could be a contributing factor. For example, digital platforms can provide a wider pool of applicants from which to fill positions and competition for available jobs may increase. But it can also be a demand issue, with firms still

recovering from the financial crisis. For the Federal Reserve and other central banks, assessing how long to keep interest rates low, the question of low wages stemming from supply (digitalization) or demand is important.

Among OECD countries, multiple simultaneous forms of involuntary part time work at minimum wage is much less common than in the US. Instead, more rigid labor markets in Europe often result in higher levels of unemployment. But the technical possibilities to have more flexible working schedules may also become more common in other countries with more rigid labor markets. While this increases efficiency in the labor market, it also raises issues about how the labor market operates – with respect to regulation, wage bargaining, pensions, and social security. The nature of work is of course not going to change overnight, but the trends towards flexibility may be a challenge for some countries that have strong institutional features for how work is organized, Sweden among them.

2.4 Demand side changes: prices and competition

Digitalization is increasing competition in some ways, but it has not necessarily led to greater competition across the board in all areas. Economists have long noted that competition is a complicated thing. Once departures from simple but unrealistic models of perfect competition or monopoly are made, it is typically the case that predictions of outcomes are much harder to make. Early literature in industrial organization emphasized the "structure-conduct-performance" hypothesis in which the characteristics of the market, such as physical aspects, geography, etc. set the stage for the incentives of firms and how they behave. These factors were deemed to determine how much competition there would be in the market. Later research has used insights from game theory to model and understand the incentives involved. Typically, outcomes of competitive processes can depend on a multitude of factors, which are difficult to disentangle in practice.

Recent research has investigated the factors that can lead to more realistic outcomes than those simple models. Some examples of these more realistic factors are conditions of entry into the market, regulation on collusion in the form of cartels, or "predatory pricing".[94] There are also various ways to affect competition. For example, a firm can potentially change the competitive landscape through advertising. As well, firms can make substantial investments in R&D to deter potential competitors from entering the market. Even relatively homogenous goods, such as mineral water, can reap close to monopoly prices under some circumstances.

It is fair to say that all the elements that characterize competition in the non-digital economy are also present in the digital economy. Indeed, in the digital economy some elements are extreme, notably in the time scale of events, which is often extremely compressed. Even within a short span of years, a company can go from "garage to global" and become an enterprise with near-monopoly power.

2.4.1 Increasing price transparency and changing consumer behavior

There are many parallels between price competition arising from digitalization and the forces of globalization. Clearly, competition in the digital world relies much on the ability to reach out across the world to new markets and consumers. In this sense, digitalization allows more globalization. However, more digitalization does not imply that each and every market will become global. Indeed, some markets for services

[94] Predatory pricing is when an incumbent intentionally sets a price below marginal cost to pressure competitors to give in or to scare them off from entering the market.

remain stubbornly local. In these markets, new forms of competition may develop, a topic we will return to further below. Therefore, even though closely related, digitalization and globalization need to be discussed separately.

One especially important aspect of digitalization is the potential to change consumer behavior in a way that increases competition. Many of the now common elements of consumer power were anticipated some time ago; see for example Lindbeck and Wikström (2000). Better informed consumers can put more pressure on retailers and increase competition, which in turn gives retailers stronger incentives for product differentiation and brand-building.

In practice, digitalization has changed the way in which consumer search for and compare goods, which is increasingly done outside the bricks-and-mortar store. But it can also occur "on the spot" with consumers entering a store and using their mobile phones to search for a lower price online, increasing consumer power. A report on Swedish data shows that almost half of all consumers in 2014 reported that they search the internet in a process called "webrooming" before making a purchase – even when the purchase is not made online, see Svensk Handel and HUI Research (2014). One out of four Swedish consumers have compared prices online and one in ten have used their mobile phone to check stock availability. In the US, nearly 70 percent of consumers search and compare goods online according to Deloitte (2014a) and close to a half of all consumers plan to shop online; see Luna (2014). Although online shopping is flourishing, it appears that digitalization has expanded the *search and compare phase* of a buy, but that the actual purchase of the goods happen in the bricks-and-mortar store. Not only do consumers have access to unfathomable amounts of data to make comparisons, they are also using it more and more.

In the UK, a study of 5,900 retail bankruptcies showed that stores in the central business district ("high street shops") have higher resilience and capacity for reinvention than shopping centers and retail parks; see Deloitte (2014b). This shows that price is not the only factor affecting consumer behavior. Other factors such as the convenience of nearby shopping still matter too.

The resilience of high street shops in the UK notwithstanding, if online internet sales continue to increase, retailers in central business districts will face even tougher times. Younger generations that are already now more exposed to digitalization will likely be more at ease with shopping online compared to older generations. We can only speculate as to the outcome of such a development, but it is likely that many retailers will manage to survive this trend only if they will maintain the ability to reinvent themselves and adapt to changing consumer behavior. For example, stores may try to sell services connected to their goods instead of only the product itself: you might not actually buy a running shoe, you pay for a "running shoe experience" with various forms of individualization, such as trying out the shoes on a treadmill. You might not buy an electronic tool, but instead use a sharing service and purchase the nails and things you need, such as with *toolpool*. The sharing economy, discussed further below, may also change consumer behavior. Does this mean that price competition is increasing and that price levels are always and everywhere under serious assault?

2.4.2 Price discrimination on the rise through sophisticated algorithms

Somewhat paradoxically, the scope for price discrimination is also increasing despite greater transparency. Just as there can be a mismatch in the labor market with a simultaneous lack of skills and surfeit of education, so too can prices be both transparent and discriminatory at the same time, perhaps a special feature of the digital economy.

There is increasing evidence of sophisticated algorithms that use very large datasets to make inferences. It has been reported that Facebook "likes" are a better guide for predicting a person's behavior than asking their spouse; see Ahmed (2015a). Tracking "likes" also makes it possible to gather a myriad of information about users that can then be used, for example, to create tailored advertisement. There is indeed a large increase in third-party services that collate and analyze consumer data; see the Economist (2014a). Algorithms are increasingly geared towards improving sales and business by assessing online behavior. For example, a consumer may be offered a discount when it appears she is likely to leave the website without closing the deal; see Tanner (2014). Notably, the algorithms can infer a wealth of personal information from various sources. A change in the price an online consumer can receive may depend on many factors. Exactly how these algorithms work is clouded in some mystery and is a closely guarded secret of the trade.

The fear of a consumer backlash against amassing and exploiting personal data may discourage some firms from using the full potential of the data for improving their business. Tony Weisman of DigitasLBi – a digital data provider – was quoted in the Economist (2014a) as saying, "We can do more technologically than we're permitted culturally."

It is well-known that Amazon may change the price of the same product multiple times during the day.[95] The price change may be driven by what the competitors are doing but also by the type of consumers who are searching the Amazon site; see Peterson (2014). Granarolo, an Italian dairy products company, uses sophisticated algorithms based on machine learning to predict demand with almost complete accuracy; see Dempsey (2014). This allows their executives to approve recommendations on supply of dairy products in close to real time.

Although sophisticated algorithms that use personal data are currently employed, a wider and broader use may have unpredictable consequences. In some countries, some forms of algorithm-based price discrimination may already be illegal, but the public perception about the use of personal data for price discrimination may be an even more significant obstacle. Consumers have long become accustomed to coupons and various forms of price rebates on goods. But if rebates come at the cost of allowing personal data to be used, consumers may react negatively.

Other forms of sophisticated price discrimination have also been observed. For example, someone who uses a price comparison engine to find the lowest price may get a better deal at the same site than a customer who went directly to the site.

While the advent of a consumer backlash is possible, we are likely to see rising use of sophisticated algorithms to assess and influence consumers. When competition is strong, firms need to find ways to reach consumers and differentiate their products from those of their competitors. This brings strong impetus to expand and deepen the use of personal data. As more personal data becomes available and the algorithms become even more sophisticated, the general price level may be affected. Digitalization may be one factor among others affecting inflation, as discussed further below. It is still too early to determine whether the ease of price comparisons will outweigh the ability of firms to price discriminate. There are also questions about what the regulatory authorities may do, especially since some prices may be different depending on country of residence or the location of the server.

[95] See for example http://www.businessinsider.com/amazon-price-tracking-2014-8?IR=T

2.4.3 Physical goods becoming digital services

Books, movies, and music have already been transformed from physical goods to digital services. For example, e-books are providing the same material as a service compared to buying a book. In many instances, the digital service is cheaper and has more content. For example, some e-books contain video and audio recordings; digital magazines likewise blend still pictures and video. 3D printers can also blur the difference between goods and services, a topic we discuss in the context of dentistry in Chapter 4.

But goods are becoming services in many other areas as well. Notably, vehicles are no longer just trucks and cars, they are essentially big computers on wheels. Commercial trucks have long been fitted with "black boxes" similar to airplanes. The data generated from the trucks can be used to control fleets, their location, speed, and so on. Scania and Volvo have been supplying such services for a long time.[96] The data can also be used for other purposes, such as giving feedback to drivers on fuel efficiency and "predictive maintenance," which can provide advance notice if the truck needs new spare parts or other service. Electrolux is exploring integrating cameras into its ovens, which can then be connected to a smart phone for access.[97]

2.4.4 First mover advantage not always present when winner takes all

It is often thought that being the first with a new product brings an advantage, but there are plenty of contrarian examples. Ericsson was close to launching a device not unlike the iPad many years before Apple introduced it. The website Boo.com selling designer clothes was launched with much hullabaloo around 2000 but subsequently went bankrupt. Today, being able to quickly increase the scale of a business has become key. As expressed by Reid Hoffman, co-founder of LinkedIn: "First-scaler advantage beats first-mover advantage; see Hoffman (2015)." In contrast to the situation about a decade ago, a number of key conditions have evolved and matured:

- The emergency of large platforms with standards that attract consumers and producers alike (the web, Apple with iOS and Google with Android).
- Trust mechanisms for digital transactions, both for goods and services.
- Digital payment systems with low transaction costs.
- Ubiquitous use of smart phones and tablets.

Just as in the analog world, being first is not always the best. If the product at launch is not of good quality or the market infrastructure is insufficiently developed, the second, third, or tenth entrant may be the one to capture the whole market. Again, a key difference with the analog world is that this process can be extremely fast, so that an obscure company can become very large, very quickly. Some videogames, such as Angry Birds and Minecraft, are examples. In contrast to the norm for firms that produce physical goods, digital firms can become tremendously successful in a very short period of time and not seldom having only one product. To survive after an initial success, they face a tremendous challenge in quickly building a new profitable line, not least since consumer loyalty to any specific digital product can be ephemeral.

[96] See, for example, http://www.scania.com/products-services/services/fleet_management/.

[97] See http://www.electroluxgroup.com/en/aeg-launches-the-worlds-first-connected-steam-oven-with-integrated-camera-21191/.

2.4.5 Brand names matter as much as before but speed is (again) higher

One feature that decidedly remains the same in the digital as in the physical goods world is the value of brand names. Coca-Cola, H&M, Volvo and all other multinational companies spend a great deal of time, money, and effort building and developing their brands.

For digital firms, the brand matters just as much – if not more. There is little time to build a brand; compared to existing companies that have nurtured their brands over decades, digital firms typically need a global view of how their brand will be perceived from the outset. Building brand names also faces new challenges in the digital age if exposure primarily comes from apps that aggregate services or provide concierge-style services that expose consumers less to brands; see for example Waters (2015a).

Speed in building brand recognition and consumer loyalty is essential for the survival of digital firms especially because services in some areas may be very similar and the need to stand out from the competition may therefore be even stronger.

Moreover, the reputation effect on a digital firm's brand firm can be very damaging, very quickly. A wrong tweet, an offensive Facebook update, a misplaced email, leaked information or passwords can quickly blow up into a maelstrom of negative publicity. When Sony's email system was hacked in 2014 and confidential emails were published online, the repercussions were wide and long-lasting. It even affected the launch of a comedy movie about North Korea and had implications for foreign policy, with even President Obama weighing in on how the debacle was handled.

In Sweden, a survey of 10,000 respondents conducted by researchers at the Stockholm School of Economics and Askus Consulting found that consumers were particularly unforgiving about the misuse of private information; see Dellham et al. (2013). But some analysts and executives interviewed in Twentyman (2015a) argue otherwise, identifying the possibility of "breach fatigue" as an explanation. The two views seem irreconcilable at first, but both can be right if attitudes have evolved over time and become more forgiving as breaches are more commonly reported. However, a survey of US attitudes shows that people trust neither the government nor private corporations to handle their personal data; see Goel (2015). Another recent survey in the US showed that 91 percent of consumers disagree that being given a discount is a fair exchange for firms to collect information about them without their knowledge; at the same time, about 65 percent of respondents asked appear resigned to this development, see Singer (2015).[98]

Whatever the overall view, some areas are more likely to be simply more sensitive in terms of how data are handled. Notably for e-commerce and online financial firms, electronic fraud and impersonation for economic gain may be especially damaging and expose them to the risk of enduring consumer wrath.

Trust is the *sine qua non* of financial transactions. In this regard, some digital companies may share elements with the financial sector. Once trust in the solvency of a financial institution is in doubt, investors dash to withdraw their cash to save what they can. Even the unfounded perception of solvency problems can be enough to trigger a bank run, as evident during the financial crisis, for example with Northern Rock in the UK or Bear Stearns in the US. Thus, digital firms will likely need to be

[98] While surveys are indicative of trends and attitudes, they should be interpreted with care. A hypothetical tradeoff between privacy and an unknown discount may be less revealing than a real situation with a specified discount. It is likely that personal data has some price at which consumers are willing to cede it; the problem is that the transaction is opaque.

as careful as financial institutions with their brand names and reputations. Just as a bank run can be the end of a financial institution, a brand run can be the death of a digital firm.

2.4.6 Unassailable monopoly one day, gone the next

The nature of competition has changed in the last few decades. As technology has evolved, the scope and nature of markets have also changed. In the 1980s, IBM dominated both the market for mainframes and personal computers. As competition increased, IBM's struggles to manage and innovate led to the outsourcing of the operating system to what was then a small, unknown company, Microsoft. Without this decision, Microsoft would not have become a dominant force in the last decades. Indeed, it started the era of Wintel – the dominance of Microsoft through its Windows operating system and Intel through its virtual monopoly on microprocessors. During the 1990', Microsoft was accused of anti-competitive behavior in the US on several occasions, as well as by the European Commission.

The charges were complicated and involved several elements. On one count, Microsoft was accused of "bundling," a practice in which it used its near monopoly on operating systems to force out competing web browsers. For example, Netscape had an early alternative to Internet Explorer, the Microsoft browser. Forcing consumers to accept IE with Windows was prosecuted as anti-competitive behavior by the European Commission.

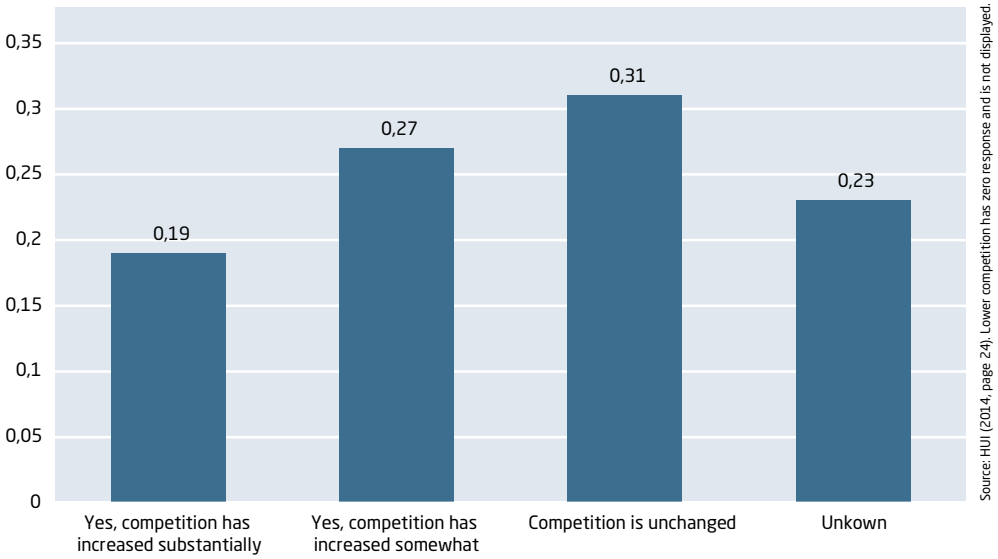
But in the end, it is not so much the competition authorities as changing technology and markets that began to rattle Microsoft. Apple's introduction of the iPhone, and later the iPad, upset a business model based on personal computer dominance. Today, Microsoft is still a huge company with the Windows and Office suites ubiquitous but no longer unassailable. The future for the behemoths of recent decades looks much less certain. The competition for business on the internet left Microsoft wrong-footed and the company is trying to regain its prominence.

The battle today between Apple and Google illustrates the nature of changing competition in digital firms. Only a few years ago, Google and Apple were competing in different markets. Google was primarily a web search company with revenues from advertising while Apple was a computer company entering the mobile phone market. Eric Schmidt, then CEO of Google, was even on the board of Apple as an outside director up until 2009. But Google's venture into mobile phones through the Android operating system made them direct competitors. Indeed, sharing board seats today would be inconceivable. This illustrates how the nature of competition can change as markets evolve, a factor that is especially pertinent with digital firms. Even when the product may evolve only gradually akin to non-digital products, the market in which digital firms compete can change so dramatically that even a near monopoly can wither in short order.

2.4.7 Has overall competition increased?

A survey of Swedish e-commerce by Svensk Digital Handel and HUI (2014) indicates that almost half of firms believe competition is increasing; see Figure 2.3. Swedish consumers bought goods from foreign e-sites worth about SEK 11.5 billion in 2014, still a small percentage of overall sales.

Figure 2.3. Has competition changed? Response from firms in Sweden, 2014



But is overall competition increasing from digitalization? More price transparency increases competition but the effects of brand names and the winner-takes-all phenomenon may be forces in the other direction. Ultimately, this is an empirical question and a subject for further research.

2.5 Changing how the economy works – the sharing economy

In the previous sections, we have discussed how digitalization alters aspects of production, labor, price setting, and consumer behavior. Many times the changes accelerate processes – from design to production and delivery. The changes are so significant that they have an effect in their own right but many are matters of degree rather than fundamental shifts. For example, replacing manual labor with machines has been going on for a long time; the question now is rather different in nature: is the pace faster and the scope more encompassing than before? But other aspects of digitalization are making even bigger inroads on humans and the economy, even before considering the possibility of artificial intelligence.

2.5.1 The sharing economy

Throughout history, sharing in various forms has been central to progress. Sharing of tools and services prior to fiat money was necessary, as the logic of specialization implies advantages to productivity that have to be balanced against the risks of relying on others for factors of production or for sustenance. Civic society and other trends have been vibrant throughout modern history. Indeed, it is hard to think of the market economy without also viewing the strong bonds and commonality that constitute the nation-state. In Levay (2013), the role and challenges of civic society are discussed in Sweden. Bergh and Bjørnskov (2011) and others have shown how trust is important in society for supporting the modern welfare state.

But just as civic society is integral to the modern welfare state, sharing as a phenomenon is overshadowed by ownership in modern capitalist societies. To be sure, ownership and rental have always coexisted, but the digital economy is making a fundamental shift away from the logic – and indeed the benefits – of ownership. This shift is perhaps the most dramatic change brought about by digitalization and has arguably just begun. While industrialization replaced manual labor with machines, this new wave may be redrawing the landscape of how capitalist economies organize themselves.

2.5.2 What is the sharing economy?

The sharing economy has been given many names, such as collaborative consumption, the mesh, the access economy, freelancing, on-demand work, and the gig economy. We will use "the sharing economy," but it may be appropriate to first define what we mean. Throughout the economy, there are idle resources – anything from spare capacity in the form of a room to a seat in a car or a vacant parking place. Idle resources are bad in the economy because by and large they imply waste. Unemployment, due to its social costs and the risk of erosion of human capital, is a particularly onerous form of idle resources.

The sharing economy provides a way for these idle resources to find their use; see for example Felländer et al. (2015) and the Economist (2015a,b). The key feature is that digital platforms allow buyers and sellers to be matched in ways that were not possible before. Essentially, the digital platforms reduce the transaction costs – or the frictions – involved to the extent that it may be beneficial to sell even miniscule idle resources. For example, finding a ride-sharing service to commute from the suburbs to the city center used to be possible to organize only within a relatively small circle of neighbors or colleagues. But with digital platforms, it is much easier today to find someone selling the service – at least in densely populated areas. In few large metropolises, carpooling is even supported by the local authorities with special carpool lanes, similar to bus lanes.

The sharing economy is characterized by:

- An idle resource for sale – either a physical good, knowledge or a service.
- Someone willing to buy said service or resource.
- A digital platform that matches buyer and seller with a very low transaction charge.

In Box 2.2 we summarize some of the sharing economy services; there are a huge number already and they are expanding fast.

While the sharing economy certainly connotes ideas of social benevolence or improving the environment, most times the driving force is the classical capitalist profit motive. The incentive to become the next Facebook, Airbnb or Uber is very strong. Striking the next mother lode can imply immense riches for the owners.

It is useful to divide the sharing economy into three categories: purely digital services that enable sharing of knowledge, those that pertain to unused physical resources, and those that involve providing labor. Sometimes the sharing activities involve all of these to varying degrees but they are still useful ways to discuss the issues involved. Some of the sharing is done peer-to-peer (P2P), some peer-to-business (P2B), and some business-to-business (B2B) – each with distinct features.

Box 2.2 A few firms in the sharing economy

Fintech, peer-to-peer lending
LendingClub, Toborrow*, Lendify, Prosper, Funding Circle, Zopa, Payoff, Estimize, Kabbage, Karrot, Vouch, Lendico, Zencap

Cars, transportation, and parking
Uber*, Blablacar, Tripda, Hailo, Car2go*, Stockholms bilpol*, Justpark, EasyCar, Zipcar, Driveway, Lyft, Sidecar, RelayRides

Lodging
Airbnb*, Housing Anywhere

Tools and miscellaneous items
Peerby, Rentmyitems.com, Ecomodo, Streetbank, Streetclub, Freecycle

Tasks
eLance, Upwork, Taskrabbit, Dog vacay, Handy, Washio, Bloom That, Fancy Hands, Spoon Rocket, Fiverr, Hassle, Shyp, Tongal, Amazon's Mechanical Turk

Legal services
Invest4justice, Crowdjustice, Upcounsel, Axiom

Business applications, professional and knowledge sharing
Simplist, Fon, Textio, Gild, LinkedIn, Wikipedia, Coursera, Studybuddy, NearDesk, BrandGathering, Nimber, Topcoder, Eden McCallum, Hoffice.

Marketplaces, fashion clothing, charity
Amazon, Etsy, Yelp, Tradera, E-bay, Blocket, Girl meets Dress, Rent the Runway, Freegle, Yerdle, Poshmark, Kidizen, Rocksbox, Just Giving

Medical
Crowdmed, Medicast, Heal, Pager, Retracehealth, MedZed, Dispatch Health

Hobbies, training, sports gear
Book Crossing, Vint*, Velib, Splinster

Food
FarmDrop, Food Assembly, Grub Club, Casserole Club, Instacart, Pallafrukt*

Note: For more explanations, go to the respective app or website. Two good sources on the sharing economy are Wosskow (2014) and the Economist (2015b). Some sharing economy platforms deliver to other countries, some are geo-based. A star denotes a service available in Sweden.

2.5.3 Knowledge sharing

Purely digital services have all the benefits of networks and scaling at low or zero marginal cost. For example, IBM's Watson computer, famous for winning at Jeopardy against the best humans a few years ago, has found uses in medical and legal services. With a huge database, be it road-street mapping for navigation, medical research for diagnosis, or legal case histories, knowledge sharing is making it much simpler and cheaper to perform even advanced services. It is also these changes that have the most potential to be disruptive for middle-class jobs, a topic further explored in Chapter 3.

The medical profession is a case in point; see for example Lohr (2015a,c). Each medical discipline contains a huge amount of medical research. Doctors may struggle to actively follow research even in their own area of expertise. Applying that knowledge is yet another challenge, for example, with new statistical inferences on likely illnesses and diagnoses. With huge medical databases available, doctors have information and tools at their fingertips to interpret the information that would be beyond the capacity of humans. Pertaining to the discussion in Chapter 1 of looking at computers as complements or substitutes, this is primarily an example where computers can serve as a tool for greater efficiency and thus support the medical doctor in making better inferences rather than replacing her. This is an example of the complementarity discussed in Autor (2014).

But knowledge sharing in the legal sector may be an example of the opposite. IBM Watson has also been used by some researchers to create a legal database that can handle a great deal of paralegal work; see Jackson (2015). Here the possibility of substitution appear greater, and we will return to these issues in Chapter 3.

2.5.4 Sharing of physical resources

Items that were hitherto too cumbersome to share or rent are now more readily available. The first wave of sharing applications allowed people to sublet rooms with ease. Car rental is also very big. There is now an explosion of firms that provide different types of homes – all from luxury rentals for tourists to sharing of office space through, for example, *Second Home*. Sharing office space can bring big advantages to startups that do not want to commit to renting more space than necessary; there are also benefits to be gained by providing meeting places for people with ideas. The same driving forces that make cities attractive and drivers of economic growth, see Shapiro (2006), are also relevant to sharing of office space. The notion of "ideas colliding" is similar to the benefits of cities, albeit on a smaller scale. Here there are existing parallels to the "makerspace" movement; see Sleigh et al. (2004).

However, small items, such as tools and parking spaces, can also be shared for shorter periods of time. There is a wealth of new ideas and entrepreneurs discovering which idle resources can be made available on the market. We are now only in the early stages of this development and how far we can go will depend on regulation, trust, and convenience but also on other factors that are not foreseeable now.

The sharing of tools is a particularly illustrative example, as it holds both the potential to disrupt as well as to increase the market. Homeowners and DIYers have long acquired various tools that they use only rarely, such as drills, saws, etc. If these tools are instead rented, the owners acquire income, the tools are used more, and rental costs are lower than the cost of ownership. But what does this mean for retailers that sell tools? Will they sell fewer if the sharing market thrives? And what does this mean for their businesses? These are questions that remain to be answered.

2.5.5 Sharing of services

The bulk of service sharing has hitherto been focused on relatively unskilled jobs. Carsharing has become a vibrant area for new apps that provide a variety of sharing services – all from an empty seat, in which case it is a service, to actually renting a car, in which it becomes sharing of a physical resource.

Many services provided in the sharing economy are low skilled, but not all. There are especially big changes in financial services or "fintech," where small companies can provide specialized services that are cheaper, faster, and easier to use than traditional banking services.

P2B lending illustrates some of the issues involved; see the Economist (2015d). For example, Funding Circle in the UK, *Ondeck* in the US and *Toborrow* in Sweden provide a platform for private individuals to loan their money to businesses. Typically, P2B firms provide a platform for the financial service but essentially never hold on to the cash. For lenders, this provides an opportunity to place their savings at a higher interest rate than in the bank at (presumably) moderate risk; for businesses, it often saves time and effort in trying to get bank loans. Moreover, the loans extended are typically smaller than those banks are interested in since the banks have almost the same marginal costs for doing due diligence and processing small loans as compared to a big one. In this way, *fintech* firms are supplying credit to parts of the economy that previously had no access to the capital they wanted; see "Box 2.3. What is fintech?" Potentially, this could be a very significant boost to how capital is put to use in the economy, enabling more small firms to get started or expand. The overall effect may be that the economy works much better.

So far crowdfunding, P2P and P2B services may not be in direct competition with banks when the focus is on smaller loans, but this may change, as expressed by Jamie Dimon, CEO of JP Morgan Chase & Co, "Silicon Valley is coming," see Dimon (2015). The nature of investment in fintech may also be changing, with more venture capital firms supplying the capital; see the Economist (2015d). In the UK, one P2P platform gets clients from a conventional retail bank in exchange for free advertisement; see Alloway and Dunkley (2015).

What this financial disruption will mean for the financial sector is yet to be seen. Margins and profits have long been high in banking and the potential for efficiency improvements is likely considerable; many banks have had their systems updated only piecemeal or created a patchwork of more-or-less incompatible systems acquired through mergers. Fees on credit and bank cards should make entry into payments systems attractive with services such as Paypal, Apple Pay and Square. Digital currencies allow money transfer at virtually no cost; see for example Mims (2015). Digital receipts have yet to make a dent in physical receipts. Thus, a great deal may happen with fintech in the years to come.

What we know much less about are the new types of risks that amass when individuals and firms use these kinds of services. Traditional banking has a long history of failures and bailouts, but also of being bailed out by taxpayers, most recently in the aftermath of the financial crisis in 2007; the financial platforms are not covered by deposit guarantees and other safety nets: any losses occurred are private.

This implies that risk is distributed in new ways in the economy, which may have implications in the next downturn that we may not yet fully understand. For example, could negative news lead to quicker dampening effects on consumption and invest-

ment than before and what happens to consumers when liquidity dries up in P2P markets? How does the nature of systemic risk change and how well are the regulators monitoring developments? How will consumers who have lost money invested in fintech companies react? These are urgent questions for macroprudential authorities, such as the Financial Supervisory Authority in Sweden.

Size and scope of the sharing economy – still small but not a marginal change

The forces and implications of the sharing economy are not a marginal shift of a few percentage points more efficiency in production. Admittedly, the sharing economy is still small. According to PwC (2014), the use of sharing economy services is still in the single digits based on a sample of 1,000 interviews, see Figure 2.7. In the UK, a Nesta study by Stokes et al. (2014) finds that 25 percent of the population has used sharing economy services; see also Jacob (2015). Wosskow (2014) reports that about 20,000 property owners in the UK rent out their driveways for parking through JustPark. According to another estimate by Vision Critical and Crowd Companies based on 90,000 customers, about 23 million people have used sharing services; see Stokes et al. (2014). PwC estimates that the sharing economy is currently worth about $335 billion, which includes P2P finance, online staffing, P2P accommodation, carsharing, and video streaming. Baeck, Collins and Zhang (2014) estimate that fintech, the part of the sharing economy devoted to financial services, is worth £1.7 billion, barely a drop in the UK financial sector ocean.

Since there are many platforms for sharing services, it is difficult to know how big the overall phenomenon is becoming, as indicated by the various estimates cited. But we are likely seeing only the beginning of the sharing economy. As current generations become more used to such platforms, the platforms will become an increasingly established part of the economy.

What is already known, however, is that some of the established sharing economy companies are very big. According to PwC (2014), Airbnb averages 425,000 guests per night or 155 million annually, which is 22 percent more than Hilton, which has 127 million annually. Uber, the carsharing service, operates in 250 cities worldwide and was valued at $41.2 billion in February 2015 – more than Delta Airlines, for example.

2.5.6 Nature of trust, limitations

There can be no sharing without trust. Indeed, almost all activities involving multiple agents, individuals, or firms involve some degree of trust. In the worst of worlds, sometimes trust is replaced by mutual need, but this is a fragile basis of relationships and is wrought with dangers and inefficiencies.

Trust is key to the sharing economy and to all well functioning economies, but alongside regulation it may be its biggest challenge. How do we trust the other party in the transaction or deal? How do we know they will deliver the good or the service we ordered? And how does the seller know the buyer will pay and is not otherwise engaged in illicit activities?

Government regulation of course has a key role in setting standards – of what is permitted and what is not. When parties disagree, they try to reach an agreement – in some cases they may compromise, in others they part ways or resort to legal action. How well the economy handles disputes – not suppressing all conflicts but not necessarily giving incentives to resort to costly court battles either – is one factor that affects the

efficiency of the economy and ultimately productivity growth. It is perhaps no accident that countries with weak institutions and lack of trust tend to grow less and become less wealthy; see Acemoglu and Robinson (2013).

But is government regulation enough to establish trust? Clearly, government regulation has evolved in tandem with people's beliefs and the outcome of elections. Sometimes accidents or events cause new legislation and sometimes there are drives to simplify. But above all, government regulation tends to be behind the curve, that is, reacting to events rather than smoothing the way forward.

In the sharing economy, this is especially true. Much government regulation originated decades ago, before anyone knew the meaning of *selfie* or *status update*. That is not to say that all regulation is outdated. There is sometimes a tendency to view all regulation as an obstacle to growth. But the absence of regulation for firms trying to innovate does not equal lack of friction, it is more likely to mean anarchy or unpredictability. So, government regulation at its best balances various interests against each other and our values in a way that does not put undue strain on progress.

Government regulation of the sharing economy – a wobbling question mark

For the sharing economy, government regulation is – if not clueless – at least a slowly wobbling question mark. Instead, trust in the sharing economy is being established largely through self-regulation, mainly using various forms of home-brewed reputation systems.

Economists have long viewed reputation effects as key to understanding outcomes. In the traditional Nash bargaining problem in the prisoner's dilemma, both prisoners have an incentive to deviate and rat out the other, thus creating the worst possible equilibrium in which they are both found guilty. If instead, choices were also affected by reputation, the incentive to deviate might lose out to other future concerns, perhaps the expectations of future income or friendships.

The sharing economy largely relies on self-evaluation to build reputation – both the sellers and the buyers evaluate each other with a simple click immediately following a transaction. Presumably, people with poor evaluations have difficulties entering into new transactions; few will trust them.

In theory, these kind of reputation-making technologies make eminent sense. Why not amass in data what in the pre-industrial age used to be known in the village? Hopefully the system is more unbiased and more forgiving than reputation building in the past.

The importance of self-regulation has been stressed by Cohen and Sundararajan (2015) but there are some drawbacks. For one, each platform uses different technologies for establishing reputation. There is as yet no common reputation history stored for each person that can be used across platforms in the way that credit history checks are made when people seek loans. This implies that whenever you want to switch to a new service, you might have to rebuild a good reputation from scratch, thus potentially strengthening lock-in into existing contracts. How much this matters is unclear, but the absence of a common "reputation log," perhaps a history trail of transactions like bitcoin, implies new types of frictions that reduce incentives to change. While, as discussed above, overall competition from digitalization is likely to increase, it may not increase to its full potential, depending on how reputation effects evolve.

Another issue is that a common "reputation log" – or even a few central ones from the services people mostly use – may raise ethical questions and practical problems, some of which we will briefly discuss in Chapter 6. The possibility of fraud with digital signatures is a risk. When banks trade billions of dollars, B2B transactions can be very sizeable and the downsides significant.

It is fair to say that we are only in the early stages of understanding how the digital economy and the sharing economy can accommodate and deal with the issue of reputation to smooth transactions and maintain high levels of trust – without resorting to legal measures. We will return to this topic in Chapter 4.

2.5.7 Changing logic of ownership

While renting and owning are central parts of our economies, the logic of deciding between them is changing in favor of the former. The advantages of owning something are well known; the item is always there when you need it, no one else can tamper with it. But there have always been some disadvantages to ownership as well:

- Ownership ties up capital that might be more productive elsewhere
- Depreciation and the need for some kind of maintenance to reduce wear and tear
- Periods of idleness or underutilization

Digital technologies are making rental feasible for a great number of items that were previously impractical. All the arguments in the previous section about the *sharing economy* have a corresponding positive impetus for a shift in favor of more rental and less ownership for individual use. All sorts of items are now available for rent via digital technologies: cars (perhaps eventually the self-driving kind), clothes, tools, etc. While these have always existed, the scale may become more significant when the marginal cost of matching approaches zero.

Car ownership is an especially interesting area. Despite all the disadvantages of car ownership in terms of cost and maintenance, it is very widespread; many people want the freedom of having a car at their disposal despite ubiquitous traffic jams and the difficulty of finding parking in big cities. Might the sharing economy shift the calculus? Throw in a self-driving car that parks itself? It is hard to predict whether consumers will react to this with minor adjustments or if we will see major changes in behavior.

There is an instructive parallel between owning/renting on the one hand and firms choosing what to produce *in-house* on the other. The initial idea of Adam Smith's invisible hand was that of a huge number of single-producer firms selling goods or services; it was not until Ronald Coase (who later received the Nobel Prize in economics) published his theory on the firm that economists had an explanation for what should determine whether a firm buys a service on the market or performs it in-house; essentially, the firm itself *supersedes* the price mechanism when items are not traded and sold on an open market. When the marginal cost of in-house production is lower than buying from the outside, it makes sense to build the function in-house. For a discussion of Coase in the context of the sharing economy, see the Economist (2015b).

What factors influence the marginal cost of buying a service or renting something on the market? Or, in other words, what are the limits of the rental market? One factor often presented is that of transaction costs, see Williamson (1979), who quotes Stanley Fischer (then an academic, currently the vice-chair of the Federal Reserve):

> "Transaction costs have a well-deserved bad name as a theoretical device…because there is a suspicion that almost anything can be rationalized by invoking suitably specified transaction costs."

Whatever the merits of the transaction cost argument, digital technologies are reducing them. They are also making inroads on another problem with rental: that people tend to take less good care of items they rent rather than own (a classic principal-agent problem). This has hitherto presented an obstacle, though not an insurmountable one, to renting a spare room, the family car, or anything held to be close to the private domain. For example, how well will a renter take care of a sublet room or apartment? Typically, landlords ask for security deposits to cover risk of misuse and wear and tear. But digital technologies are giving renters and landlord more tools to *mitigate* this incentive problem. As discussed above, the possibility of rating *both* parties to a transaction establishes a reputation. The value of the reputation loss may be much worse in the digital economy and this may potentially resolve the problem of a broad but sweepingly unidentified transaction cost. Indeed, there are reports of people having a difficult time hailing an Uber car, likely due to poor ratings in previous transactions; see Streitfeld (2015b).

How much will the sharing economy grow and how much will rental increase compared to owning? While guesses abound in reports, there is little foundation for such forecasts and those that exist tend to be rather speculative. As consumers become more used to the sharing economy, the direction of growth is unquestioned but the speed and scope will depend on regulatory responses. Notably, the sharing economy has evolved from areas with large fixed costs, such as housing and cars, to other areas. But at some point it is likely that the marginal benefit of using sharing services will reach a plateau, not dissimilar to the argument made by Coase about the size of the firm with respect to deciding what to do in-house and what to outsource. People are unlikely to want to rent items that cost little and are used every day. The economy is now in a transition phase where producers and consumers are exploring the limits of sharing and where that new plateau might be.

Box 2.3 What is fintech?

"Silicon Valley is coming," wrote Jamie Dimon, head of *JP Morgan* in a recent letter to shareholders; see Dimon (2015). He was referring to the rise of peer-to-peer (P2P), peer-to-business (P2B) and other acronyms popping up like weeds to describe the services offered by platforms like *Funding Circle*, *Lending Club*, and *Prosper* (see "Box 2.2. A few firms in the sharing economy".[99] Stockholm has become a major hub of fintech in Europe, second only to London, with 18 percent of all European fintech investments amounting to $532 million during 2010-14.[100] Fintech is still small compared to volumes in global finance estimated at $4.7 trillion with profits of $470 billion; see the Economist (2015m). So far, P2P platforms have been issuing a comparatively small share of overall lending volume with about $10 billion in loans last year; see the Economist (2015l). But fintech is increasing rapidly, with the potential to disrupt the big banks – if they allow it.

Banking is particularly amenable to digitalization, as the main commodity is already represented by numbers. Fintech companies use digital platforms for all their activities, thus largely replacing physical bank branches with websites and cloud computing.

[99] For an overview of fintech, see, for example, Baeck et al. (2014), Morse (2015), and McKinsey (2015).

[100] See http://www.investstockholm.com/globalassets/2.-understartsidor-investment-opportunities/fintech/stockholm_fintech_report.pdf

Fintech thus has the potential to vastly increase the efficiency of matching available capital to entrepreneurs and households. A small firm or startup looking for modest amounts of capital to invest in new machines or to expand are able to directly reach investors via digital platforms with low transaction costs. Also, the digital process of vetting and due diligence on risk is often much quicker than the methods used by traditional banks, especially time-consuming face-to-face interviews. Also noteworthy is that the traditional bank's costs of doing due diligence on a small-to-medium loan are not appreciably lower than those associated with a large loan; see the Economist (2015k). Since small loans typically generate much less profit in relation to the time required to arrange them, they tend to be less attractive to the banks. The advent of fintech thus heralds potential improvement of capital availability in a market segment where it has been lacking while enhancing competition and efficiency at the same time.

Initially, fintech firms were catering to needs that were not being met by the banks, but that is beginning to change and they are beginning to compete with banks in other segments of the financial sector as well. In Sweden, *Klarna*, the electronic payments company, has recently applied to the Financial Supervisory Authority for a permit to offer banking services, such as issuing credit cards.

Banks weighed down by legacy IT systems with "spaghetti" complexity

Many traditional banks have old IT systems, so-called legacy systems, that have evolved over the years and successively patched and upgraded. Or as expressed by Francisco González, CEO of the Spanish financial services group BBVA: "...more spaghetti on the spaghetti," quoted in Arnold (2015). Another unflattering characterization is that "asset management [is] stuck in the digital Ice Age." See Grene (2015).

The software often uses old code written in *COBOL*, which makes upgrades to modern IT systems major undertakings replete with risks of faults and downtime that may be very costly. Moreover, the popularity of bank mergers also implies that many banks have several different IT systems with various degrees of compatibility issues. In theory, simply starting afresh with a new and modern IT system would be the obvious solution but this is not easy in practice: while getting the inventory of widgets in stock in a firm would be problematic, getting the numbers wrong in a bank could put the whole edifice at risk. For example, technology glitches at RBS caused 600,000 payments and direct debits to go "missing." See Arnold and Braithwaite (2015). A botched upgrade could have profound impact on reputation, which is especially serious in an area where trust is *sine qua non*.

Benefits

Digital technology can be deployed to make existing ways of providing finance more efficient. In a sense, fintech is democratizing finance, opening up more investment opportunities – and risk – to smaller players, such as "mom and pop" operations. A key benefit to the economy is catering to the segment of investment needs for small and medium sized enterprises (SMEs). While SMEs capital requirements are smaller, the time required to acquire capital from traditional banks may present a substantial hurdle. Fintech thus overall provides smoother functioning of capital needs and improve the capacity of SMEs to invest and grow. This should ultimately contribute to better productivity growth for the whole economy.

Digital technologies enable a myriad of new ways of providing capital and services:

- Virtual investment advice or "robo-advisers" can offer automated services at lower cost, 24/7, and in different languages; see for example Flood (2015). Clearly, building trust can be a challenge, but substantially lower fees could compensate for this, especially since the track record and quality of human investment advice is not held in universally high regard.
- Refinancing of loans to poor students based on future earnings potential calculated according to academic history; see the Economist (2015l, n).
- Extend credit to people with poor credit ratings based on guarantees from friends and family, thereby relying on potential social pressure to repay; see Economist (2015n).

- Searching vast amounts of unstructured financial data to detect fraud; see the Economist (2012a).
- Lending money based on assessments of creditworthiness derived from cash-flows, past bills, invoices, employment history, and social media history; see the Economist (2015n). Invoices issued to large corporations may as creditworthy as corporate bonds, see the Economist (2015k). Some lenders require intrusive monitoring of current accounts to monitor activity and substantial changes may trigger a new payment plan; see the Economist (2015n).

How threatened are traditional banks?

Banks make money on their net interest margins, charging fees for payments and services, and on the differential between buy and sell rates for currencies and financial instruments. Most of these are now subject to competition from fintech firms in one way or another. The effects on banks have been evident for some time, with continued reductions in employment as transactions and analysis migrate to digital platforms. In its latest Global Annual Banking Review for 2015, McKinsey (2015) emphasizes that cutting costs in banking is the main – if not the only – driver of profits.

While the competition is real, how large the threat is to traditional banks is an open question. Gapper (2014) argues that technology will hurt the banks, not kill them. One argument is that there are still barriers to competition on the core business of deposits and other highly regulated areas of finance, an area that is not profitable when interest rates are extremely low. The Economist (2015j) notes that banks may not be as incapable of change as claimed, noting that fintech firms have so far not broken into everyday banking, such as current accounts. In Sweden, the Financial Supervisory Authority has reassessed oversight and may require fintech firms to acquire permits as credit institutions with stricter requirements; see Wolf-Watz (2015). In Germany, new rules may stifle investments in crowdfunding because investors are required to issue a statement about their financial status for investments above €1,000 and these are only permitted if the investor has liquid assets in excess of €100,000 or monthly income of more than twice the amount invested; see Vasagar (2015b).

Risks

The rise of fintech is bringing a myriad of new interconnectedness into the economy and there is little data on – or understanding of – its size and magnitude. Individual fintech firms may have control over their own lending data, but loans and credits may be passed on to third parties – or along even longer chains. This could change the sensitivity to financial shocks in ways we do not yet fully understand. Notably, the effects on investors and consumer behavior have yet to be tested in a new downturn; see, for example, Skypala (2015). Moreover, it remains to be seen what will happen to profits in fintech when the current super-low interest environment ends and interest rates rise to historical levels.

These and other questions related to understanding the implications for monitoring financial stability are emerging. Tett (2015) argues that the elements of financial innovation, arbitrage, and cheap money in fintech bear some resemblance to events and actions leading up to the financial crisis in 2007; see also Gapper (2015). While the amount of loans is still small, the new tentacles are creating new interdependencies that may become systemically important; see Corkery (2015).

Another set of questions concern risks to low-income borrowers. Just as sub-prime borrowing allowed consumers to buy houses they essentially could not afford, fintech can provide easy credit in a matter of minutes to individuals that may be beyond their ability to repay, for example, in the event of unemployment. With interest-on-interest accumulation on bad loans, the situation may quickly become untenable, especially for people who have accumulated several loans or who take out new loans to finance repayments of old ones; see Corkery (2015).

2.6 Output gap and sustainability

2.6.1 Misidentifying potential GDP, missteps in policy?

No one quite knows what potential GDP is, but it is used a lot in forecasting. To be fair, the difficulties with potential GDP are well known and recognized; few use the concept without caveats and other supporting statistics. It is typically thought of as the level of GDP where inflation pressures are neutral or, for inflation-targeting central banks such as the Riksbank and the Bank of England, the level of GDP consistent with being on the inflation target.

But what does it have to do with digitalization? Arguably, it is becoming increasingly important. It is typically not potential GDP directly that is used by central banks, governments, and forecasting institutions, but rather the difference between potential and actual GDP – the output gap. The output gap is a measure of the degree of resource utilization in the economy: being below the potential implies that there are free resources available and vice versa. This matters because in the conceptual framework of stabilization policy, being below potential GDP typically implies that inflation pressures are weak and monetary policy can be expansionary (i.e. low interest rates); conversely, if the economy is above potential, resources are being well utilized and inflation pressures may be building up, an argument for the central bank to have more restrictive monetary policy (i.e. higher interest rates).

What, then, is the connection to digitalization? In this chapter we have set out arguments for how the economy is subject to more competition, works faster and more efficiently, and more goods reach more people at lower cost. These are all factors that pertain to supply side efficiency. In some cases, we get better utilization of existing resources and in other cases, productivity may rise.

Methods to calculate potential GDP

Before discussing the detection of structural shifts in potential GDP driven by digitalization, it is instructive to first review methods used to calculate the measure. There are three main approaches, all with various strengths and weaknesses: the production function approach, the unobserved components approach, and pure statistical filtering (such as the HP filter). All the methods use historical data to estimate potential GDP but they differ in how much economic theory they impose; pure filtering techniques typically use no theory at all, but instead just smooth fluctuations and essentially draw a trend line through GDP, thereby creating the business cycle.

It is well known that GDP – and hence potential GDP – is measured with considerable uncertainty; see for example Orphanides and van Norden (2002), Sometimes, revised statistics can radically change the position in which the economy was thought to be several years hence. It is also known that some measures, such as the HP filter, are the most inaccurate for the start and end points in the series, where arguably interest is the strongest.

Structural shifts in potential GDP?

If indeed structural change in potential GPD is underway, what would it look like? The most helpful structural change is of course a big spike from one year to the next, clearly observable from an identifiable event. For example, for variables such as Foreign Direct Investments (FDI), at least for small countries, big shifts can often be attributed to single events, such as a merger or relocation of corporate headquarters, and so on.

No such easy visual clue exists for GDP and digitalization. A shift induced by digitalization is likely to be gradual and last a long time, perhaps decades. There are also issues with measurement; see Coyle (2015). As production using digital techniques continues to improve efficiency in the economy, there may well be improvements from year to year that are very difficult to detect, given the considerable uncertainty that already surrounds GDP measurement. Even small improvements by one tenth of a percentage point of GDP – or small multiples thereof – is a substantial shift but is dwarfed by measurement uncertainty. One conclusion from this is that policy analysis needs to pay particular attention to other sources of information about shifts in potential GDP to make an informed judgment about the effects of digitalization. When it comes to effects on inflation, however, there are some further issues involved, which are discussed in the penultimate section of this chapter.

2.6.2 Digitalization and sustainability

The idea of using resources more efficiently is closely linked to the idea of sustainability in a broader sense – especially for the climate and for population growth. If the same welfare and consumption can be obtained through better use of existing resources, this should improve prospects for sustainability. Digitalization has perhaps most environmental impact if it can lead to more efficient transportation and less waste in travel. Truckmakers, like Volvo and Scania in Sweden, are exploring ways to have several trucks driven in a convoy with minimum distance between each, thus reducing air resistance to all but the first truck in the line, potentially leading to substantial fuel savings. Intelligent traffic lights and other infrastructure that help cars and trucks maintain a steady speed may also reduce fuel consumption.

The sharing economy is also associated with better use of resources, especially when pockets of idle resources are put to use. For example, when fewer seats are left empty in cars less carbon is used per passenger; intelligent software can improve traffic flows and public transport and so on.

It is thus tempting to think that there might be a one-to-one correspondence between the rise of the sharing economy through digital services that improve efficiency and other goals of sustainable climate change. While some contribution by digitalization to ameliorating climate change is likely, the effect may not be quite so simple and there may be forces moving in the opposite direction. Economists have long discussed the effects of price changes in terms of substitution and income effects. In this context, the implication could be that better use of existing resources leads to spare resources at given consumption levels, which can translate either into higher savings or investment but could just as well translate into higher consumption. Suppose, for example, that a household saves money by renting out a spare room. This money can of course be used for whatever purpose, including higher consumption of energy, for example.

Thus, the effects on the environment from better use of existing resources are ambiguous. But even if all of the gain is used for consumption, this may bring considerable benefits. Notably, lower income families will also be able to enjoy a higher standard of living due to better availability of cheap goods and services. For example, Fraiberger and Sundararajan (2015) use a model to estimate the benefits of peer-to-peer (P2P) rental for cars and find a significant shift away from ownership to rental. Their results indicate that consumption shifts are more significant for below- median income users, to whom most of the consumer surplus also accrues. Or put differently, those with lower incomes can benefit more from the sharing economy because spending less money makes for the possibility of a better consumption bundle.

While this result is based on estimates from P2P rental of cars, it is likely that the larger welfare effects for low income groups holds much more broadly when it comes to consumption. Many more people will be able to afford to buy services that were hitherto the province of high income earners, or as expressed by Hal Varian, chief economist at Google: "A simple way to forecast the future is to look at what rich people have today," quoted in McAfee (2015). Of course, higher consumption is only one aspect of economic wellbeing and the overall result also hinges on how the labor market adapts, the topic of Chapter 3.

2.7 Can digitalization explain flatline inflation?

Inflation may be affected by a host of factors, all from oil shocks and the price of coffee to wage setting in the labor market. It is beyond the scope of this report to discuss all of these issues. Instead, we will outline how digitalization may be contribute to low inflation. Can a mismeasured output gap, discussed above, in conjunction with more price competition explain how inflation has flatlined in Sweden and other countries despite the efforts of the central banks to kick-start the economy with quantitative easing and negative interest rates?

Breman and Felländer (2014) argue that a fair share of the Swedish consumer basket, about 37 percent, is either directly or indirectly affected by digitalization. Apel et al. (2014) find some support for a structural shift in how firms set prices. In its monetary policy reports from February this year, the Riksbank posited low capacity utilization as a main explanation, along with the effects of import prices and exchange rates. In the June report, the Riksbank emphasized that prices of domestic goods and services are rising and that resource utilization is beginning to increase.

The Riksbank also discussed factors other than macro. Jonsson (2007) discusses increased competition and inflation. The possible channels through which digitalization is affecting the economy are outlined in the February 2015 report; some of the micro factors discussed in this chapter are illustrated among these. Moreover, the Riksbank mentions the possibility that structural change and technological unemployment will constrain wage growth and hence inflation. One particular channel is through e-commerce and greater price transparency holding back inflation. The European Central Bank, on the other hand, discusses the effect of e-commerce on euro area data and finds only limited evidence of price effects (Monthly Bulletin, Feb 2015). But, as for Sweden, durable goods have declined in the last ten years, especially due to competition in electronics.

These are useful first steps in the analysis but they miss the broader picture. Overall, what we are seeing is many markets undergoing microeconomic improvements that, as a whole, are changing how the whole economy behaves: microeconomic changes are having macroeconomic impact. In this chapter, we have discussed the range of ways in which the economy is becoming more efficient: digital technologies are improving the match of supply and demand in product and labor markets; price comparisons and transparency are changing the way consumers consume. Demand for labor is probably also changing, with more demand for special skills.

More efficiency in matching supply and demand can raise potential growth, as does lower capital needed to start firms. But better use of existing resources can also give lower inflation impulses at the same level of resource utilization. In some cases, for example with carsharing, the need to own a car declines and hence one effect may be to dampen consumption of durable goods. Depending on what happens with the

resulting higher disposable income, the effects on GDP can be different. If consumers use the freed resources to buy other goods and services, the overall effects may be neutral; but if they use some part to increase savings, growth may be dampened from the demand side.

The supply-side effects of digitalization increase the efficiency of production but the speed of the improvement depends on a variety of regulatory and institutional obstacles. It is likely that digitalization will improve productivity growth but the effects may take long time to materialize, especially in light of the known dampening macro trends on growth discussed in Chapter 1. How much of the micro changes from digitalization can explain inflation is an empirical question that has received too little focus from central banks. Indeed, the microeconomic changes are largely absent from the typical macro models used by central banks and this is a serious omission in times of rapid technological change.

2.8 Summary

Digitalization is bringing a microeconomic revolution to the economy. Some of the changes are fast, notably those that are consumer-driven. Other changes are subtler, especially those related to resource utilization. Technological improvements have been a recurrent theme since the Industrial Revolution and the changes have had huge impact on living standards and welfare. While the changes now underway are not as fundamental as during the Industrial Revolution, they are affecting several sectors within a compressed period of time. They have the potential to improve productivity growth against the known macroeconomic headwinds of demography and high public debt.

In this chapter we have also explored how digitalization can affect capacity utilization, a concept that underpins a great deal of the work of forecasting and simulations carried out by policy institutions. The effects discussed here are of a qualitative nature, but a lot more work needs to be done to understand and estimate the size of the changes already in motion. Even small changes on the order of one, or even a few tenths of one, percentage point on GDP growth may be significant and can alter policy conclusions. The challenge is compounded by measurement in official statistics. As goods are becoming digital services and many popular digital services are free or available at low cost, the uncertainty surrounding estimates of inflation and GDP is becoming more serious.

Digitalization is changing the way the economy works by reducing frictions, improving knowledge transfer, and reducing the required capital needed to start companies. It also changes how business is conducted and the nature of competition. But while competition is increasing on many fronts, we are also seeing the rise of companies with near-monopoly power due to rapid expansion with network effects, putting a new face on challenges for competition policy and regulation. Current regulation has evolved over the years in an analog world and need to be updated. Indeed, how well we are able to benefit from digitalization will to largely depend on how regulation tackles these challenges (further discussed in Chapter 4). The sharing economy is an especially big shift and may have wide-ranging implications for how we buy goods and services. It may also have profound implications for employment and increase the prevalence of self-employment in the economy (discussed in Chapters 3 and 5). Moreover, with the expansion of the sharing economy, the pros and cons of owning vs renting may shift dramatically. We are now only embarking on the process of understanding how far-reaching these changes will be.

3. Implications for the labor market

"I've come down in the world." Mr. Molesley in the TV series Downtown Abbey

3.1 Introduction

In *Thinking Fast and Thinking Slow* by Daniel Kahneman, a main theme is how two parts of the brain interact with each other to perform different functions. The first part is autonomous, governing functions such as walking, face recognition, and other things that we do mostly effortlessly; the other part is the analytical one that requires conscious effort from the brain. With some oversimplification, computers and robots are good at the latter but bad at the former, while for humans, it is the reverse. These two worlds are increasingly colliding and causing frictions. And it is occurring not in a dramatic Hollywood fashion but affecting everyday work in broad sectors of the economy – ranging from manufacturing to legal research and creative writing. Does this mean that the robots are taking over our jobs?

One conclusion to emerge is that the last few centuries of technological change have not, in fact, led to mass unemployment; that is, technological change has been neutral for the amount of work in the economy in the long run. Moreover, as emphasized in Autor (2014), there is evidence for complementarity between machines and human work, especially in the latter half of the 20th century: machines are improving worker productivity rather than reducing the total amount of human work. But, as we will explore in this chapter, there are some compelling arguments for why this might not be sustained during a period of transition in the coming years, looking one to two decades ahead.

Even though long-run neutrality for technology and jobs is a reasonable starting position, it is *not* a law that holds true under all circumstances, especially not in the short to medium run. There are two reasons to be concerned about the pace of automation and its effects on labor:

- Digitalization has broad effects on virtually all sectors at roughly the *same* time
- The changes today are much faster the previously technological disruptions

The first point makes digitalization different from previous periods of structural change. The market economy is quite capable of shifting resources from waning sectors to waxing sectors but the challenge is greater when the driving force affects most of the economy virtually simultaneously.

The multi-shock challenge is compounded by the high speed of technological dispersion, currently much faster than previous technological disruptions, as illustrated in Figures 2.1 and 2.2 in Chapter 2. It is not that Adam Smith's invisible hand has stopped working but rather that the labor market and our institutions may be too slow to adapt due to various frictions. The effects of digitalization on the labor market over decades may be quite dramatic even if the year-on-year changes are small. It is difficult to predict the magnitude of the effects, but they are likely to depend on how firms respond and on how political institutions adapt. A "muddling through," or even worse, protectionist response may increase the risk for a prolonged period of bad labor market outcomes.

It may be worthwhile to recall that the Industrial Revolution contained episodes of difficult adjustment. People had to adapt or be impoverished, especially without the social welfare protection that is available today. As emphasized by Mokyr (2004), "*Life did not improve all that much between 1750 and 1850.*" Mr. Molesley, the fictional character in the TV series *Downtown Abbey* set in the early 20th century, finds his job as footman gradually eroded in pay and status. The modern equivalent of this could well happen to professionals, office workers, and skilled labor. As elucidated by McAfee and Brynjolfsson, there has never been a better time than the Digital Age to be a worker with special technological skills, but it is not such a great time to have ordinary skills, quoted in Bernstein and Raman (2015). Ford (2015a) and Cowen (2015) make similar points and argue that weak wage growth for large groups in the US is only the beginning of wage polarization in the labor market. Susskind and Susskind (2015) go even further and argue that technology will imply an end to the professions as we know them, as new digital tools will be able to more cheaply incorporate expert skills in law, medicine, architecture, etc.

In this chapter, we first discuss how the Swedish economy has coped with structural change in the past. We then draw on the academic literature on the effects of technology on jobs. Next, we turn our attention to advances in robotics and the implications for the labor market, especially the way robotics may affect the amount of human labor. We examine the literature that predicts that a large share of current jobs may be automated through digitalization, notably Frey and Osborne (2013). While the results are intriguing, the risk that particular professions may be automated may distract from a more pertinent question. The issue is rather how to design policies that make the consequences of structural change as *unrugged* as possible without damaging productivity growth. More specifically, there is a challenge in improving conditions in the private sector to ease job creation, a topic we also return to in the last chapter.

Indeed, it is crucial to look at *both* job destruction and creation in the labor market, not just the former as in Frey and Osborne (2013). We draw on new developments in robotics and software automation to discuss features that are likely to affect the impact on the labor market that have not received much attention to date – a more holistic approach. We then show that some professions that might, according to previous estimates, have diminished have in fact increased. Other forces, such as demographics, demand, and profitability can be crucial. Even if digitalization is one strong driving force in the economy, it is not the only one.

We also highlight some aspects of the ongoing technological change that are particularly relevant for small, open economies. While the automation of manual work may easily spread from the US to other countries, the same may not hold true for certain non-manual work, such as business analysis, legal research, and journalism, that are increasingly being automated in the US. The potential gain of automation may be muted in smaller countries because smaller scale weakens network effects. Or, in other words, the automation of work done in the English language is going to be stronger due to its bigger scale.

For all these reasons, the US is likely to be far ahead in automation for non-manual work. Moreover, in areas where institutional features are important, such as law, automation software from the US will also not translate directly. But it would likely be wrong to conclude that small countries are safe from automation. A more constructive view is that there are opportunities for entrepreneurs to find clever ways to handle idiosyncrasies and language in smaller countries and not wait to be swooped up by a big (US) platform, a point we discuss in Section 3.4.

3.2 Lesson from previous periods of structural change in Sweden

The models, empirical work, and statistical analysis of how jobs may be automated, or how humans and new technology can complement each other are somewhat limited, because the period we know most about, the latter half of the 20th century and onwards, is relatively short. It may very well be somewhat special too, in that is dominated by increased demand for skills arising from technological change.

In this section, we draw on lessons from economic history to give a broad picture of structural change and its implications, at the expense of being somewhat less empirically precise. This sets the stage for the next section, where we review the academic literature on jobs and technology.

In addition to reviewing broad changes in this section, we also examine the specific experiences from periods of major upheaval, or job destruction, to draw some lessons that may be applicable in the future. In particular, we discuss the experiences of the slow erosion in textile production as well as the more dramatic implosion of the shipbuilding industry. The reason for selecting these two sectors is twofold. First, they constitute major changes within their respective sectors, the most significant disruptions in the Swedish economy in the 20th century. Second, they illustrate paths of disruption – one fast and one slow – that span the space of possible outcomes but with the significant difference that digitalization is set to be much broader in scope and to affect several sectors at the same time. Or put differently, it is worthwhile to learn from all periods of structural change and determine what aspects may be relevant to how we adjust to digitalization.

It is worthwhile to stress that Sweden has a long tradition as a small, open economy with significant trade. Schön (2014) paints a picture of a trading nation going through waves of technical change and being subjected to fluctuations driven by external shocks, such as development in raw materials. From the 1950s, Sweden did rather well and developed heavy industries and manufacturing multinationals, notably Atlas Copco, Alfa Laval, Brown Bovery (later ABB), Ericsson, Volvo, and Saab, to name a few.

3.2.1 Electricity adoption disrupted jobs

Electricity is a general technology that impacted on all aspects of the economy, and therefore may contain information as to what we might expect from digitalization. Barroso Morin (2014a) uses a newly digitized dataset for the concrete industry from 1929–1935 in the US and finds that electricity adoption did induce a shift away from labor. If this holds true for electricity, it may be even more so for computers, also an all-purpose technology. Indeed, Edquist and Henrekson (2006) argue that ICT is the only all-purpose technology that has increasing returns to scale, due to Moore's law. Moreover, Barroso Morin (2014a) also shows that the labor share of income declines and there is some evidence for jobless recovery in the US.

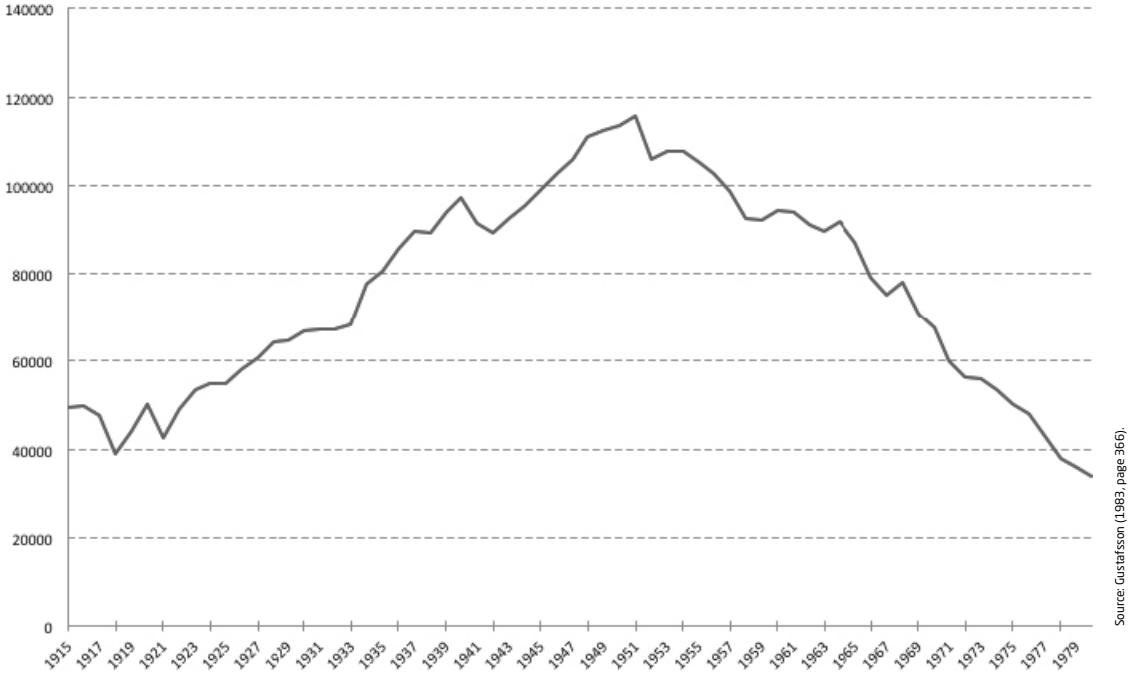
More research is needed to better understand the extent to which the result is applicable in a broader context and over longer time periods. The effects of electricity in the last century were fundamental and occurred over a long period of time. As we discussed in Chapter 2, the speed of digitalization is an argument that supports larger effects than from other technological advances, including that of electricity.

3.2.2 Slow decline in textiles in Sweden

The textile industry is one example of a prolonged decline and may be relevant to other industries exposed to global competition or disruption from new technology. At

the outset, the textile industry was fairly sizeable. Employment in the Swedish textile industry rose fairly steadily from the beginning of the 20th century and reached its peak in the 1950s at around 115,000 workers, see Figure 3.1. In terms of total private-sector industry, textiles accounted for about 15 percent in the 1950s, see SIND (1991) and Gustafsson (1983).

Figure 3.1. Employment in the Swedish textile industry 1915-1980



Source: Gustafsson (1983, page 366).

From the 1950s, due to strong competition from abroad, textile production was put under pressure and declined fairly steadily. For some communities, the changes were rather drastic but these changes are not well documented and thus mainly anecdotal. Many of those employed were women, for whom employment opportunities in other industries were likely limited at the time. In 1989, only about 20,000 or 2 percent of the total manufacturing jobs were in textiles.

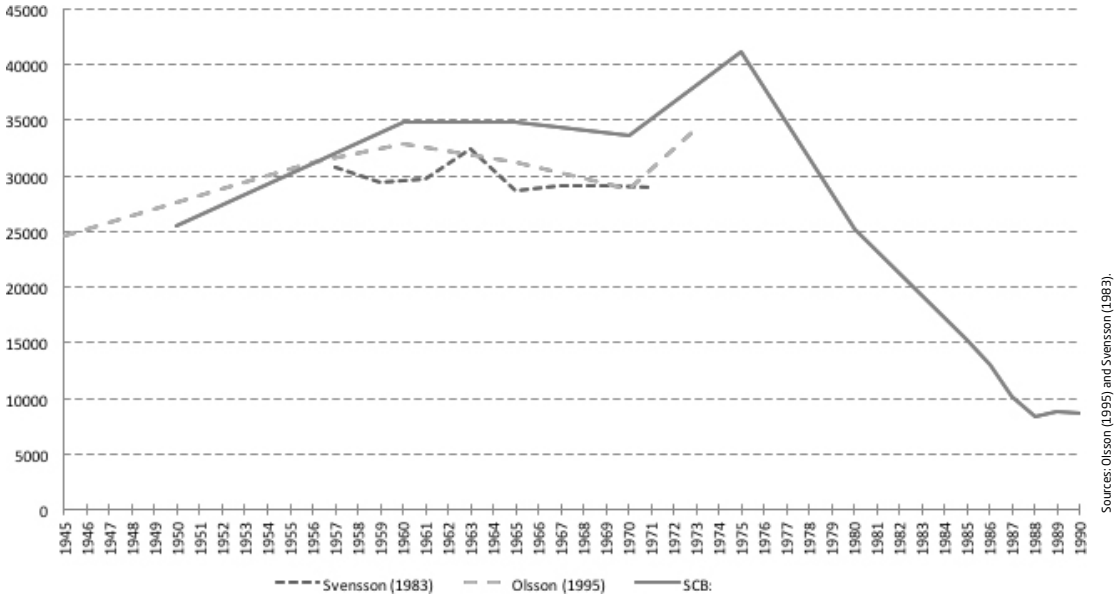
Unlike the experience from the decline in textile production, digitalization will likely allow a relatively short time to manage adjustment.

3.2.3 The Swedish shipbuilding crisis of 1975-1982

The latter half of the 1970s turned out to be a period of crisis and decline for the Swedish economy. A series of political choices led to lack of fiscal discipline and tensions in the labor markets, all aggravated by inflation from high oil prices. Mining, paper, and steel mills were affected, drastically reducing the demand for iron ore. But in terms of severity, the downturn in the shipbuilding industry was unprecedented in Swedish history; see Schön (2014) and Magnusson (2014). In a few short years, 1974–1977, the value of the shipbuilding industry was cut in half. At its peak in the mid-1970s, shipbuilding employed about 40,000 people, see Figure 3.2.

At its peak in the mid-1970s, shipbuilding accounted for about 1.6 percent of the total private sector, a share that continued to fall up until the 1990s when it accounted for about 0.3 percent. While one should be careful in comparing timelines, the adjustment in the textile industry occurred over roughly three decades, while the decline of shipbuilding was much more compressed, over a period of roughly 15 years.

Figure 3.2. Employment in Swedish shipbuilding 1945-1990



Note: There are some minor differences in definitions, for explanations see respective source.

Sweden was not the only country in crisis in the end of the 1970s. The UK also experienced a period of decline, with unrest and strikes in the mining industry. The response of the Swedish authorities was different from elsewhere in Europe, notably Germany and France. In Sweden, the government assumed ownership of shipbuilding companies, thus prolonging the period of painful adjustment and incurring considerable losses for the taxpayers. In other countries, prices in declining industries were sometimes subsidized instead; see Schön (2014).

We cannot know what would have happened without government nationalization, but swifter bankruptcy seems a likely scenario.

3.2.4 Experiences from larger disruptions at the firm level

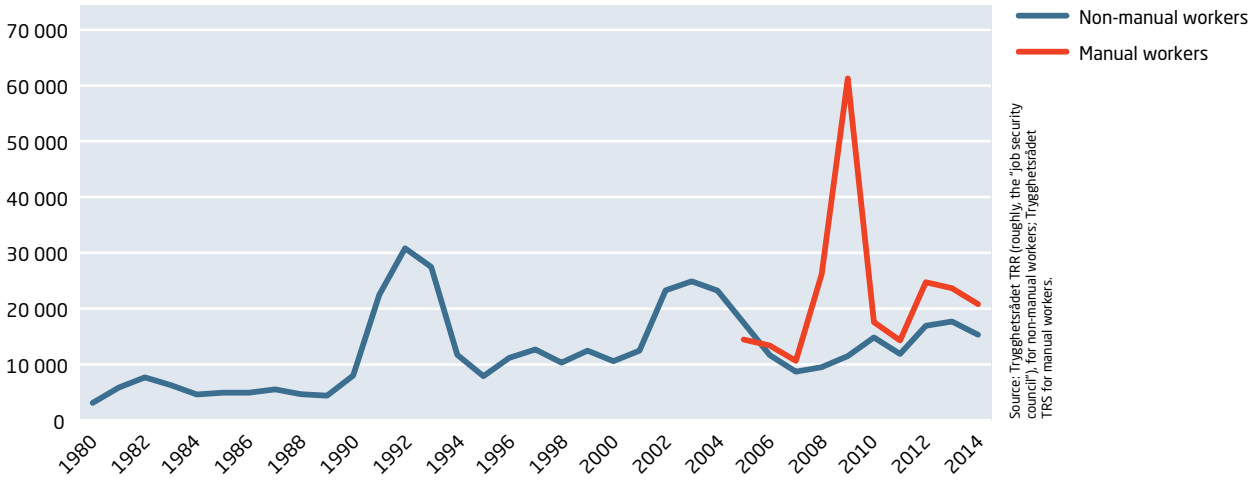
It is instructive to review major events in Swedish corporate history to discern the economy's capacity for structural change, regardless of whether or not developments were directly related to digitalization. Big events can tell us how workers are absorbed by the same sector or how they move to another area. In this regard, one of the largest defaults in modern times is the one that of the automaker Saab in December 2011. The company had been making losses for a long time, had changed owners, and had tried various ways to restructure.

Although the end of Saab should not have been a surprise due its lossmaking and against the backdrop of global overcapacity in the auto industry, for many people it was; see TRR (2014). The default was a major event with 3,300 jobs lost in the city of Trollhättan, with a population of about 56,000. Despite the scale of the job losses, most of the people affected found new employment. Assisted by *Trygghetsrådet*[101], within a two year period, 91 percent of non-manual workers found new work, 4 percent started new companies, 4 percent went back to school, and 1 percent chose to exit the program. Of those gaining new employment, about 4 out of 5 got the same or higher pay; see TRR (2014).

[101] Trygghetsrådet is a non-profit foundation owned by labor market partners and helps displaced non-manual workers find new jobs.

Another major event in Sweden was the decision of pharmaceutical giant Astra Zeneca to eliminate research activities in Södertälje in February 2012. Most of the people affected were highly skilled workers and within a two-year period most, about 85 percent, found new jobs afterwards, although only about 55 percent of those workers received the same or higher pay; see TRR (2015). The examples of Saab and Astra Zeneca illustrate how the labor market manages to adjust to large firm-specific shocks. Figure 3.3 illustrates the general trend for numbers of displaced workers. Prior to the 1980s, non-manual workers in Sweden were rarely laid off, a trend that changed thereafter.

Figure 3.3. Workers losing jobs



Note: no statistics are available for manual workers prior to 2004. The diagram shows only people who were eligible for TRR or TRS and not all redundant workers.

3.2.5 Structural change 1970–2012, overall changes in employment

In the 1970s, the agricultural sector had already undergone radical decline, see Table 3.1, but it would shrink still further by nearly 5 percentage points as a share of overall employment until 2012. The most noteworthy change over this period is the decline of employment within the industrial sector by about 10 percentage points. Unpaid work in households also declined, as more women entered the labor force.

Table 3.1. Overall changes in employment, Sweden

Sector	Share 1971/75	Share 1991/95	Share 2008/12
Agriculture	7.1	3.9	2.5
Industry	28.5	20.5	18.8
Construction	8.6	6.1	6.9
Transport	6.6	7.0	7.3
Trade	15.5	15.3	13.3
Other private services	9.7	13.8	22.8
Public sector	24.0	33.4	28.5
Total	100	100	100
Paid work	74.8	85	-
Unpaid household	25.2	15	-
Total	100	100	-

Source: Schön (2014).

Better data is available for later periods. In a comprehensive study of the Swedish labor market, Heyman et al. (2013) investigate job flows using micro data. They find that 190,000 new jobs were created in the period of 1990–2009, with a net result of about 3.4 million jobs created against 3.2 million jobs destroyed. In an average year, about one-fifth of all jobs in the labor market were turned over, giving some indication of the Swedish economy's ability to adjust to changing demand and new technologies. Most of the jobs were created in the service sector, while the manufacturing industry exhibited a decline in employment. In a study of job reallocation in Swedish manufacturing during 1972–1998, Andersson (1999) finds considerable flows. But there are periods of large scale movement hidden behind the smaller average change. There is also evidence that most of the reallocation occurred within narrowly defined sectors within manufacturing.

Some other trends during those years are also worthwhile to highlight. Small and medium size enterprises accounted for most of the new jobs while large companies tended to reduce the size of their workforce, especially during the crisis in the 1990s. During these years, educational requirements increased and the number of people without high school diplomas (secondary school leaving certificates) decreased by about half; see Heyman et al. (2013). Thus, the demand for skilled labor increased.

3.2.6 Empirical estimates for risk of automation

A new branch of the literature tries to estimate the probability that some tasks will be automated and hence the likelihood of jobs disappearing. In this research agenda, jobs are assessed according to tasks, whether requiring mainly creative, repetitive, empathetic, or cognitive skills. Using statistical techniques in static context, the headline numbers indicate the probability that a robot or a computer may replace a human.

Frey and Osborne (2013) have received much attention for their paper, in which they assess that almost half of the jobs in the US today may be automated in the not too distant future, the next two decades or so; for the UK, the figure is somewhat lower at about 35 percent, see Knowles-Cutler et al. (2014); for Sweden, slightly over half the jobs are subject to automation, according to Fölster (2014) who uses similar methods but different data. Also based on Swedish data, Heyman et al. (2015) estimate that about 40 percent of the total workforce are in the high risk category, about 50 percent for the private sector, a result similar to the Frey and Osborne (2013).

Apart from the headline result that almost half of US jobs may be automated in the near future, Frey and Osborne (2013) also give detailed probabilities for each profession. They identify 117 out of 702 professions as having above 90 percent chance of automation, among them fashion models, library technicians, telemarketers, paralegals, and manicurists. Heyman et al. (2015) identify 14 such professions out of 114 Swedish occupations, including fashion models, numerical, library, and filing clerks, shop and stall salespersons, and assemblers.

These models provide one way to address the risk of automation that is based on assessing the task according to categories but this is only a *partial* view of how automation may proceed. In Section 3.4.3 below we will discuss other factors that may be just as important, notably demography, regulation, and the costs of automation compared to human labor. Moreover, the analysis focuses only on job destruction even though we know from experience that new jobs are created all the time as a result of new technology and changing demand. For instance, personal trainers, professional computer gamers, hackers-cum-data-security engineers are all jobs that, not so very long ago, were either non-existent or very few in number.

On a methodological note, the assessed risks of automation are forced into fairly uniform slots on the number line between 0 and 1. For example, in Frey and Osborne (2013), we find probabilities such as 0.98, 0.98,...,0.99 in neat order. But the ordering is purely a result of distributional assumptions. If indeed there were objective probabilities of automation, based on all factors that mattered, there is no inherent reason for them to be ordered nicely.[102] Thus, there is no basis for making comparisons between professions that are close to each other in terms of probability of automation.

Evidence of effects of digitalization and automation but other factors matter too

The labor market is in constant flux, with employment increasing in some professions and decreasing in others. The reasons are sometimes complex, other times easier to isolate. The effects of digitalization are among the more complicated. We know that digitalization has caused disruption in photography, music, movies, and the publishing businesses, but more gradual changes can also be discerned. For example, when older workers retire, firms sometimes use these opportunities to change work processes rather than replicating previous methods. This implies that the effects of digitalization on the demand for labor might also come gradually, especially in mature industries and services. But which effect will dominate?

In order to illustrate how specific professions are changing, we have used data from Statistics Sweden with three-digit classification covering the period 2001–2013[103]. This period covers the aftermath of the dotcom bubble at the turn of the century and a few years of high productivity growth. It also encompasses the recent financial crisis. Moreover, some professions are small in terms of total employment, and so changes in percentage terms can be very large. For all these reasons, it is important to be careful when drawing inferences from the data.

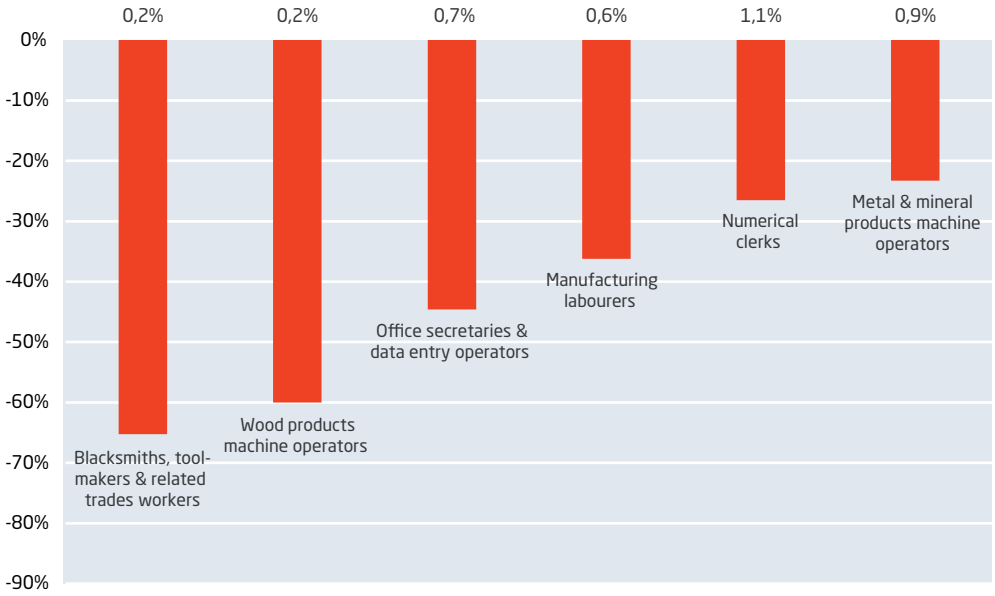
A question of particular interest is in which professions employment have changed the most over this time period, as this can give an indication of the broader changes in the labor market, some of which stem from digitalization. In Figure 3.4 we illustrate the six occupations that have decreased the most in absolute numbers of workers employed; shares of total employment for each are displayed above the bars. The biggest decreases have occurred for blacksmiths and toolmakers, a decline of two-thirds over the whole period, from 25,869 to 8,995 workers with a share of total employment in 2013 of about 0.2 percent. In all likelihood, this change is due to other changes in the labor market. The decline in machine operators in the wood products and metalworking industries may be due to changes in global and domestic demand as well as the perennial drive for productivity growth in manufacturing, some of which is probably related to increased use of robots and machines. But the decline in "manufacturing laborers" may be related to increased use of robots. The decline is also consistent with the high risk of automation estimated in Heyman et al. (2015) that we discuss more fully later in this chapter.

Office secretaries, data entry operators, and numerical clerks have been more directly influenced by digitalization, declining by almost half and just over one-fourth, respectively, during the period 2001–2013, each representing roughly one percent of total employment. These are the occupations that should decline even more according to the probability assessments in Frey and Osborne (2013). It could well be that most of the decline has already occurred and that further changes will be slower in the making.

[102] We would see probabilities such as 0.45, 0.57, and 0.83 with various forms of discrete jumps between different professions.

[103] It would be not appropriate to focus only on sectors that are dominated by digital platforms, as those account only for a small part of the economy.

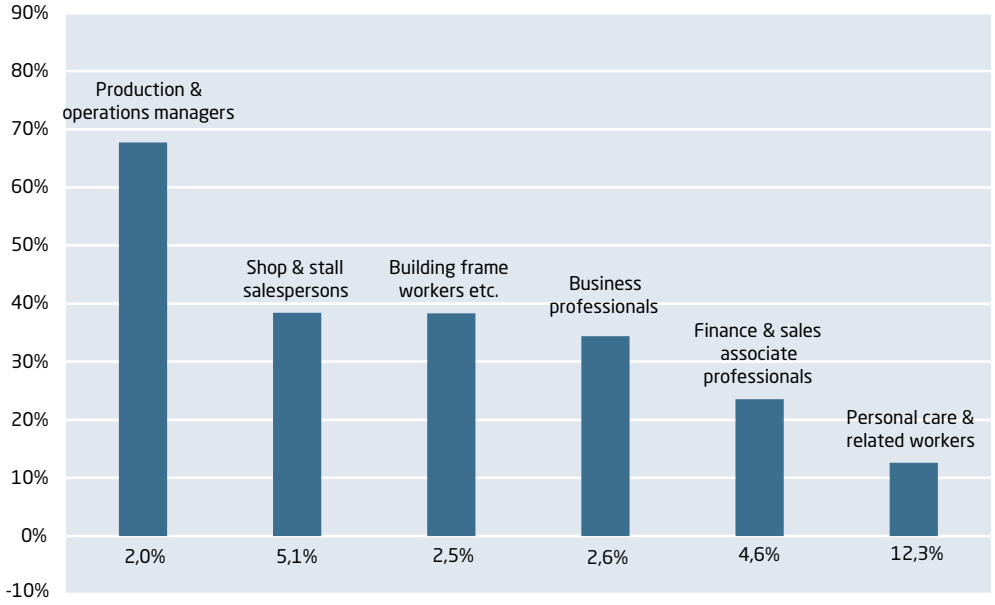
Figure 3.4. Occupations in Sweden that have decreased the most, 2001-2013, percent



Note: Bars show percentage change from 2001 to 2013 in the occupations that have decreased the most in absolute numbers. The numbers above the bar represent the size of the occupation as a share of all workers employed in 2013. Own calculations. Source: Statistics Sweden.

The occupations that have increased the most in absolute numbers are displayed in Figure 3.5. Due to its size, with more than 12 percent of total employment, the increase in the sector for personal care and related workers is significant (and does not include the more modest increase in qualified nurses of about 16 percent with a share of employment just below two percent). Here, the driving forces are most likely demography and increased demand for health care as incomes rise. It cannot be ruled out that digitalization has dented the increase in health care employment but the overriding conclusion is that other factors may at times be much more important than technology.

Figure 3.5. Occupations in Sweden that have increased the most, 2001-2013, percent



Source: Statistics Sweden.

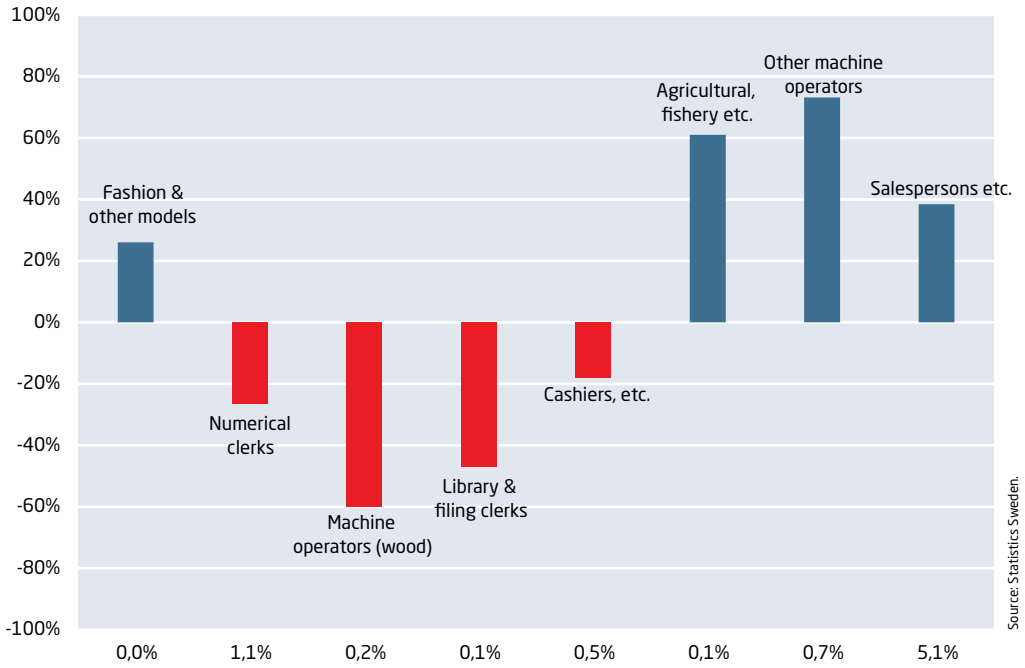
Note: Bars show percentage change from 2001 to 2013 in those professions that have increased the most in absolute numbers. The numbers below the bar represent the size of the profession as share of all employed 2013.

Rather significant increases in IT professionals occurred during 2001–2013, where computing professionals and associated computing specialists increased by (not displayed) 34 and 22 percent respectively.

It is noteworthy that the number of business professionals increased during this period, a trend that might be reversed if some of these functions are taken over by software, as discussed above. Another occupation that has increased against the tide of automation is shop and stall salespersons – retail workers. Selling via digital platforms like Amazon, provides pressure towards fewer workers but the increase might reflect the changing nature of such jobs, for example, upskilling in the way that the invention of automatic tellers actually led to demand for higher skilled bank staff; see for example Bessen (2015). Production and operations managers represent 2 percent of employment in 2013 and the occupation has increased over the whole period, which is consistent with a low chance of automation in Heyman et al. (2015a).

What happens if we compare the probability of automation from Heyman et al. (2015a) with the trend in data since 2001? While these probabilities should be seen from a forward-looking perspective it stands to reason that we might find some evidence already in the data for the last decade. In Figure 3.6, we use the estimations from Heyman et al. (2015a) to select the occupations that have a higher than 90 percent chance of automation. As can be seen, the picture is a bit mixed. Fashion and other models are supposed to be among those in high risk and yet the occupation's share of total employment is virtually unchanged, albeit a very small group. One explanation for this pattern is outlined in "Box 3.2. Demand related issues", namely that demand for the profession prefers real people, perhaps because they are deemed more effective in generating interest in the products they showcase.

Figure 3.6 Change in employment, occupations with high risk of automation, 2001-2013



Note: The occupations selected are those from Heyman et al. (2015a) that have a higher than 90 percent chance of automation within the next decades. For each, we compute its share as a percentage of total employment and calculate the change over the whole period, 2001-2013. The red bars are consistent with declining employment shares while the blue bars denote increases in employment shares, thus illustrating that other forces can be more important than the technical possibility of automation. Own calculations.

Three other occupations at high risk have actually increased over the period: agricultural workers, machine operators, and salespersons. But library and filing clerks have decreased, as one would expect. While the figure gives broad support to probable effects of digitalization it also clear that there are other changes that may explain these changing shares, which may have little to do with computers or robots, such as aging populations and changes in demand as incomes go up. It is a mistake to consider digitalization as the only force that matters.

What can we learn from past periods of structural change?

Two features stand out from the foregoing discussion. First, the economy is always undergoing changes. Second, there are periods of rapid change, often caused by external events, such as new technology, changes in demand, or fluctuations in prices of raw materials. For example, the Swedish mining industry is sensitive to world prices of minerals. If you take a walk in the countryside, you are likely to stumble across an abandoned mine that has become unprofitable due to declining prices of minerals or raw materials in world markets.

Most economists would agree that the economy is resilient and adaptable. To be sure, some of the periods involved difficult times, but the economy as an aggregate is able to shift workers from one sector to another. Hall and Krueger (2015) argue that the sharing economy may provide a cushioning role by easing the transition from different forms of work and reducing the risk of unemployment. This adaptability is likely the result of how institutions cope with changing conditions, discussed for example in Acemoglu (2002). In Davis and Haltiwanger (2014), evidence is found that the US labor market has deteriorated in its ability to re-allocate workers between sectors, or "labor market fluidity."

Arguably, the ability to shift work from one sector to another will be crucial in obtaining the benefits of digitalization while reducing its downsides, notably the risk that temporary unemployment will become long-term unemployment. Experience indicates that the risk of being permanently unemployed increases dramatically after about six months out of work, as skills and self-confidence begin to erode.

3.3 The effect of automation on employment and wages

The academic literature seeks to understand the driving forces behind how technology affects the labor market and especially numbers and types of jobs. These issues are important because only when we understand them can we adapt and determine the appropriate policy responses. There is a broad consensus about the empirical facts:

- Deskilling of labor occurred during the Industrial Revolution in the 19th century.
- Increased demand for skills was prevalent during much of the 20th century.
- Job polarization – the shrinking of the middle class – has taken place in the labor market over the last two or three decades. In Sweden, only the better paid jobs have so far increased, an experience that differs from many other OECD countries.
- Wage polarization has occurred in the US with stagnant real wage growth for broad groups, but not in Sweden. In fact, developments in Sweden are rather the opposite with good real wage growth in the last twenty or thirty years.

Above all, one conclusion stands out from the literature: there is nothing inevitable about how technology impacts on the labor market. As posited by Acemoglu (2002), how institutions respond to changes from technology may alter the paths in good – or in bad – ways. Moreover, the nature of technological change is likely of crucial

importance. Notably, general purpose technologies, such as electricity and computers, may have broader effects than other innovations; see Barroso Morin (2014a, b) for an account of the effects of electricity. When reading the literature on previous technological changes and responses of the labor market, it is important to keep in mind that digitalization differs from previous periods in several ways. As discussed in Chapter 2, these are:

- High speed of adoption at low marginal cost
- Increasing returns to scale and network effects
- Non-rival and non-exclusive nature to some but not all parts of digital services

Industrial Revolution was mainly deskilling

During the first phase of the Industrial Revolution, technological innovations were by and large *deskilling*; see for example Acemoglu (2002), and Acemoglu and Autor (2011). Unskilled labor was hired to operate machines and thus replaced skilled artisans at lower wages, a chain of events that led to social upheaval. In particular, the Luddite movement tried to resist change by destroying machines, efforts that ultimately proved futile. Remnants of the fear expressed by Luddites have never disappeared and have now reappeared in public discourse, although so far without the drama of the past.

The period of deskilling during the Industrial Revolution is largely a consensus view, but Katz and Margo (2013) use micro data to argue that the picture of technology displacing jobs should be more nuanced. In particular, while this effect occurred in manufacturing, it did not happen in the aggregate economy: starting in the 1850s, highly skilled workers increased as a share of total workers. Therefore, they conclude that the picture is mixed: only some reallocations between sectors caused unemployment.

Complementarity between jobs and machines, skill-biased technical change

In contrast, much of the development during the last couple of decades has been skill-biased technical change. This means that recent innovations have led to an increased demand for skills in the labor market. Autor et al. (2003) find that computerization can explain about 60 percent of the estimated demand shift favoring employees with university education during 1970-98. Acemoglu (2002) surveys the evolution of skills and concludes that most of the 20th century was characterized by an acceleration in demand for skills.

Much of this literature emphasizes the complementarity between humans and machines; see the seminal work by Acemoglu (2002, 2003) and a recent account by Autor (2014). Labor productivity rises over time as employees work with machines as opposed to the experience during the Industrial Revolution when machines indeed replaced some people. Graetz and Michaels (2015) find that industrial robots have contributed to increasing wages and total factor productivity. Akerman et al. (2015) confirm complementarity in Norwegian data.

To varying extents, complementarity between human and machine is evident everywhere. When jobs are destroyed due to machines, they are often the physically arduous and dangerous jobs. For example, extracting minerals from mines used to be a dark and perilous business; today much of the work, at least in OECD countries, is done by machines operated remotely; see Ek (2014). Bessen (2015) uses the example of ATMs and bank tellers to illustrate the same point. When people no longer had to see a teller to withdraw cash, bank tellers might have become superfluous. Instead, they began performing higher quality services requiring more skills, such as providing financial advice.

Despite all the evidence of complementarity between humans and machines, there has always been some *angst* about robots taking over work, at least outside the economics profession. Recently, for example, famous physicist Stephen Hawkins and Microsoft founder Bill Gates articulated such views and there are several books by economists and non-economists that express these views, for example Cowen (2015), Ford (2015a), and Susskind and Susskind (2015). Regardless of the chosen view on the ultimate effects of digitalization on jobs, the existence of complementarity does not rule out difficult adjustments in the short- to medium-term.

Decline in demand for skills over the past decade?

Recent work by Beaudry et al, (2015) challenges the trend towards demand for higher skills arising from technological progress. They argue that this trend was reversed in 2000 and obscured by the aftermath of the Great Recession, thus painting a rather dark picture. They argue that having a college degree is less a path to management than being able to compete for entry-level jobs against applicants with lower education. In other recent work, Graetz and Michaels (2015) find no effect of robots on aggregate employment but some reduction in demand for mid-level jobs, similar to the trend during the Industrial Revolution.

A more detailed analysis of the demand for skills is estimated in MacCrory et al. (2015). Using US O*NET occupational data for the period 2006–2014, they detect a significant reduction in skills that compete with machines and an increase in skills that complement machines. While not providing conclusive proof, these findings are indicative that a fundamental shift in the types of skills demanded is underway.

Polarization – can increases in inequality and wages be explained by technology?

The literature finds overwhelming support for labor market polarization and lower wage growth for unskilled workers in the US. For example, Autor and Dorn (2013) find that job polarization stems from the interaction between consumer preferences and falling costs of automation. They find evidence of reallocation from other sectors to those with low pay during 1980–2005. Notably, employment increased for security guards, food operatives, assembly, and mining. In these occupations, wage growth outpaced other lower level service jobs. Autor (2014) argues that these are jobs that require a skill set that comes easy to humans and where robots are not yet capable or too costly; that is, jobs that are neither complements nor substitutes for machines. For example, robots easily fit the windshield on new cars in factory assembly but repairing a broken windshield is still a manual job.

In a study covering 16 countries, including the US, the UK, and Sweden, Goos et al. (2014) find evidence of labor market polarization during 1993–2010. The results are replicated for Sweden in Adermon and Gustavsson (2015). They find that mid-level jobs have so far mostly evolved into more high paying jobs rather than the low paying kind. Akerman et al. (2015) find evidence that access to broadband internet increases the wage bill share of skilled workers in Norway. Based on the Scandinavian experience, employment polarization is not necessarily followed by wage polarization; see Adermon and Gustavsson (2015). However, this wage polarization has occurred in the US. Acemoglu (2002) finds that average wages for low skilled workers have declined in real terms since the 1970s and he conjectures that the outcomes in different countries stem from how institutions cope with technological shocks. Moreover, Acemoglu et al. (2014) show that productivity growth in the IT sector is driven mostly by reduced employment rather than better labor performance. Goos et al. (2014) stress that technological advances are more important for the labor market than the effects of offshoring.

The abovementioned studies concern the economy as a whole but research is also emerging that analyzes the effects of digital platforms on the labor market. Agrawal et al. (2015) find evidence of frictions in an *online* labor market as measured by the value of information. In particular, they find that small pieces of information in the form of employment history for offshore workers can substantially increase their future pay compared to those without such as history; also, they find that digitalization primarily benefits workers with higher wages.

Theoretical models where machines destroy jobs

Above, we discussed the development during the latter half of the 20th century where technology led to demand for higher skills. This trend is now beginning to be questioned in the academic literature. For example, Beaudry et al. (2013) find a shift in the relationship between machines and skills since the beginning of 2000. Throughout history, the effects of technological change on the labor market have been different depending on the rate of structural change and on institutional factors; it would be rather optimistic to assume robot and human complementarity will prevail in the short-to-medium term no matter what kind of technology shock makes an appearance. There are periods of change when employment effects have been negative, for example following the introduction of electricity; see Barroso Morin (2014b).

Indeed, Acemoglu and Autor (2011) illustrate a model where technical change does not raise wages of all workers and where there can be substitution between human labor and machines. Models with even darker implications for mankind are found in Sachs et al. (2015), Benzell et al. (2015), and Sachs and Kotlikoff (2012). With some variations, these models result in lower welfare for future generations due to human and robot substitution. Even though robot innovations can be welfare-enhancing in the long run under some parameterization, the short-run effects tend to be bad for humans. The wage share of income is declining in these models, consistent with new findings in the literature.

3.4 Humans and robots…or humans vs robots

We have discussed lessons from the academic literature concerning the effect of technology on employment as well some features of structural change in the Swedish economy, drawing on economic history and recent economic research. Arguably, consensus among economists is that as machines destroy jobs, new ones will be created – especially in the service sector. The implication of this view is that things are normal and no special action is required from firms or governments. Bessen (2015, page 3) captures this view in the following excerpt:

> "New technology will surely take over more tasks that humans perform, but many human qualities will remain important in global commerce. Although computers can pick stock portfolios, financial advisors provide reassurance when markets are down. Although computers can recommend which products to buy, salespeople understand consumer needs and inspire confidence that unforeseen contingencies will be handled fairly. Although computers can make accurate medical prognoses, they don't yet have the bedside manner to guide patients through difficult medical choices. And computer scientists don't foresee computers acquiring such capabilities anytime soon."

In this section we summarize recent advances in robotics and knowledge-based systems, drawing especially on Ford (2015a), and we take issue with the view summarized by Bessen. Already today most of the services that are claimed to be beyond technology in the above paragraph are already possible – or on the way to being implemented. The speed at which this occurs may indeed hinge more on other aspects than on technological impediments.

3.4.1 Humans make mistakes and some may lack social skills...

In *Thinking Fast, Thinking Slow,* Daniel Kahneman discusses many examples of experts' poor assessments. This is especially true in the business of forecasting, where the anecdotal evidence of bad performance is rather overwhelming and the culprits easy to find by comparing forecasts to outcomes. The internet is awash with quotes about the future of computers and the internet, many of which have been spectacularly wrong. But even experts can be mistaken when the data is hard to interpret. For example, then Chairman of the Federal Reserve Ben Bernanke initially diagnosed the subprime meltdown in the US as being too small to have an impact on the rest of the economy.

Top experts in their fields are of course not alone in getting their assessments wrong, the risk of overconfidence in predictions is a very human trait. As emphasized by Kahneman, humans tend to be bad at some things they think they excel at:

- In finance, actively managed funds rarely do better than index funds, sometimes worse.
- Wine experts can be worse at predicting good vintages than formulas that use weather, soil, and other factors as inputs.
- Risk of infant mortality is higher based on clinical assessment than based on simple formulas for heart rate, respiration, and reflexes.

As the examples illustrate, the value of expert assessments is both an amusing and serious subject. It is fun when experts get it wrong but alas the matters at hand are serious, sometimes concerning the health of the economy, sometimes the health of a newborn.

Experts may have a vested interest in highlighting and exaggerating their own importance. In recruitment, there is evidence of bias in that employers tend to hire those similar to themselves. So far, it has been difficult for non-experts to question the experts, but the ubiquity of the internet is beginning to correct this imbalance. For example, for health-related issues it is easy for to search for others with similar symptoms and assess the quality of advice.

Health care is sometimes used as an example of where human contact is desirable – with doctors, psychiatrists, etc. There is a perception that people do not want to interact with a computer concerning highly emotional issues. After all, computers cannot feel empathy and even if they are programmed to simulate it, people may object, knowing that the feelings are not genuine. There may be some truth to this objection, but it is not self-evident that these obstacles will prevent the takeover of certain functions by software. When given a choice of interacting with a computer to get an immediate response or waiting a long time to see a human doctor, some people may prefer the immediate response, especially if the software has a good track record. What will people choose: an immediate response from Dr. Apple, Dr. Google or Dr. IBM or having to wait an unspecified time for a human doctor? Being con-

fronted with this choice may come sooner than we think; see Crow (2015). Moreover, even doctors who are good at clinical assessments may not necessarily be good at interacting with patients. The point is that it is difficult to predict how far technology will make inroads in these areas as well, especially since values may change. Younger generations are more used to interacting with software for other tasks, after all, so why not for health care too?

What does this imply for the discussion of tasks that may be taken over by software? The main takeaway is that software may increasingly be better than humans at finding patterns in data and presenting them in an objective way, not clouded by ambition or embarrassed by a change of mind on a topic. Indeed, the whole issue of automation of knowledge-based systems that can take over non-manual jobs concerns this question (more on this below). How far such expert systems will go and how much they will replace human experts is impossible to know, but may depend on some identifiable factors that we will discuss further below (Section 3.4.3). Those who argue that many tasks are intrinsically better done by humans also need to take into account that humans are not always as good as claimed. Indeed, Susskind and Susskind (2015) argue this point and posit that the professions, as we see them today, will gradually disappear and be largely replaced by technology. It is likely that developments are moving some way in this direction, but it is a mistake not to consider the inertia of institutions as well as the crucial role of tax on labor, a point we return to at the end of Chapter 5.

3.4.2 Role of robots on the labor market today

Machines and robots are now migrating from factory floors to logistics centers and offices and into knowledge management tasks and journalism. The ongoing changes are very broad and the last couple of years have shown tremendous advances.

Ford (2015a) discusses these changes and makes a compelling argument that the speed of adoption and its effects on the labor market will be quite significant. The combination of emerging standards for software code as well as broad applications make it possible to explore automation in a wide variety of areas previously largely unaffected.

Automation of low-skilled jobs

As discussed above, employment in manufacturing has declined and new jobs have been created in the service sector, but automation is beginning to make further inroads into simple service sector jobs. Frey and Osborne (2013) show that many tasks in the service sector are subject to automation if they are routine and do not require much in the way of personal or social skills.

How far this development has progressed may be a surprise:

- Semi-autonomous warehouses where many – if not most – tasks are done by robots
- Restaurants can be automated
- Next level of automation in agriculture
- Self-driving trucks are now on the roads in some US states

The examples in Ford (2015a) show how the technical possibilities are rapidly expanding beyond the most well-known case of self-driving vehicles. Costs are decreasing in several areas and the drive for profits is inducing further shifts away from labor to machines. For example, logistic centers and warehouses are designed

with robot automation as an integral part of design, laying out barcodes for the machines to follow, somewhat akin to building roads that allow cars to travel efficiently. Warehouse robots made by companies like *Industrial Perception* are improving all the time, with speed, dexterity, and object recognition.

Jobs in fast-food restaurants that have long been the province of low-skilled workers are now subject to automation. *Momentum Machines* have designed machines that can make 360 hamburgers per hour, exactly to customer specifications; the *Kura Sushi* restaurant has pioneered automation, including all elements from making the sushi and putting it on a conveyor belt to automated billing. Monitoring by management is done off-site.

In agriculture, automation has already had tremendous impact in developed countries but has so far left some manual labor for tasks such as picking grapes, strawberries, almonds, and oranges. Not only are these tasks now being automated but new techniques are making inroads towards improving the entire agricultural process, enabling control of fertilizers, pesticides, and other elements affecting yield, a topic we return to in Chapter 4 in the context of regulatory obstacles. *The Economist* (2014c, d) gives further examples of how big data and technology can be used to improve crop yield and increase farm productivity, although the methods remain controversial.

Automation of high-skilled jobs

During the last few years, we have seen advancements in hardware and programming that enable robots and computers to perform jobs that are typically deemed as requiring high skills and/or a college degree. Indeed, the incentive to replace high-wage earners might be as strong – if not more so – in lieu of larger potential cost savings and rigid labor markets, notably in Europe. Moreover, in the examples mentioned below, anecdotal evidence indicates improved productivity.

A starting point, at least a symbolic one, for the vast potential of computers to also perform highly skilled work originates with two well-known competitions of human vs. machine. First, the win of IBM's Deep Blue against then-reigning chess world champion Gary Kasparov in 1997; and second, the win of IBM's Watson in Jeopardy against the reigning champions in 2011. Especially the latter became a powerful – but somewhat overused – symbol of what computers are capable of. After all, great potential to solve such problems is only part of the human skill set in knowledge-based organizations. But as the book by Ford (2015a) points out, this is beginning to change:

- Automated newspaper reports from sports events and releases of economic data.
- Automated knowledge work, and including elements of in-house work and crowdsourcing.
- Automated data modeling work, finding good fit to empirical data in science, economics or any other area.
- Legal briefs that scan enormous amounts of legal documents to find precedents or other supporting material for cases.
- Software robots scan financial markets for investment opportunities and eliminate the need for trading pits.
- Automatic grading of school essays.
- Automated music programs that generate quality high enough to be played in concerts.

The current state of computer writing may not (yet) win stylistic prizes, but can produce accurate and grammatically correct reports; they are also faster and already difficult to distinguish from human texts, see Box 3.1. Indeed, computer-generated texts may in some instances be better and contain fewer grammatical errors. For example, *Quill*, a new program from *Narrative Science*, can produce all sorts of reports, including business and other analysis, and argues that the results are indistinguishable from those written by the human hand. *Automated Insights* can generate text from spreadsheets. One study that uses a survey to compare the perception of computer-generated articles with human texts finds the former a bit boring but also largely indiscernible from texts written by journalists; see Clerwall (2014). In a contest between an experienced journalist and a machine, the latter was much faster but with less style – for now; see Vanek Smith (2015). The Associated Press is already using software to generate more than 3,000 financial reports per quarter, see Mullin (2015), and automated reports are used in banks such as Credit Suisse; see Yang (2015). Some books are also software-generated, for example, the *Insead* marketing professor Philip Parker has by his own estimation more than one million such books, of which more than 100,000 are available on Amazon, see Bosker (2013).

Box 3.1 Guess the computer-generated text

Example 1

"Things looked bleak for the Angels when they trailed by two runs in the ninth inning, but Los Angeles recovered thanks to a key single from Vladimir Guerrero to pull out a 7-6 victory over the Boston Red Sox at Fenway Park on Sunday."

Example 2

"The University of Michigan baseball team used a four-run fifth inning to salvage the final game in its three-game weekend series with Iowa, winning 7-5 on Saturday afternoon (April 24) at the Wilpon Baseball Complex, home of historic Ray Fisher Stadium."

Source: Podolny (2015).[104]

Ford (2015a) provides other examples that illustrate how the possibilities have been extended in many areas. Legal analysis sometimes requires huge numbers of documents to be analyzed. With *e-discovery* software, it is possible to replace large numbers of (entry-level) lawyers or paralegals and indeed perform work that was previously prohibitively costly or time-consuming. Markoff (2011) illustrates this by comparing a lawsuit in 1978 that involved hordes of lawyers who examined six million documents at the cost of $2.2 million to the capabilities and costs of software available today. The *e-discovery* software, for example, has been used to scan 1.5 million documents at the cost of $100,000 in a very short time, probably less likely to miss relevant information than humans attempting the same task.

Missing relevant information is one potential human weakness, biases another. These are well documented in the literature; see, for example, Kahneman. In recruitment, sometimes employers hire people who are most like themselves instead of the applicant who is actually most suitable for the team. Here, software can suggest matches that might not otherwise take place and potentially reduce biases, a development also occurring with online dating. Recruitment is an area where there are many strong views and the software will have to prove itself. But *LinkedIn* is already becoming an often used tool; other software, such as *Gild, Entelo, Textio Doxa,* and *Gapjumpers*

[104] The first example is written by a computer.

are providing digital hiring services; see Cain Miller (2015). If the software becomes widely used, hiring may become cheaper and less prone to biases – and may lessen the role of human resources. A pertinent ethical question in this context is how much humans should override the machine, especially with decisions concerning life-changing events; see Lohr (2015d).

It may be instructive to compare the potential effect of digitalization on lawyers to that of economists (disclaimer: the author is an economist). Basic legal research can now be done by computers, thus potentially displacing junior to mid-level lawyers; for economists, technology has instead been complementary: allowing researchers to build mathematical models and run estimations that were simply not possible before. Indeed, advances in computers have likely spurred the degree to which economics has become a more quantitative subject.

Changes are also occurring in areas where creativity is important, for example, through automated music generation. Software has also produced paintings. Digitalization is thus entering into areas that are also considered art. It remains to be seen how much progress will be made but the results so far are astounding. The notion that a computer could come up with a symphony, such as the *Iamus* program, which can be played at a concert is extraordinary.

It is fair to say that the extent to which computers are actually creative is controversial. But in the end, what matters for the impact on the economy is if output is treated in a similar way – and that remains to be seen. The notion that creative outcomes can be "coded" is not as bizarre as it might sound at first. Computers use randomization and mathematical routines to come up with answers. Good randomization combined with sufficiently clever rules may well be indistinguishable from human creativity. Nobel Prize-winning physicist Richard Feynman sometimes described his theorizing in this way: "... for Feynman, the essence of the scientific imagination was a powerful and almost painful rule. What scientists create must match reality. It must match what is already known. Scientific creativity is imagination in a straitjacket," as described in Gleick (1993).[105]

Overall, the advancements of clever software into cognitive and creative tasks can make a lot of entry-level and mid-level analysts, such as journalists and writers, superfluous; the computers can collect and amass the data, and increasingly, they can also analyze the data. The program *Eureqa* has been demonstrated to be able to use mathematical techniques to find physical laws and is know available in the cloud for any kind of model analysis that tries to fit a model to data. Sometime in the future these kinds of programs will be competing against PhD researchers. Since researchers tend to specialize in some particular area, the software may be more open to trying models and approaches that researchers may not know about. When there are fewer low-to-mid-level analysts, potentially there will also be a correspondingly lesser need for senior management.

One hurdle for software is the mistrust of the *black box* nature of some recommendations. People want to understand why a model produces a particular result; a pure correlation based forecast or recommendation is typically not held in high esteem.

[105] Economists sometimes use the concept of observational equivalence to denote situations when the data is congruent with several different explanations of what drives the result. If an output generated by a computer – a book, a painting, or music – is treated in the economy as if were a creative piece of art, then its impact will be similar to "real" art and its origin will not matter. But the laws of economics still hold: if a computer generates large numbers of creative outputs, these will become less valuable due to effects similar to inflation.

Indeed, without understanding why a model produces a particular result, people (managers, policymakers, doctors etc.) tend not to trust the result, quite regardless of past forecasting prowess. This is why, for example, automated forecasting routines in institutions are typically complemented with anecdotes and finding the "right narrative."

Distrust of the quality of software recommendations may be lessened, or even overcome, by showing not only the conclusion but also the underlying reasoning. Hosea (2015) makes this point in the context of medical diagnosis but the arguments apply much broadly. IBM's WatsonPaths can do this by showing the *path* the computer followed to arrive at the result. The experience of WatsonPaths in health underscores this. For example, in a cancer diagnosis, if the software can list the research papers and statistics used to generate the recommended option, the physician can then decide whether or not to trust the results, which is an example of complementarity between human and machine. Indeed, in some instances, the software might do better. Ford (2015a) documents cases where the right diagnoses baffled the physicians but were resolved with the software. When the software is right most of the time and can produce coherent reasoning behind its answers, it can take over quite a lot of sophisticated tasks, including forecasting and business analysis.

There are at least two important takeaways from these examples and anecdotes that matter for their impact on the labor market and the economy.

- There are many changes occurring at the same time in different sectors that can replace labor: all from making hamburgers and sushi to writing business reports.
- The drive to improve existing goods and services, or invent new ones, will lead software programmers into new territory, including areas that have so far remained less affected.

Polarization and skills

One important question is whether the coming decades will see more complementarity or more substitution between humans and machines. Brynjolfsson and McAfee (2014), and Cowen (2015) and Ford (2015a), argue that the skills needed to thrive in the future labor market will lead to even further wage polarization. Cowen (2015) poses the following question:

> "Are your skills a complement to the skills of the computer, or is the computer doing better without you? Worst of all, are you competing against the computer?"

It is likely that having some digital skills will lead to better opportunities in the labor market. By contrast, for someone with little understanding of how computers work, the risks of worse wage prospects or unemployment are evident. Clearly, many jobs do not require programming skills and technology is becoming simple to use but then the complementarity between human and machine is low. Cowen (2015) also argues that wage polarization in the US would have been more severe if protected jobs in the public sector are discounted. In Chapter 5 we will explore education and digital skills in more detail.

Ripple effects of automation

When one type of job is automated, it also affects jobs that are, in an economic sense, nearby. For example, it is obvious that self-driving vehicles can ultimately make taxi

and truck drivers superfluous. Moreover, ripple effects may also be considerable. For example, Jain et al. (2015) discusses how insurance premiums for autonomous vehicles will decrease as accidents become fewer. This would reduce the need for staff in insurance companies, coming in addition to further automation of insurance claims already underway; see the discussion in Section 2.3.6 in Chapter 2 of how the Dutch insurance company *Inshared* has eliminated several layers of human interaction through software automation. Moreover, the need for driving schools will also be fundamentally eroded. Perhaps even more significantly, hotels and restaurants along major transportations arteries, where truck drivers make stops en route may lose many customers and some may fail, thus reducing employment opportunities outside of cities. Thus, self-driving vehicles may indirectly cause disruption to the economic sustainability of sparsely populated regions, thus increasing the effects of urbanization.

Other ripple effects may be impinge upon the relationship between junior and senior staff. If more junior staff are replaced by software or robots, fewer managers are needed as well. Moreover, the long hours of preparatory work that junior staff perform in knowledge-based organizations to qualify for senior positions is part of a learning process to become better at the trade. If the share of this on-the-job training goes down, then the skills of senior staff may gradually erode, unless compensated with some other factor. This could well represent a more prevalent form of *deskilling* of the professions (lawyers, accountants, doctors, etc.) argued in Susskind and Susskind (2015).

It may also be the case that some skills will no longer be needed and that institutions will adapt. Evidently, that has already happened across some skilled manual work. For example, car trouble is diagnosed not by a mechanic poking around under the hood, but by plugging the car into a computer – and so the need for comprehensive knowledge of the engine is correspondingly less today. Similar skills transformations may also occur for non-manual workers. The point here is that further digitalization may have broader effects on the need for skill sets and the circumstances within a firm. How to deal with these issues may depend on the sector and the company, but it may be useful for senior managers to have a view on the skills needed in the organization and not only the short-run benefits of automation.

3.4.3 Forces that limit automation

The implications from the previous sections constitute a bleak future for employment but there are several factors that may limit the speed of job displacement and allow more time for adjustment for workers and for policymakers. Autor (2014) emphasizes the complementarity between machine and computers in historical data; Frey and Osborne (2013) and Bakhshi, Frey and Osborne (2015) argue that creative jobs will have less risk of automation because creativity is different from rules that can be implemented by computers. But as we have seen above, software with the appropriate mix of rules and randomization can appear to be quite creative. And so, if robots are not to replace all jobs, what are the forces that may prevent this?

The effects of technology on the economy and the labor market will arguably depend on at least three key factors that may in some instances slow the technological feasibility of automation:

- The cost of automation compared to human labor
- When people's preferences favor interacting with another person rather than a machine
- Existing and future regulation

Automation still involves high costs in many areas, compared with human labor

With the basis of Moore's Law (discussed in Chapter 1), there is a general presumption that the costs of computing speed are going down as chips are becoming ever faster. If Moore's Law continues to hold, however, it does not necessarily imply that costs of automation will decline at the same rate. For example, the first self-driving vehicles used state-of-the-art electronics, sensors, and computers that were quite costly and could quite easily be worth more than the rest of the car. In the early stages, the Google car is reported to have included $75,000 worth of electronics, but Ionut Budisteanu, a Romanian youth, was able to design a self-driving vehicle at a fraction of that cost using more off the shelf electronic components and clever programming, see Foy (2014), a point echoed by Ragunathan Rajkumar, an expert; see Waters and Sharman (2015). Major car manufacturers can do the same and push down the costs of autonomous vehicles, thus making them increasingly attractive. But this will take time, especially considering regulation and safety issues.

Thus, the process of reducing costs may be slow in many areas, as exemplified by the auto industry. New technology eventually trickles down to mid-range cars but the process takes time and tweaking. Scale of operations may help to reduce marginal costs, a path further fueled by strong competition.

The scope for cutting costs with digital technology is now being explored in broad sectors of the economy by new and existing firms. The sharing economy exemplifies the drive to find new markets and reduce costs in existing ones with digital platforms and tools. But are costs coming down fast enough so that we will see robot chefs in our kitchens anytime soon? *Moley Robotics* is developing such a robot that can learn and use thousands of different recipes and is expected to be available commercially in 2017 at a price tag of about $15,000; see the Economist (2015e). The safety requirements imposed on such a robot are likely to be significant, which will contribute to high costs in the foreseeable future. Some people who can afford them might buy them, but in the meantime most everyone else will just have to put up with using the numerous semi-autonomous kitchen appliances already available. As discussed by Autor and Dorn (2013), relative costs matter. Overall, the cost of factors other than computer processing speed may put a significant brake on the speed of automating tasks – in industry and in homes.

Demand for human interaction likely to remain in some areas

Autor and Dorn (2013) discuss how consumer preferences may impact the labor market, notably if consumption has close complements or substitutes. Demand is also about preferences and these may be quite important for the jobs that may be automated. People who can afford a $15,000 robot chef may still prefer to go without one: perhaps they like cooking or prefer to eat out or order in. Culinary activities exemplify an area with strong traditions and cultural norms that may supersede cost benefits from automation or at least act as a strong counterweight.

Indeed, preference for human contact may in some instances be an impediment to automating many service-sector jobs. How people react to buying a service that is automated versus provided by a person may depend on the context, culture, and other factors. Most people have grudgingly come to accept that customer service via telephone requires navigating through several layers of menus, all to weed out as many simple questions as possible, but with the result that reaching a person on the other end is cumbersome and sometimes not even possible. Moreover, the person on the other end may physically be in another country and time zone.

The logic of cutting costs dictates reducing staff, but the logic of customer loyalty and brand reputation may go the other way. The technical possibility of interacting with digital media will increase in the future but raises further issues. What do people value and where do we draw the line for when we want to interact with a person? If indeed there is such a line, will it shift over time as attitudes change? Might there even be a backlash against automation? In Box 3.2, we illustrate some of these points with examples.

Box 3.2. Examples of demand-related issues with further automation

Education

Education has a low probability of automation according to Osborne and Frey (2013). Yet massive online courses (MOOCs), education apps, and other software are changing the fundamentals in education. When children are learning the to read, write, and do arithmetic, they can interact with software, such as *EdQu*, *Razkids,* and *Mathletics*, with high pedagogical content; for higher education, the best teachers can design and implement courses with potentially global reach. Thus, it is in theory possible to reduce the number of teachers and reward the superstars at the best universities.

In such a system, the software would do most of the work and the teacher might help primarily if someone gets stuck. The question is not if it can be done – clearly it can. In Korea, students are already learning English with the help of robots. Rather, the question is: do people want this or not? Some further automation of grading and improving mathematics and science education are likely inevitable, but how far is an open question: our norms and cultural values may vastly limit the scope for schools with few teachers.

Transportation

Transportation is among the sectors with high risk of automation. Self-driving vehicles can clearly challenge jobs for drivers of taxis, trucks, trains, airplanes, boats, and buses. Self-driving trucks are already on the roads in California and Nevada, see Kessler (2015), and it is likely only a matter of time before we see autonomous trucks and other cargo carriers.

Here, the demand for interaction with the counterparts may not be enough to save such jobs. People will probably accept self-driving taxis, but when it comes to self-driving trains, the world is more divided: in many countries, trains are still driven manually, but when it comes to self-driving trains, the world is experiencing a trend of introducing more of them. The majority of trains are still driven manually but some trains in, for example, Tokyo, Seoul, Singapore, Paris, and Copenhagen have self-driven trains servicing the metros. And nowhere are completely automated airplane pilots used for passenger transport. Despite the possibility of pilot error, the world of travel does not yet seem prepared to accept pilotless planes.

Fashion models, etc

People who work as models have a high probability of seeing their jobs automated according to Frey and Osborne (2013). In theory, current technology allows computer-generated "people" to appear in advertising both in video or in still pictures; even catwalks could probably be automated with current technology – or at least soon in the future. But even though we can make any kind of computer generated object, the modeling profession may well be safe from digitalization. Simply, there is demand for real men and women as models, even though some of them are highly paid. The ultimate object of models is to generate demand and as long as models do this, they may be safe.

Health workers

In some instances, it is very hard to envisage machines ever substituting for humans, such as for childbirth and such. But it may be possible in other areas, clinical diagnosis for example, especially if the cost of using the automated system is lower and the waiting time is shorter. Doctors are no different from other professions in that technical skill, in surgery for example, need not be accompanied by superb social skills. It is conceivable that software could be programmed to display more empathy and sensitivity than a stressed and tactless surgeon. Surgeons already guide robots in some operations that require great precision.

Regulation can slow digitalization

Regulation affects all areas of business and, of course, aspects of digitalization as well. As digital firms try to disrupt existing businesses, there is an ongoing concern as to what extent regulation applies (see also Section 3.5 on the sharing economy).

Existing regulation is there to protect workers and consumers, but not all regulation is necessary and some may be outdated. In New York, questions have been raised about Airbnb and the extent to which Airbnb hosts should comply with regulations that apply to hotels, as they may be in competition for some of the same customers. Uber is in conflict with taxi drivers and regulation in many countries. Overall, existing regulation and future regulation can have major impact on how digitalization affects the labor market and the economy (more on this in Chapter 4).

Steps towards a more holistic view on the risk of job automation

Frey and Osborne (2013) and Heyman et al. (2015a), discussed above, estimate the risk of automation based on the nature of the tasks, basically the input factors in production. These provide a perspective on the challenges for the economy but, as noted above, tell only part of the story.

In this section, we illustrate another perspective based on the tasks that can already be performed with robots and software. Frey and Osborne (2013) focus on the *potential* for automation of input tasks in production while we argue that it is important to also consider the *output* of production and other economic driving forces. For example, journalists are at low risk of automation, just below one-fifth, according to Heyman et al. (2015a). But we have seen software already exists that automates sports writing and business news. Thus, considering only the potential for job automation may lead the analysis astray and also be unhelpful when designing a policy response. Ultimately, the possibility to automate a task performed by a certain occupation is only one aspect of whether the good or service will be automated.

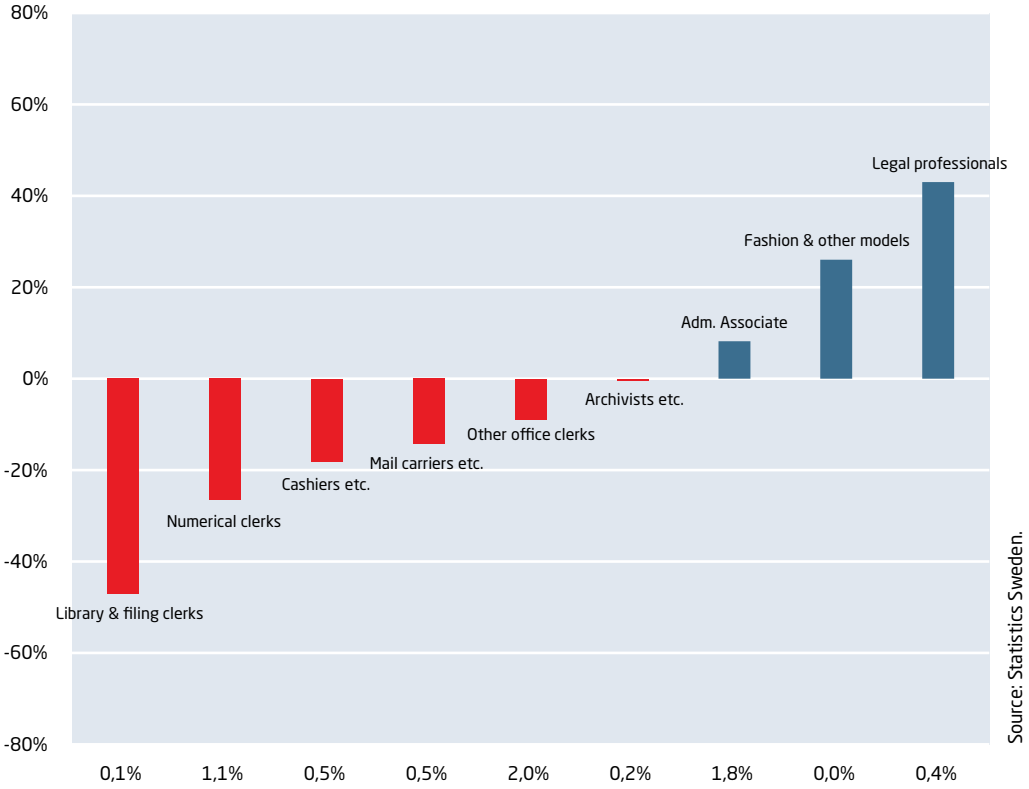
In Figure 3.7, we show the change in some selected occupations in Sweden based on the reading of the material in Section 4.2. We see that many of the occupations where software has made significant inroads have declined substantially over the period. Granted, the size of each of these occupations is relatively small as a share of total employment. For example, librarians declined by about 50 percent from 2001 to 2013 but constitute only 0.1 percent of employment. But many of these small occupations add up to numbers that matter to the whole labor market. According to Fölster (2015), somewhere between 9–15 percent of all jobs disappeared due to digitalization during 2006–2011.

The bars at the far right display two occupations that deserve some explanation. First, fashion models have very high probability of automation, a whisker below 100 percent according to both Frey and Osborne (2013) and Heyman et al. (2015a). Yet fashion modeling jobs have increased over this time period. Some possible explanations of this development illustrate the limitations of focusing only on the technological feasibility of automation. Fashion models might not be automated because of demand issues, for example brand recognition and such. If a model increases sales more than a computer generated image, the former will prevail: after all, the choice is about profitability.

Second, lawyers have increased considerably in Sweden. Fölster (2015) discusses one possible explanation, arguing that complexity is increasing and thus justifies the need for more lawyers. Complexity stems from regulation and the changing environ-

ment, all which are exogenous (excluded) from probability assessments in Frey and Osborne (2013). One notable example of greater complexity is financial regulation following the strengthening of oversight and implementation after the financial crisis. But greater complexity can also stem from changes in the tax code. Also, higher employment numbers for lawyers might be related to anticipated changes in regulation and lobbying, for example with increases in staff working with compliance with new financial rules and risk assessments.

Figure 3.7. Selected occupations at risk of automation, percentage change, 2001-2013



Source: Statistics Sweden.

Note: The occupations have been selected as prone to digitalization on the basis of the literature review in Section 3.2.6 in this chapter. For each occupation, the percentage change in the number employed is computed over the whole time period. The total employment share of each occupation is shown at the bottom. Own calculations.

Small countries may have slower rate of automation for knowledge-based work

Automation of knowledge-based work, like that of lawyers, business analysts, and journalists may be much slower in small countries, such as Sweden, as compared to the US. The scale of the US economy means that investments in automation software can bring large rewards compared to input costs. The same may not hold to the same extent for small countries. For example, the *ediscovery* software for legal research is designed for the US market but cannot be used as easily for other countries with different legal systems and traditions. The software either has to be adapted or made from scratch, which may be costlier when the scale is small. Automated writing is another example where English is dominant and the quality of automated English texts is likely to be superior to most other languages, at least for a long while.

None of the small-country issues/scale are insurmountable obstacles to automation. Once a platform has been established in the US, the steps to translate into other areas are smaller and the platform may come in with a bang. The Swedish social networking

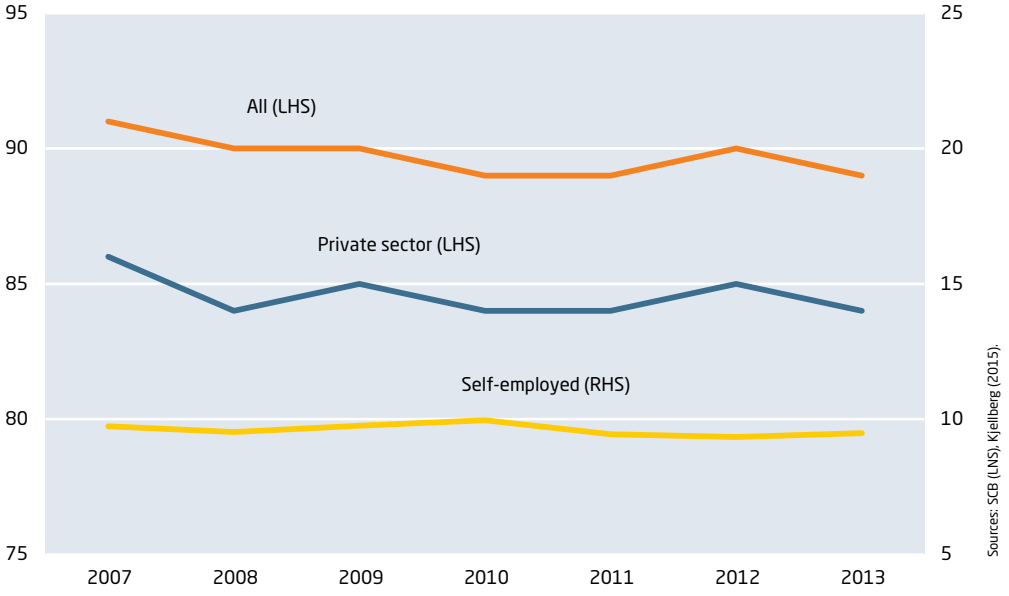
site *Shortcut* was popular, but was nevertheless eclipsed by *Facebook*. It may well be that methods to adapt language will also improve quickly, similar to how GPS navigation is becoming ubiquitous even in areas with low population density. But idiosyncratic rules and local government regulation are still likely to slow down and reduce some competition from international platforms (see more on this in Chapter 4). However, to conclude that small countries are "safe" from automation based on big platforms would be a mistake. A more proactive view would be that there may be opportunities for entrepreneurs to build clever ways to account for local idiosyncrasies, in Europe and elsewhere, before the big platforms come knocking.

3.5 Changing nature of work and its implications

Throughout this report, we have highlighted the importance of institutions for how well the economy copes with structural change. Few institutions are as important as those related to the labor market. In Sweden, the model with strong insiders with close to permanent employment contracts is still persistent but has also evolved over time. Figure 3.8 shows that most private sector employment is covered by collective bargaining agreements in the labor market. It is also evident that this share has declined somewhat during the last couple of years. The share of self-employment in Sweden, with its own set of rules, is largely unchanged at around ten percent. Similarly, there are no changes for the coverage of those employed in the public sector (not shown), who are all covered by collective bargaining agreements. The share of workers on temporary contracts has fluctuated somewhat but is somewhat higher today, about one percentage point, compared with 2005.

Much of the structure of the labor market focuses on providing a social safety net for the insiders with jobs. Also, collective agreements stipulate agreements over vacation, pensions, unemployment insurance, and many include top-ups to parental leave. To be entitled to unemployment benefits, for example, people have to have been in work for six out of the last twelve months.

Figure 3.8. Types of employment contracts in the Swedish labor market, percent of total



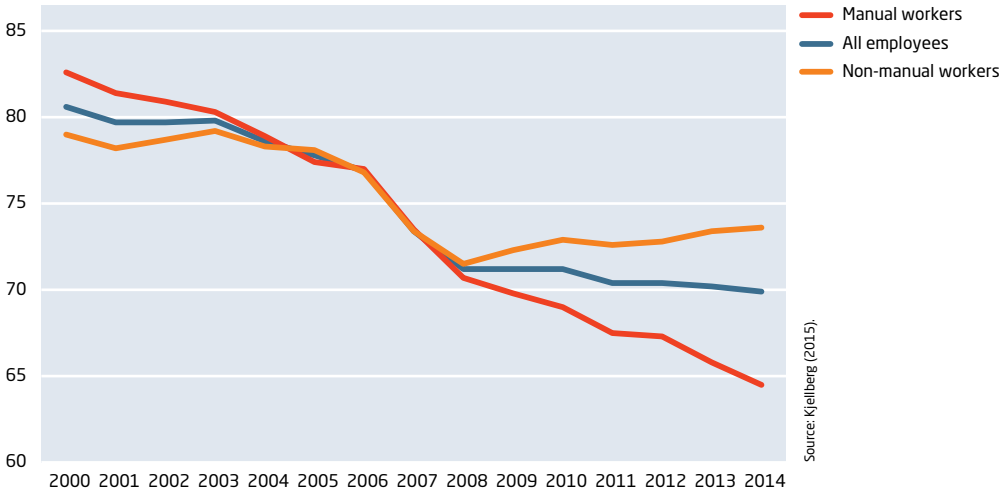
Sources: SCB (LNS), Kjellberg (2015).

Sweden has one of the most pronounced dual labor markets in the OECD

In comparisons with other OECD countries, Sweden is the epitome of a rigid labor market, featuring strong rights for insiders on permanent contracts; see OECD (2015b). There are, however, possibilities for unions and employers' organizations to bypass first in-last-out clauses in negotiations, which reduces some of the inflexibility. But when it comes to temporary workers, the Swedish system offers among the weakest protections in the OECD. Taken as a whole, this means that Sweden has one of the most pronounced dual labor markets among OECD countries; see Cahuc (2010, pages 150–153).

Some recent developments are noteworthy. As shown in Figure 3.9, union membership has declined fairly dramatically throughout this time period driven by both non-manual and manual workers up until 2006. After the center-right government came into office in 2006, differentiated fees for unemployment insurance were put into force in 2007, after which the share of union membership among manual workers continued to steadily decline while non-manual worker membership resurged somewhat. Overall, membership went down by over ten percentage points over the period 2001–2014.

Figure 3.9. Union density in decline 2001-2014



The trend in the Swedish labor market has been towards more flexibility with temporary workers, reinforcing the dual labor market with severe job insecurity for outsiders and strong protection for insiders. As digitalization affects the way we work, it may also alter the structure of employment in more fundamental ways by potentially increasing the share of self-employment, the topic of the next section.

Digital disruption to the labor market model?

The shift to digital could fundamentally change the labor market. *The Economist* illustrated this possibility with a front-cover image of office workers being thrown asunder by a tornado.[106] The implications are two-fold:

- Workers are being replaced by machines
- Labor market agreements may be subject to radical overhaul as labor is being sliced, diced, and atomized via digital platforms

[106] June 18, 2014.

There is no doubt that digitalization – and especially the sharing economy discussed in Chapter 2 – may have major impacts on the organization of labor, but it is also likely that the effect will depend on the choices of political institutions. In Box 3.3 below, we discuss some scenarios for how the sharing economy might affect the labor market.

Digital platforms that connect freelancers with consumers have built their business model on contracting work and typically do not prove employment status. By acting as a platform for providing contracts without the other commitments associated with being an employer, firms within the sharing economy can keep their costs much lower, and thus be very competitive against firms that pay social security, pensions, on-the-job training, and other employee benefits. The competitiveness is magnified many times over by the network effect: only comparatively few employees are required to run a platform that serves millions and thus the cost per unit of service can be very low.

The possibility to use technology to outsource both simple work and work that requires high skills can have considerable impact on wages and hiring decisions. Why take on permanent staff when more tasks can be bought on the market as needed? Potentially, this fundamentally shifts the raison d'être for the firm that won Robert Coase the Nobel Prize (see Chapter 2). Jobs that can be subdivided into separate parts can then either be outsourced or automated. So far, this has so far had the greatest impact on low- and mid-level jobs but highly skill professionals may also be affected, such as people working in law firms, management consultancies, or fund managers and other services in the financial sector. Their reputations and standards have enabled them to charge high fees but that may change in the future. Indeed, the incentive to outsource tasks to algorithms and to sharing platforms or cloud services should be the strongest where the biggest cost savings are to be made.

While the sharing economy provides low costs and high efficiency and enables people to work part time with great flexibility, it is also increasingly under assault on legal and moral grounds, as well as for exacerbating inequality. While these issues have been prevalent throughout periods of rapid technological change, digitalization may vastly increase the effects over a short period of time, making it more difficult for people and institutions to adapt.

Legal challenges to the sharing economy

The arrangement as contract worker vs. employee status has recently been challenged in a California court that decided in favor of the plaintiff against Uber, see for example Bradshaw (2015), which ruled that the freelancer should be considered an employee. Should this ruling have wide applicability, the whole sharing economy model may be severely affected. Uber is being challenged not only in US but across the world, notably in France with taxi drivers staging protests in Paris and with negative rulings from the Constitutional Court, see Reuters (2015), and recent arrests of senior Uber representatives; in Germany, a nationwide ban was subsequently overturned and again challenged; see Vasagar et al. (2014). A search of the internet for "Uber" and "legal" will return countless examples of challenges in countries all over the world.

Moral and ethical challenges to the sharing economy

While the challenges to Uber – and other sharing economy platforms – are traveling their course in the courts, the arguments often used against them are moral and ethical. The labor markets in the US and in other countries have increased in polar-

ization in recent years; in the US in particular, labor market polarization has also resulted in wage polarization. Jobs in the service sector have increased, but mainly those with low pay, see Section 3.3 in this chapter.

The research on job polarization in the US has received a great deal of media coverage. Many news stories discuss the difficulties for low-skilled employees to survive on their wages; see for example Porter (2015a), Leubsdorf and Hilsenrath (2015), and Keen (2015). McDonald's workers have been protesting in several cities. The work of Ashenfelter (2012) documenting McDonald's pay across countries, found that real wages declined in the US during 2000–2007. Jacobs et al. (2015) document that some low-paid workers in the US need public assistance in the form of food stamps despite working full-time, and calculate that the cost to the US taxpayers amounts to $153 billion per year. They contend that this amount is a subsidy to firms with low wages. Kantor (2014) discusses how some families are unable to plan their week of study or childcare due to erratic schedules, thus making family life more difficult as well as preventing upskilling and realization of the American dream through hard work and education. The erratic work schedules are the fruit of software that can optimize when staff is needed at very short notice, depending on factors that affect demand for fast food, cappuccinos, or other services in the low-wage sector.

Should the wage disparities continue to increase in the US and other countries, the debate about these low paying jobs will increase, as well as the potential for conflict. The actor Charlie Chaplin in *Modern Times* captured the zeitgeist of discontent with the Industrial Revolution with the worker struggling but failing to keep up with the machines in the automated factory; likewise, the image of struggling dockworkers waiting in line for day work was memorably captured in *On the Waterfront* with Marlon Brando. There is a perception that our time's equivalent are the baristas juggling coffee cups to affluent customers; contractors in the sharing economy waiting for work online, the dockside being replaced by a computer. Whatever the merits of the perception, the issue of stagnant wages and increasing inequality are well documented and the challenge they pose may increase in the digital economy. In Sweden, the relatively high salary levels at the lower end of the pay scale pose a particular challenge for the employability of low-skilled workers, for whom entry into the labor market poses a rather high hurdle to overcome. This difficulty is likely to be accentuated in the years ahead due to the large inflow of immigrants seeking asylum in Sweden and other affluent countries.

Risk sharing in the labor market

In Sweden, labor market institutions are centered on workers with indefinite employment contracts, so-called insiders. The sharing economy may shift the balance between insiders and outsiders. Being self-employed typically involves a higher level of risk than being employed, notably being responsible for finding business opportunities as well as requiring considerable administrative work for taxes and such. Some people want the degree of autonomy associated with being self-employed and are prepared to accept the higher level of risk and administrative burden. In Sweden, the share of self-employed workers has been fairly constant at around 10 percent of the labor force, see Figure 3.8.

To be sure, even in Sweden, a country with fairly strong employment legislation, workers are laid off in the private sector all the time. But, by and large, self-employed people tend to have higher levels of risk than employees. Should the number of self-employed workers increase significantly, they will become more important to politicians. This may result in pressures to change institutions to reduce the level of risk they are exposed to. As noted by the Economist (2015b):

"...governments will have to rethink institutions that were designed in an era when contract employers were a rarity."

Economic constraints to the sharing economy

The sharing economy and hiring freelance work is still subject to some of the constraints of traditional economic models. As discussed in Chapter 2, the logic of Robert Coase has shifted but not disappeared. At some point, the marginal cost of hiring temporary workers in the digital labor market will be higher than having the function in-house.

What factors might affect the tradeoff between marginal cost and marginal revenue? At least two issues stand out. For one, firms that rely on their reputation need high quality staff who enhance the trust in which the firm is held. For example, *MyClean* discovered that contract workers got lower ratings than those who were employed; see the Economist (2015b). With reputation such a potentially fragile thing, firms must be mindful of quality. Another traditional upside of employment is that firms also take some responsibility for training employees and for lifelong learning. These features are important in the knowledge economy but also potentially for lower skilled workers, for example in the efficient operation of logistics distribution centers to be able to update and upgrade systems.

A second major issue is the risk of downtime. When tasks are optimized, sliced, and outsourced as much as possible, small disruptions in one part of the chain can cause production to grind to a halt altogether. Faced by such a specter, management has to decide how much to weigh *cost reductions* from outsourcing against the *benefits of control and reliability* of operations.

The risk of downtime may be higher the more interconnected things are, either physically via global supply-side chains or in digital networks. Small errors in software – or indeed malevolent hacking – can spread faster and more widely. For example, with the Internet of Things, the vulnerabilities to the system may have parallels to banking, in which one shock can unravel and cause domino effects. Indeed, such fears were present, but never materialized, concerning the Y2K millennium bug, which may well be thought of as a historical example of a systemically important event for digital vulnerability. With the advent of smart cities where cars, subways, energy systems, elevators, and all other things are connected, small shocks can have big consequences, especially as the code to optimize functions becomes ever more complicated.

A particular example is the financial risk connected to digital systems, which stem from payment systems in firms. Administrative work connected to paying salaries, bills, and other outgoes tends to be repetitive and thus subject to automation; see Frey and Osborne (2013). But if things break down, wages and bills do not get paid. Depending on the type of operation, the risks to the business may justify keeping more functions in-house than pure cost efficiency arguments would entail, exemplifying the tradeoff between efficiency and risk management. For some businesses, retaining more functions in-house may be likened to paying an insurance premium in exchange for lower risk of downtime.

Box 3.3. How much will the sharing economy disrupt the traditional labor model?

Some argue that digitalization will imply the end of existing labor markets as we know them. In such a scenario, most things are automated and the available jobs are mostly in the service sector, on digital standby for meager wages; inequality is rampant and unemployment is involuntary rather than by choice. How far away from such a bleak picture are we?

Some arguments give credence to the idea that we are moving in this direction, but as discussed above there are forces that slow down the change as well. Overall, however, there are other forces, such as demography and changing demand, that may be just as important. The degree of automation will be affected by the possibility of generating profits, and not by technical feasibility alone. Moreover, the path is not a deterministic law of nature and will be affected by political choices and their implementation by institutions.

Perhaps at the outset, we might state the obvious possibility that the sharing economy model could be found incompatible with existing labor laws or other regulations. This is not as extreme as it may sound. The US court in California that decided an Uber contractor should be given the status of employee is a case in point; some sharing economy platforms have already taken steps in this direction, notably Hello Alfred, Instacart, Munchery and Shyp all converted their contractors into employees; see Waters (2015b, c) and the Economist (2015f). In Sweden, the taxi business is being investigated in a governmental inquiry, which is essentially about Uber.

If the sharing economy model is curtailed, it need not take the form of outright legislation, but the courts and other government agencies might create expectations of rights for contractors that increase the potential liability of firms using this labor model. Either by legislation or through expectations of future legislation, the use of the sharing economy model might expand only a limited amount. We do not believe this to be the most likely scenario, but it cannot be ruled out.

Perhaps a more likely scenario is that the world takes steps towards a larger sharing economy and our institutions adapt as well. How this will unfold will be largely path-dependent and country-specific.

How far will development towards more self-employment go? As discussed in Box 3.3, the outcomes will depend on choices and how we respond to technology and changing possibilities in the labor market. What is clear is that there are great opportunities to improve the functioning of labor markets so that they become more flexible. There are many groups that would benefit from more flexibility, not least among them parents with young children, students wanting to supplement their incomes etc. For firms, the greater flexibility will imply possibilities to provide more and better services at lower cost. And yet, a substantially increased amount of self-employment involved in the sharing economy is not a sure thing. While many economic forces are pulling in this direction, these forces are not the only ones that matter. The legal battles now underway belie some political choices already on the table and which will have to be addressed in one way or another.

Box 3.4 Labor market disruptions in developing countries

This discussion above has centered on developed countries in the OECD with a special focus on the US as the technology leader and with implications for Sweden. But it is worthwhile to also briefly discuss the effects on other countries, especially those in Asia and particularly China. China was able to leapfrog several steps in technological development and was not inhibited by having old systems in place or the need to cater to political forces the way democratic countries must. As a result, some southeast Asian countries have more modern capital stock and infrastructure than many OECD countries.

In the last decades of this rapid development, southeast Asian countries have benefited from work outsourced from OECD countries, all from manufacturing of iPhones to support centers or software development. With plenty of cheap labor available, outsourcing was attractive and allowed global companies to keep costs low. The same logic of keeping costs low may now lead to a wave of reshoring – manufacturing of electronics and other products may return to OECD countries but in the form of jobs for robots instead of people, especially as labor costs in some of those countries have been rising.

If jobs in manufacturing and textiles are indeed reshored, the upheaval in southeast Asia may be considerable. With little or no social safety nets, the unskilled workers in factories will find it hard to find other work. Also, the political processes that may have prevented some of the outsourcing from OECD countries may even accelerate this process.

There is a risk that reshoring may be much more disruptive for developing countries without adequate social safety nets than outsourcing was in the OECD; see for example Ford (2015b). It is sometimes said of China that it may grow old before it grows rich; reshoring due to digitalization may intensify this trend. As expressed by Dani Rodrik, the emerging world may have to cope with "premature industrialization" or, in the words of Raghuram Rajan with regard to India, "premature non-industrialization," see the Economist (2014e). This captures the challenge of having a manufacturing base without other functioning features of economies in the developed world, especially services. Should manufacturing in China and emerging economies become uncompetitive, there are too few other exports to support growth.

3.6 Summary

This chapter discusses how the labor market may be affected by digitalization. We draw on experience from research, previous periods of rapid structural change, and a discussion of how robots and software are evolving. An overall reflection is that several centuries of technological development have not led to mass unemployment. Another feature is that the latter half of the 20th century has involved complementarity between human and machine, although there is some evidence that this has changed in the last decade. Moreover, there is overwhelming evidence of labor market polarization, which has also translated also to wage polarization in the US, but so far not in Sweden.

Overall, the recent changes have also led to higher wage inequality, especially in the US. Also in Sweden, Gini coefficients have increased somewhat, albeit an increase from the lowest levels of inequality in the world. There are likely several explanations for these changes, of which technological change is but one. But digital technology can create enormous wealth with "winner-takes-all" features from network effects and increasing returns to scale. The most pressing issue is not the super-rich, who are likely to increase in number, but about the wealth and welfare for the other 99 percent of the population, a topic we return to in Chapter 5.

The question at the core of this chapter is whether things are different this time. We argue that they are, in the sense that the labor market may be facing decades of difficult adjustments for large parts of the economy. There are substantial trends in various occupations that are likely driven by digitalization but no evidence of an avalanche about to bury jobs and wages. Of the more major changes, the workforce in personal care and allied occupations (the health sector) stands out with substantial increases in employment, driven by changing demographics and increasing demand for such services. Other professions in Sweden have also increased, such as lawyers, despite the fact that technical possibilities to automate should be considerable.

A key message of this chapter is thus that automation and digitalization are present but can be superseded by other economic forces, institutions, and demand responses. Without potential profits, automation will not occur even in areas where the technical possibilities allow them to happen. It is a mistake to only view the risk of automation from a technical feasibility perspective and not consider other mechanisms that may be equally important.

Digitalization implies a potential for higher efficiency and flexibility in labor markets at lower costs. Depending on how governments respond, productivity may either continue at the present lackluster pace or return to previous higher growth paths. Getting policy wrong at this juncture can have dire consequences for the labor market and for medium- to long-run welfare. Indeed, considering the magnitude of change underway, the "muddling-through" approach may lead to unnecessarily high costs in terms of unemployment and lower productivity growth. The risk of populist policies that lead to protectionism would only make matters worse.

In the next chapter, we turn to questions about the role of regulation that are conducive to future productivity growth and job creation.

4. Regulation and obstacles in the digital economy

"Essentially we want to see how we can regulate these new business models in a way that would protect consumers and not hinder innovation." Marina Lao, director of FTC policy planning office in the US, quoted in Financial Times, 2015-05-11.

"When there is competition through new technology, we must examine whether the regulation is still necessary." Daniel Zimmer, chairman of the German Federal Competition Commission, quoted in Financial Times, 2015-06-02.

4.1 Introduction

Ask any entrepreneur and they are likely to talk about the difficulty of navigating regulation. Governments regulate a wide variety of businesses but there are considerable differences in regulation between countries and even within countries. Sometimes local government is responsible and sometimes central government. In many areas, there is also a substantial degree of self-regulation, a matter that is becoming increasingly important in digital markets.

While regulation is inherently complicated, the underlying rationale is not. From an economic perspective, the notion of market failure is what motivates regulation.[107] The main practical raison d'être is to ensure consumer safety – that the medicine we take has the effect it claims with acceptable risks and side-effects, that our food is safe to eat and that the elevator does not fall down when we use it.

In addition to safety, regulation serves a multitude of other purposes, such as worker safety and tax and data collection, ensuring a level playing field in competition, environmental protection, etc. Many of those rules serve valuable purposes and may even contribute to welfare over and above the improvement in safety standards. For example, effective price competition brings consumers more quality for less money, while environmental protection can contribute to mitigating pollution and improving quality of life.

But a lot of regulation is complicated and does not achieve its goals efficiently.[108] Moreover, regulation sometimes changes incentives in unpredictable ways that may not meet the objective of consumer protection and thus may sometimes not fulfill its original purpose. Moreover, even when the purpose of each area of regulation on its own has some merit, there may still be considerable issues with the totality of regulation. Rules tend to accumulate over time as values and demands change, but the mechanisms for keeping the overall burden of regulation at a reasonable level are generally weaker than the forces that crave new rules.

Successive governments in Sweden, as in other countries, have often pledged to reduce the overall regulatory burden. But even with the best of intentions, this goal often proves elusive when confronted with a cacophony of conflicting demands. The main explanation is, of course, found with powerful special interest groups that advocate

[107] Especially "asymmetric information," a situation in which the buyer in a transaction is at a disadvantage, and "externalities," when the actions of one party affect a third party, such as with pollution or traffic congestion.

[108] The OECD often divides rules into four different categories: rules that prevent competition; rules that prevent firms from growing or expanding; rules that generate high costs of compliance, and rules that make adaptation to new technology more difficult. For a discussion of this in a Swedish context, see Tillväxtanalys (2010).

increased regulation, sometimes with the noblest of intentions, but sometimes with the intent of protecting their market power by raising the entry hurdle. Safety concerns can all too easily be misused to prevent competition. There is a considerable incentive for special interest groups to increase regulation stemming from two interrelated factors:

- Keeping prices and wages high
- Excluding competition by raising requirements and/or erecting other entry hurdles

Both factors tend to prevent competition and benefit those firms or individuals that are already well established in the sector or market.

It should be stressed that not all new rules are bad and the absence of rules would bring havoc. In fact, quite a lot of rules and their application are crucial to creating trust in markets. Without trust and standards, much fewer transactions would take place. Regulation of banks engenders trust in banking, regulation of cars ensures safety for drivers and pedestrians. The European Single Market has been instrumental in harmonizing rules, setting standards, and removing obstacles to free trade in goods and services. The European Single Digital Market likewise has the potential to help bring the benefits of digitalization to the wider market and consumers. However, the outcome crucially depends on how the regulation is designed; the details matter.

In this chapter, we focus on the factors that hinder productivity growth discussed in Chapter 1. Productivity and the amount of work (Chapter 3) together constitute GDP, thereby forming the foundation for consumption and welfare. Digitalization is now entering this already complex maze of economic relationships. In this chapter we also shed light on the strategic challenges faced by firms. In times of technological quantum leaps, senior management must weigh the risks and benefits of investing in new ways of doing business, often in the face of strong corporate inertia that protects existing business lines.

4.2 Legal and regulatory hurdles

4.2.1 How regulated is the economy?

Before we discuss regulatory obstacles for the digital economy, let us briefly review the general stance on regulatory reform. This topic is broad but nonetheless a useful starting point to discuss how the digital economy may be seen through the prism of existing regulation.

Regulatory reform slowing down in OECD economies

OECD (2014a) discusses how reform of product market regulation has slowed down in OECD countries with respect to previous assessments in 2003 and 2008. In the last few years, OECD countries have implemented reforms by reducing state ownership, reducing price controls, and easing administrative burdens for start-ups. Nevertheless, substantial room for improvement remains, especially in the governance of state-owned enterprises and concerning regulatory barriers to entry in network industries.

Sweden has the lowest regulation of professional services and retail trade; see OECD (2014a, pages 77–78). Major institutional reforms were introduced in the late 1990s and until 2008, after which the pace of reform decelerated. In its recent recommendations to Sweden, OECD (2015b) highlights the country's good performance during the financial crisis but also identifies some challenges. In the context of regulation,

one recommendation is to simplify procedures for licenses and permits; see OECD (2015b, page 11). In their flagship report *Doing Business 2015*, the World Bank (2015a, page 4) places Sweden in the top 6th percentile among 189 countries but also notes few regulatory improvements since the last measurement the previous year. Similar to the OECD (2015b), the World Bank (2015a) also stresses bureaucracy, for example concerning zoning restrictions for housing, as a hurdle. This places indirect obstacles for achieving the benefits of digitalization (see further below) and is also an issue for the overall functioning of the economy.

In a recent microeconomic assessment of Sweden, World Bank (2015b) describes restrictive labor laws as an obstacle for economic growth. In addition, firms with fewer than 250 employees report taxation as a hurdle more often than large firms do. The lack of appropriate skills in the labor market is another commonly reported theme across firms of different sizes.

Increasing demands for professional licensing raises costs and makes it harder for low-income workers to secure employment

Licensing of professions is a broader question than digitalization but it is important for at least two reasons. First, as discussed in Chapter 3, digitalization will disrupt the labor market. If displaced workers find it harder to switch jobs – into another firm or sector – due to regulation, it is important to assess how reasonable those restrictions are in the first place. Second, the growth of new jobs may be hampered by unnecessary licensing requirements.

Professional licensing serves several functions, such as creating a standard that sends a signal about competence. It can also safeguard consumers and can thus create confidence so that markets can thrive. But professional licensing becomes a regulatory obstacle when it protects a profession from competition and market entry. Depending on the profession, the standard may be very high such as for lawyers, or relatively low, such as for florists.[109]

If consumer safety is the main concern, a mapping onto licensing requirements would likely not yield a list that could easily be understood as measures that are necessary to protect consumers; see Porter (2015b). For example, unlicensed tour guides in Washington are illegal but still manage to provide a quite adequate service according to the Economist (2014f). Some have even been subject to court injunctions, which were later overturned; see the Economist (2014g). A recent report has found that today almost three out of ten professions in the US require a license, an increase from about one in twenty in the 1950s; see Kleiner (2015). With some assumptions, the report estimates an implied loss of about 2.8 million jobs. From a survey, Kleiner and Kruger (2013) estimate that 38 percent of all professions either have to be licensed by the government now – or soon will be – and that this results in an average wage premium compared to unlicensed work of about 18 percent.

The increase in occupational licensing in the US also recently received attention from policymakers; see Fleming (2015). A recent report highlights that too often the cost and benefits of licensing are not properly weighed: see White House (2015) and that the costs of the entry requirements disproportionately fall on weaker groups in society. The report also sheds light on the arbitrary nature of licensing requirements and how they are updated.

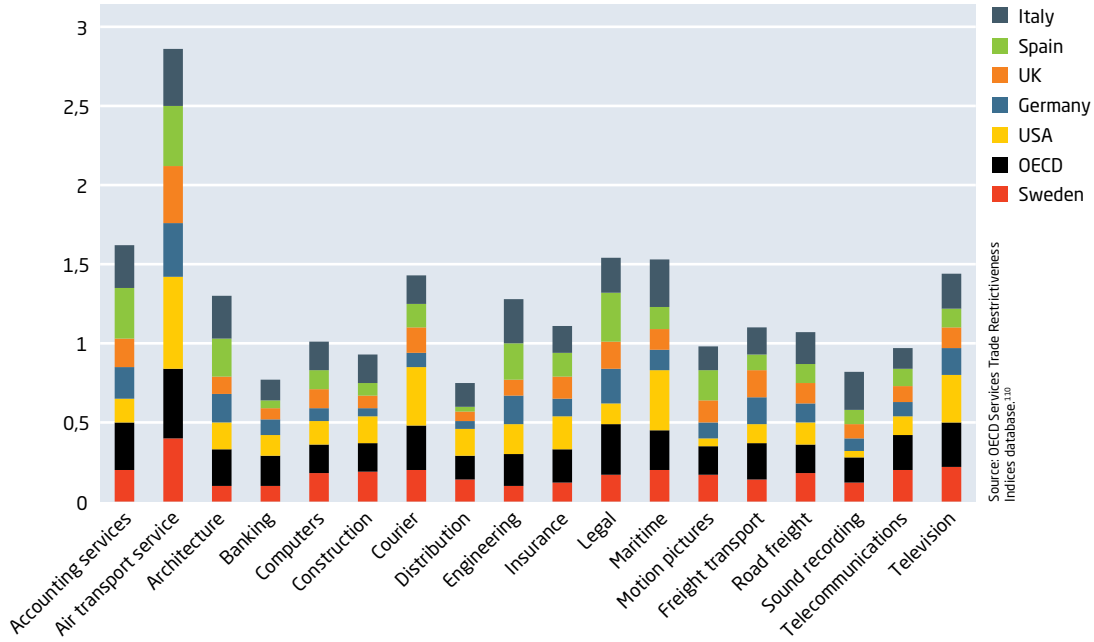
[109] This is not intended to imply that florists do not need skills, only that there are no clear consumer safety issues involved.

In the EU, Koumenta et al. (2014) on the one hand find that occupational regulations cover about 10–24 percent of the labor force, much lower than in the US. On the other hand, they find evidence that intra-EU migrants are less likely to be in these professions, which might be indicative of barriers to migration. Free movement of labor is a pillar of EU membership and the European Commission is doing a great deal of work and monitoring to improve it. Some professions remain regulated but many have been opened to EU-wide competition. Some barriers in terms of difficulties in recognizing professional qualifications remain, especially in health and social care, education and construction; see GHK (2011). For these, and especially for health care professions, automatic recognition of qualifications might promote better alignment between the supply of skilled workers and the likely increase in future demand.

Considerable variations in restrictions to trade services in the OECD

Trade in services is subject to a variety of regulations. Despite harmonization in the EU, some differences remain. As Figure 4.1a shows, air transport services have the most remaining restrictions while banking, distribution services, and sound recording have the least.

Figure 4.1a. Restrictions on traded services in the OECD organized by service, 2014

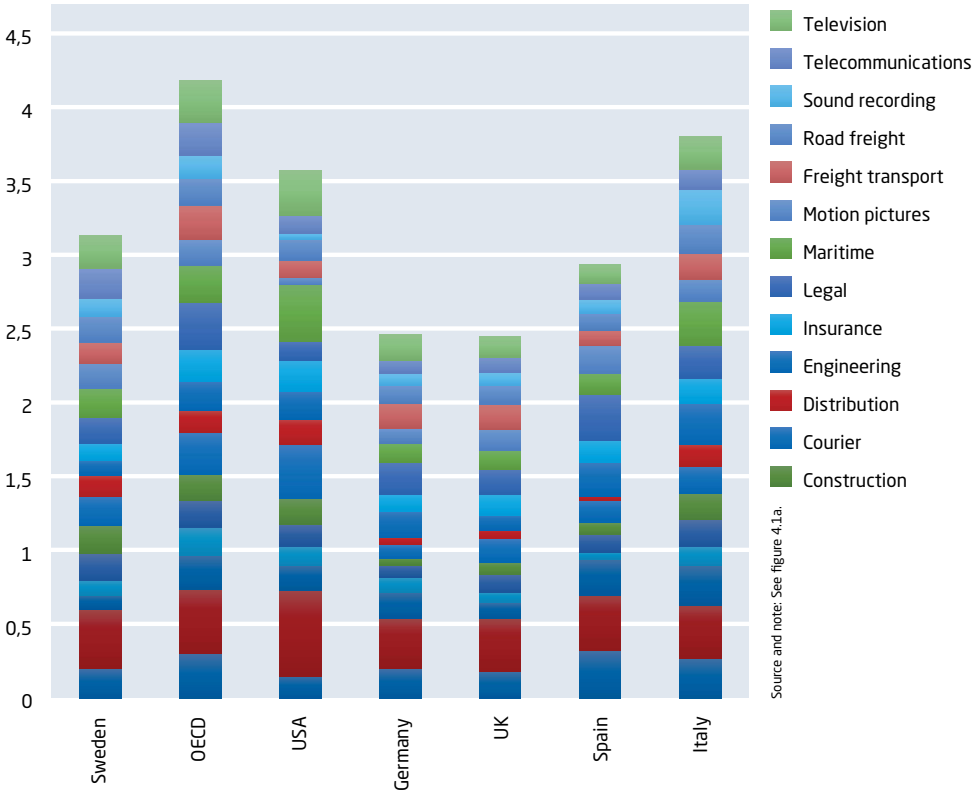


Note: Each sector is evaluated on the degree of restrictiveness from 0 to 1, the latter being the most restrictive. Each country's scores are added to each bar for a total score to give an indication of overall restrictiveness. The OECD average (displayed in black) also includes six major emerging economies: Brazil, China, India, Indonesia, Russia, and South Africa.

Figure 4.1b displays the same information as Figure 4.1a but organized by country instead. Among the selected countries, Italy has the most restrictions among the European countries but it is below the OECD average (that has been expanded to also include six major emerging markets which often tend to increase the average degree of restrictiveness). The US has a fairly high degree of trade restrictiveness, just below Italy. Germany and the UK are about on par and the lowest in this sample. Sweden is above Spain, Germany, and the UK but below Italy in terms of trade restrictiveness in services.

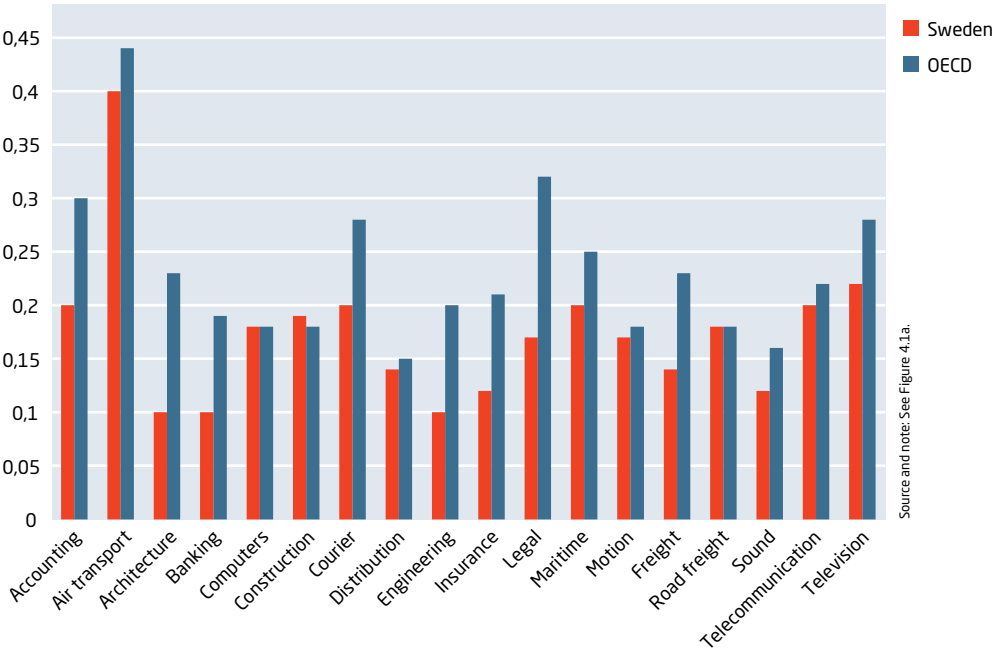
[110] See www.oecd.org/tad/services-trade/services-trade-restrictiveness-index.htm

Figure 4.1b. Restrictions on traded services in the OECD organized by country, 2014



Finally, on a sector-by-sector basis: see Figure 4.1c. For construction services, Sweden is actually above the OECD average. For all other services included in the sample, Sweden is at or below the OECD average, but in some areas not by much – such as for air transport, computer services, road freight, and telecommunications. Sweden has low restrictions in architecture, banking, and engineering.

Figure 4.1c. Restrictions on trade in services, Sweden compared to the OECD, 2014



Before we turn to issues of digital regulation, we will briefly discuss two topics that concern legal aspects of digitalization: intellectual property and patents. While they have had a huge impact on progress and productivity– and indeed still do – for the sake of brevity, we will only give an overview.

Ongoing challenges for intellectual property rights and copyright in the digital economy

Few issues are as clearly associated with the challenges of production and distribution of digital goods as copyrights and intellectual property (IP) rights. It is not that IP was not an issue in the days of analog music, movies, books, newspapers, and magazines; but rather the issue is that IP comes to center stage when digital material can be distributed at low cost. Indeed, digitalization has shaken these industries deeply.

The first wave of digitalization of music brought a tremendous amount of litigation as music producers confronted the rising challenge of pirated goods. We saw P2P sharing of music, for example via the company *Napster* that started in 1999. The initial response in the industry was to litigate, which was made more difficult by the scale and global nature of the piracy. Some of the piracy was commercial in nature and some of it for personal use. Even though Napster was shut down by court order and subsequently liquidated, the events rocked the music industry and propelled questions about how to make money in the shift from analog to digital. Notable fears were that all music would be free so that artists could no longer make a living and that diversity would disappear.

A recent report that has studied how creative artists have been affected by digitalization has, perhaps somewhat surprisingly, found that the industry may be in as good shape – and in some ways better – than before; see Johnson (2015). Although the path has not been straight and the process is still ongoing, the industry has adapted and has found ways to make money from creative works in a variety of ways, including sale via digital platforms and subscription services.

While the handling of digital piracy is a concern for producers, it has also given rise to new and developing business models in order to be able to continue to earn money from digital distribution and it has created value for artists and producers. To be sure, subscription is not new but digital distribution brought new challenges to the existing business models. Nowadays, we are seeing subscription-type services for:

- Books (Amazon Kindle, Oyster, Readly, Scribd)
- Magazines and newspapers (Next issue, pressreader, Magzter, Readly)
- Movies (Netflix, HBO)
- Music (Spotify, Apple)

Technology is evolving as consumers are adapting their behavior. People accustomed to reading print books and newspapers may simply prefer this format and be slow to change – or perhaps not change at all. But predicting a further rise in the overall population who consume media primarily via digital avenues is not overly bold.

While those creative businesses have already changed dramatically in how artistic content is distributed and how money is made, further changes are nonetheless underway. It will likely be many years before the industry begins to stabilize. In the meantime, legal issues of copyright and IP are likely to remain at the forefront.

Patents, a huge area of law in search of a new model

Patents are another big issue for producers. The original motivation behind patents was to balance the incentive to innovate against the consumer benefits therefrom accrued. With very strong and long lasting patents rights conferring monopoly rents, much benefit is given to the incumbent. On the other hand, with too little protection, consumers may benefit in the short run but the incentive for firms to innovate and make new products may be dampened, thus diminishing or destroying long-term benefits. The balance between these two dimensions is a delicate matter and there are those who question whether the balance is not too heavily tilted in the interests of producers; see the Economist (2015g). OECD (2015f) stresses that the context in which intellectual property operates has changed substantially, for example, with the advent of cloud computing, and that investment in intellectual property-protected capital is growing faster than investment in tangible capital; see also Hargreaves (2011).

The issues are made more complicated by a number of interrelated factors. First, different technologies have different lifespans, meaning that the length of time they accrue benefits varies considerably. Development of new drugs typically takes years of research and large costs and can give income streams for a long time. By contrast, technical advances in phones and computers quickly reach consumer markets but their life-spans tend to be much shorter. Where can we draw the line between different industries in ways that are not arbitrary and yet manage to balance conflicting goals? This is an open question.

Second, the monopoly rights from patents have given rise to a whole industry of patent applications, all from the mundane and frivolous to the truly original. The old saying "publish or perish" that applied to books may also characterize patents. Famously, even huge companies such as Apple apply for patents for items that seem somewhat unrelated to core innovation, perhaps most famously patenting the roundness of the corners on the iPhone. Firms own not only technologies but libraries of patents, some of which will never see the light of day and others which are core standards in smart phones, computers, or other electronic devices. Many of the big tech companies are involved in litigation on patents in one way or another. For example, Ericson is suing Apple for patent infringement and Apple is doing the same against Samsung and so on.

Third, the vastness of the patent system has given rise to a legal froth for so-called *trolls*. These are patent lawyers who earn considerably by finding patent infringements – whether real or not. Trying to recoup a small percentage of some technical standard used in millions of products can give large rewards. It may well be the case that the incentives are too much tilted towards legal wrangling and that our current system actually hampers innovation; see OECD (2015f) for a discussion. The danger posed by the patent trolls is likely to be most severe for small companies in the start-up phase when they may be the most vulnerable.

Ambitions in the European digital single market (DSM)

The European Commission has recently launched an agenda for a Digital Single Market for Europe; see European Commission (2015). The aim is to improve access to services from music to movies and books and more, to harmonize consumer protection and data protection with the ultimate goal of facilitating job creation. There are specific proposals in several areas:

- Improving trust in cross-border e-commerce rules
- Ensuring parcel delivery is affordable also across borders

- Preventing geo-blocking, whereby online content is restricted or not sold to some member states
- Modernizing copyright protection
- Reducing VAT-related burdens across borders

These ambitions are now being discussed and the timetable includes finalized proposals that are supposed to be delivered this year and next. In this chapter, we touch on mainly the last two bullet points.

4.2.2 From traditional regulation to digital regulation

New and better products can outcompete old; this happens all the time, unless new regulation prevents it by creating enough hurdles to deter market entry and competition. Governments and authorities need to be mindful of this risk. Since the digital innovations have the potential to upset quite a lot of businesses, the forces that may stifle competition are going to be strong and ubiquitous.

Nowhere is the pandemonium greater than in and around the services provided by Uber, the ridesharing/taxi service. [111] As discussed in Chapter 3, Uber has accumulated more legal headlines in France, Germany, and other countries within a short period of time than most other companies do in their lifetimes. *Airbnb* has also attracted considerable legal scrutiny, especially in New York where a recent report from the attorney general has alleged that almost three-quarters of their listings are illegal; see Streitfeld (2014). But the legal challenges to Uber are in a class of their own.

The challenge for regulators around the world is to infer what kind of company Uber actually is. Does it provide taxi services or is it a way for people to share rides? Although driving a passenger in a car is a simple activity, the rules and regulations concerning the activity are far from simple. As expressed by Commissioner Catherine Sandoval, California Public Utilities Commission, the first regulatory body to license the kind of services provided by Uber:

> "So the bigger issue really came around what is, not Uber Black, but Uber X, and Lyft, and the others, where you have just regular people who have driver's licenses, not commercial licenses, and are not licensed limo drivers. So one of the regulatory questions is, is the new school app-based match up ridesharing exempt from regulation, or indeed, are they a charter party carrier, or a taxi, or if they're operating in a different way, are you a passenger stage corporation? So among our goals were and remain to balance public safety, consumer protection, reliability, innovation, competition, as well as be mindful of privacy."[112]

It is likely that the real reason for the attention Uber receives has more to do with political economy. Those who lose the most from competition with ridesharing services are in only one profession – taxi drivers. The issue is not black and white, however, and is more complicated in markets where taxi drivers had to pay large sums for their license (or "badge"), a cost ride-sharing services tend to avoid. Moreover, the payment of tax is a controversial issue: ride-sharing services, especially uber-pop, are sometimes accused of tax avoidance. The ride-sharing services tend to retort that their drivers are

[111] The irony of the backlash against Uber is that the when the self-driving car finally arrives as a consumer product, the need for drivers might be much reduced anyway.

[112] Quoted verbatim at the Federal Trade Commission seminar on the sharing economy, 2015-06-09, see https://www.ftc.gov/system/files/documents/videos/sharing-economy-workshop-part-3/ftc_sharing_economy_workshop_-_transcript_segment_3.pdf.

not their employees and hence the responsibility of paying income and payroll tax rests on the individual driver. Here the challenge for the regulators and for the ride-sharing services is to use technology to make it easy to pay tax when mandated but also to review the threshold points at which tax becomes payable. In particular, it is not reasonable to put equality of tax bracket on an occasional ride-sharer with a professional driver.

Getting the appropriate balance between different concerns and reforming tax payments matters a lot for how the sharing economy will evolve. Consumers will benefit from the convenience and lower cost of goods and services provided online. But the issue is much broader than that. At stake is not only regular or extra income for those working in the sharing economy, but also their possibility to shift between freelancing/education/regular employment; see Hall and Krueger (2015). Working in the sharing economy may be a way to avoid unemployment and to retain a foothold in the labor market in times of fast technological change, especially if combined with wider social security coverage and lifelong learning (see further in Chapter 5).

Regaining productivity growth will require realizing the benefits from the digital economy, which will depend on how rules are adapted in several areas:

- Labor markets, such as differences in risk for employment/self-employment (see Chapter 5)
- Ease of entry for new firms balanced against consumer safety
- How taxes are collected, especially when goods become digital services
- Striking a balance between not stifling innovation and protecting producer interests;
- How we treat privacy

While the discussion of ridesharing is important, the real crux is the signal sent to the rest of the economy. Entrepreneurs and innovators searching for a new way to improve businesses and disrupt old ways may be less inclined to risks if high regulatory hurdles are erected – or perceived to be possible ex post. In this section, we discuss a few examples of issues that prevent the full benefits of digitalization while highlighting the importance of good government as a keystone in times of great technological change.

Box 4.1 Digital challenges for firms

Regulation

Businesses have to comply with a myriad of existing regulations but digitalization has some special features that stand out. The core of digital technology is the low marginal cost through scalability and the network effects that enable a firm to reach not only its local market, but the region, country, continent or indeed the entire world. All regulation that hinders expansion is an obstacle both for new and existing businesses and diminishes the benefits of the technology. Geo-blocking with specific country restrictions, asymmetric taxation between digital and non-digital services and different regulatory environments are all examples of this. The European Union is working to reduce regulatory differences through the single market and harmonize standards for qualifications and services but important differences remain. Since cultural and language barriers are significant, regulatory obstacles over and above these hurdles can imply the difference between expanding or staying put. Facebook is subject to regulatory investigation by the European Commission and has argued that the intention of one EU regulatory environment is degenerating into 28 different jurisdictions; see Allen (2015).

The EU is of course not alone in having varied regulatory environments. The US gives considerable freedom to the states, resulting in an environment on par in complexity with the EU but less weighed down by language barriers and different legal frameworks.

Incumbent's curse

It has long been observed that existing businesses – even or perhaps especially successful ones – can succumb to what has colloquially become known as the incumbent's curse. One Swedish example is Ericsson, the telecoms giant that suffered the curse but was able to recover after significant reductions in force. Nokia in Finland was once the dominant mobile phone maker, Microsoft missed the shift to smartphone devices only to try to jump on board after the train had already left the station, and Kodak went into bankruptcy a few years ago.

Research paints a common theme for these failings that, as a matter of course, mostly are not due to myopia or incompetence; see for example Bower and Christensen (1995). Successful firms may find it hard to diverge from a profitable line of business on which the organization was built. The sales force, skilled workers, and indeed - actually especially – existing *customers* may all prefer the old technology and work towards incremental change. Such a development holds true until a disruptive technology gains a foothold and creates a new market, attracting attention and growth. At this point, it may be too late to make a strategic shift. Incumbent firms need to create management structures that can place bets on disruptive technologies and withstand internal opposition when dictated by strategic concerns.

Although easy to describe in theory, this is hard to do in practice, as the bets may *cannibalize* existing profits. New production methods or new products can make old ones obsolete, just as 5 ¼-inch floppy disks were replaced by 3½ inch disks, which were then replaced by CD/DVD, which gave way to network storage and cloud services. The sharing economy may also decrease the need for ownership when many more items can be rented as needed; see Chapter 2.5.

Overall, the chance of long-term survival may all too often lose out against the certainty of lower profits in the short-to-medium term. Digitalization may well be the perfect storm for the incumbent's curse.

Digital skills and labor market mismatch

Big technological shifts imply challenges for the skill set of people in existing businesses as well as for the education system trying to catch up. Facit, the Swedish mechanical calculator company, had its core competence in mechanical skills. When electronic calculators came, the company was not able to regroup; see Sandström (2013).

The mismatch in the Swedish labor market has become more significant in recent years, with an increase in both unemployment and vacant positions (the "Beveridge curve"). In Europe, many people lack digital skills (see Section 5.3 in Chapter 5). To stay competitive, firms need to ensure that workers have adequate training. On the job learning and a life-long perspective on acquiring skills has never been more important, be it for the individual or the firm.

Intellectual property and patents

Digital technology has had profound impact on all items that can be reproduced, such as music, film, and print items. For all those businesses, market conditions have changed and intellectual property remains a crucial concern. Piracy and illegal distribution were difficult to prevent but new business models are emerging to enable producers to charge fees. Still, the changes underway will continue to impact on competition, especially for newspapers, video, and music content.

The handling of patent rights – both the firm's own as well as avoiding infringement of the rights of others – is another complex area. Legal, business, and technical questions overlap as markets and products evolve quickly; see OECD (2015f) for an overview. Patent infringements can be costly, but the area also attracts legal arbitrage and so called *trolls* that try to extract rents, which may dissuade smaller firms from entry and be a cost burden for larger firms.

4.3 Taxation and the digital economy

All the factors that make taxation difficult in the economy are even more challenging for digital goods and services; see OECD (2015g) for a comprehensive overview of taxation in the digital economy. The location of the platform, the use and delivery of the good or service, may all be in different locations within different jurisdictions. Similar physical goods and digital equivalents are taxed at vastly different rates, distort the market, and create peculiar incentives. The case of books vs e-books discussed below is a case in point. This issue is likely to become more important as physical goods are increasingly transformed into digital services.

In Gaspar et al. (2014), an independent expert group for the European Commission, recommendations are given on taxation of the digital economy. Their report stresses a number of central features for how the taxation framework should progress:

- No special tax regime for digital companies: general rules should be applied to all
- Steps toward stable and predictable rules
- Highly restrictive use of tax incentives; and apply them only where there are market failures

These recommendations likely represent consensus among economists but the challenge lies in their implementation. To strive for neutrality, it is important to avoid distorting incentives to less productive uses. The predictability of rules is key to creating conditions for long-term investment but extends well beyond taxation – including regulations discussed in other parts of this chapter as well as corruption. The expected return on an investment can change not only due to taxation but also if requirements to operate change or costs imposed through graft or red tape. For example, a tax increase can have a similar effect on costs as a requirement to introduce additional safety or licensing requirements.

For the digital economy, the above recommendations are a good starting point but a great deal of work remains to be done on a technical level that is beyond the scope of this report. Instead, we will illustrate the discrepancy between the digital economy and the rest of the economy with the example of books. A variety of forces as well as historical accidents can result in taxation that is difficult to understand – and much less justify.

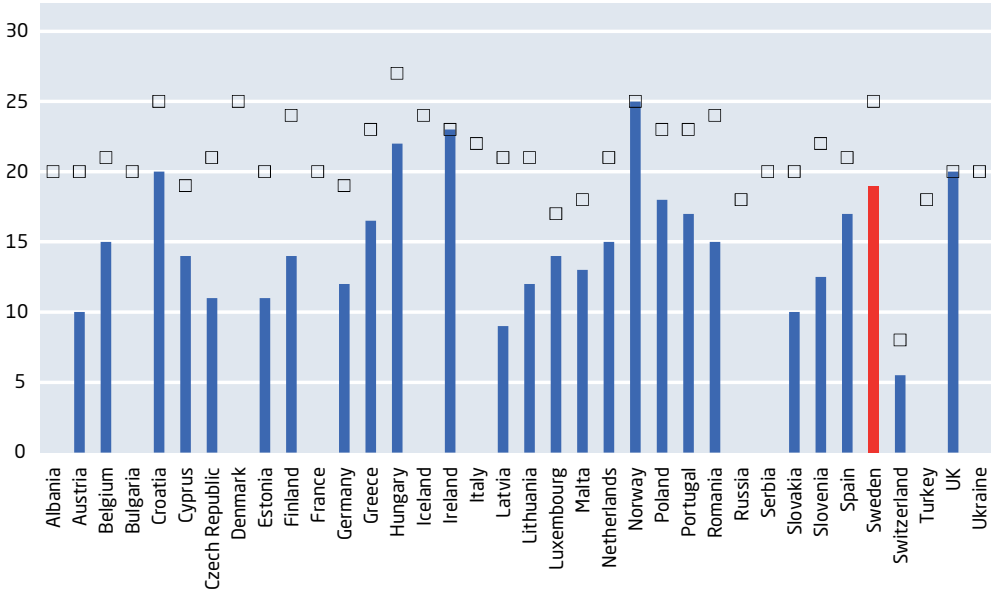
Tax discrepancies between books and e-books

Navigating VAT rules is not for the faint-hearted; there are many differences across countries and various rates within countries, which makes it difficult for businesses. From an efficiency perspective, having a flat VAT would be easiest for firms to administer but political considerations often result in lower VAT on some categories, such as books, food, and children's clothing, depending on the country. Among the tax heterogeneities, one of the most difficult to understand is the difference between VAT on printed books and e-books; see Heyman (2015) and the International Publishers Association (2015). Reading a book or an e-book are arguably just different ways to consume the same good.

For countries in Europe, Figure 4.2 shows the differences in VAT on books and e-books in the vertical bars, along with the general level of VAT. Overall, the price difference is quite significant in Europe. Although only a few countries have no differences and a fairly low applicable VAT, such as France, Iceland, and Italy, most other countries have considerable differences. Ireland has one of the largest discrepancies at 23 percentage points, with zero VAT on print books but 23 percent on e-books; Denmark

has the same VAT for both media, but at the high rate of 25 percent. The median difference in VAT is just over 12 percentage points. In Sweden, the difference is 19 percentage points. For the 79 countries covered in the survey, 35 apply a higher rate of VAT to e-books than to print books.[113]

Figure 4.2. Difference in VAT on print books and e-books in Europe 2015, percentage points and the general level of VAT



Source: International Publishers Association (2015).

Note: The bars show the difference between VAT on print books compared to e-books. Some countries have no difference (and hence the bar is at zero, in Italy, for example). The square indicates the general VAT level in that country.

Trade barriers in e-commerce

In the EU, the basic principle for commerce is freedom of movement for goods and labor. Although a high-level principle, it is not without exceptions and Member States are permitted to impose their own restrictions, motivated, for example, by consumer safety concerns. Such restrictions may be subject to (re-) assessment by the European Court of Justice and are occasionally overturned.

For new digital trends, there is considerable regulatory uncertainty. But for more established areas, such as e-commerce, NBT (2015a) notes significant improvements in regulation during the last couple of years. There has been full harmonization of EU rules on distance-selling and abolition of some establishment requirements. Nonetheless, some obstacles remain for regular e-commerce, such as labeling requirements on products and complying with procedures for local VAT payment. There are also issues with knowing which national rules actually apply in cross-border transactions; for example, which standards apply for marketing, data processing, and sales contracts; see NBT (2015a, page 41) for a summary. For example, barriers are set up by requiring top-level web domains and a physical presence in the country, which raises costs and administration.

By contrast with the tangible remaining obstacles for e-commerce, regulation for new digital trends is murkier; see NBT (2015a). The new business models emerging in the digital economy do not all fit into established regulatory boxes:

[113] The US is not included in the International Publishers Association survey.

- What is the responsibility of the platform owner? Full liability, partial liability, or none – as only a conduit for the transaction? Relevant to most of the sharing economy, exemplified by Uber and Airbnb.
- How should product information requirements be applied to digital devices? Small screens easily become overburdened with information, which is exacerbated by varying national requirements.
- Rules on data protection and cloud services are vague.
- Taxation is a challenge, especially when physical goods become digital services, such as print books vs e-books.

4.4. Regulatory hurdles for digital goods and services need more attention

The legal hurdles for firms in the sharing economy are discussed in Chapter 3. In this section, we instead turn to matters related to regulation of digital goods and services. The issues concerned are broad and affect many aspects of how digital firms compete in markets, ranging from financial regulation to consumer safety. Although copious material exists in each area of regulation, work that provides an overall perspective is sparse. The challenge is that each area of regulation requires specialized knowledge and it may be hard for a non-expert to assess the importance of technical standards and what kind of hurdle they present.

One overall issue for countries in the EU compared to the US is that of the scale of the market. In Chapters 2 and 3 we discussed how the digital economy benefits most from low cost of expansion; the marginal cost of a new user is virtually nil and as users increase, network effects generate increasing returns to scale.

In Europe, the language barrier presents an obvious, major obstacle but arguably it is becoming less so over time. Browsers that can translate text to one's preferred language instantaneously lowers the bar. The difficulty for businesses is instead the cost of adapting their services to various institutional requirements in EU countries, especially since technology expands quickly and regulation lags behind developments. The issue of harmonization is a challenge in the US as well, with varying regimes throughout the states and strong degrees of autonomy. But the EU has to contend with both harmonization and the language barrier.

In the absence of a broad overview of technical hurdles, we instead provide a few examples that illustrate the issues at stake:

- Legal uncertainty about liability for self-driving cars and other transport.
- Legal uncertainty about liability for the Internet of Things (IoT) where gadgets large and small have internet connectivity.
- Asymmetric standards for items built with 3D printers.
- Heterogeneity of local government data and rules.
- Strengthened investor protection deters funding for fintech; see Vasagar (2015b).

Legal obstacles for self-driving vehicles despite vast potential to save human lives

The example of self-driving vehicles is the most widely known. The question of liability in the event of a crash is an important one, but may be one peculiar instance where existing obstacles may be deleterious to consumer safety. Worldwide, more

than a million people die in car accidents every year. There are compelling arguments that self-driving vehicles would result in far fewer accidents; the social and human gains would be sizeable. Edith Ramirez, chair of the Federal Trade Commission:

> "These potential benefits are immense, but so too are the potential risks...We have an important opportunity right now to ensure that new technologies, with the potential to provide enormous benefits, develop in a way that is also protective of consumer privacy."[114]

Notably, there are ethical and quasi-philosophical issues at stake. For example, a person involved in a crash may make split-second decisions about where to steer the vehicle, either at minimum risk to himself or the more altruistic choice of veering into a physical obstacle with greater risk of personal injury. Such choices would have to be pre-programmed by the manufacturer supplying the software that controls the car, and thus a technical solution that improves safety becomes an ethical question that society may not be comfortable with. Essentially, the issue may be weighing the small risk of injuries from self-driving cars against the big potential gains from lives saved through automation. While the potential gains in terms of saved lives are not much disputed, the slowness of regulation implies that the process may nevertheless take many years.

Challenges for liability and privacy for the Internet of Things (IoT)

Other legal uncertainty about IoT may also retard its adoption. When everything is connected, there are great potential benefits but also new risks. If the toaster malfunctions, will the error spread to the pacemaker? If the traffic light breaks down, will the lights in the tunnel work? Essentially, this concerns the risk of contagion or the "butterfly effect," referring to how seemingly unrelated events (a butterfly flapping its wings) can have major impact in non-linear/chaotic systems. If most things are connected, it stands to reason that the risk of contagion may be greater, especially because it is difficult to maintain an overview of all technical aspects that may cause a single system to malfunction.

For firms that build functionality with IoT, the consumer safety issues and liability in the event of an unforeseen event may be a significant hurdle. The IoT also encompasses many issues of privacy where progress may have outstripped regulation. Many devices will be built by manufacturers unused to cybersecurity. Even when security is built into devices, detection might be hard as we do not (yet) interact with gadgets the way we interact with computers. Moreover, the issues may be more serious with IoT than for other data. The hacking of private data in the form of passwords and even financial data may be considerably less upsetting to people than if information about their medical history is leaked, because this can damage job opportunities and affect insurance premiums. For example, a known genetic predisposition to a particular disease may lead to instances where private insurance might be very expensive or unavailable.

No specific laws regulate IoT, which is instead governed by existing legal frameworks; see Croft (2015). This is one explanation for how IoT may be slow to catch hold. Since interconnected devices may contain a lot of personal data, regulators are in new territory as to what kind of consent is needed because while some uses of IoT may

[114] Quoted in Kuchler (2015).

be frivolous, others might be a matter of life and death. For example, it has been suggested that personal technology that monitors health can warn of impending heart attack and thus help save lives, but the same data can also be scanned and analyzed to suggest potential medicines, possibly blurring the line between welcome health monitoring to intrusive personal advertising. The current way of giving consent (such as quickly checking some boxes to participate in networks or download updates) may be problematic when the data is generated by our bodies. The practical issues involved in obtaining consent may be substantial. For these reasons, IoT is likely to take time to implement and the benefits may be a long time coming.

Idiosyncrasies in local government prevent economies of scale for digital services

The right to local self-government is a key feature of democracies and most communities enjoy some autonomy in decisions at the local level; see Hooghe et al. (2010). This helps keep local politics vibrant and ensures that people can vote on matters that affect the local community. Nevertheless, there are several factors that would bring efficiency gains if organized by central government. The trade-off between local accountability and central government economies of scale is a perennial question that is particularly relevant to reaping the benefits of digitalization. Let us consider three examples:

- Taxation
- Schedules, flow of traffic and government data
- Parking zone regulations

If each local government uses the same open data format, app developers can construct software that can be used in the whole country, in every US state, or across the EU. But local rights to self-government mean that such standards often need to be voluntary. However, if each of Sweden's 290 municipalities, or each of France's nearly 37,000, has its own data format the difficulty of incorporating idiosyncrasies into the code may be insurmountable when the cost and benefits are weighed. Each country has its own set of institutions and responsibilities. Nesta, an innovation charity in the UK, has been pioneering various forms of initiatives for open data in governments and the uses to which it can be put. Nonetheless, the value of accelerating work towards voluntary standards that enable the possibility of scale should be considerable, but the supposition that this will take time is not a risky one.

Parking regulations are useful to illustrate the potential benefits of common data standards. With common data, an app developer can write code that can be used in the whole country and eliminate the need for different software for different areas. Moreover, if cities and boroughs within cities can set common rules for parking, parksharing can help to ease the challenge of finding a parking space, an unwelcome obstacle for people coming home or away on business. Someone who owns a free parking space can simply rent it out to whoever wants it via a sharing app; see Wosskow (2014). Moreover, cars that people rent or share can park nearby and be called when needed, which will be especially useful in a future with autonomous vehicles.

Common data standards make the integration of public transport information into commonly used software, such as Google Maps, much more seamless. The benefits to households and consumers would be considerable, especially in congested cities where people want to drive alternative routes to avoid congestion or find alternatives in public transportation.

In Sweden, governmental institutions are not allowed to collate data from different sources, such as tax returns and social security records, to improve services or detect abuse. Ekholm (2015) argues that governmental institutions will find it more difficult to perform their tasks because of outdated views on data. More specifically, it is difficult to process and use data more efficiently to learn from experience and find patterns if every step must be monitored by lawyers.

A final example concerns the tax code. The difficulty of declaring income varies considerably from one country to the next. For most households in Sweden, the process is very streamlined and, for the most part, people can simply confirm the pre-populated tax return form provided by the tax agency via text message or online. Business tax returns are more complex but software is available that automates much of the process. In contrast, the US tax code is one of the more complicated and the benefit of pre-populated tax forms for households would likely be considerable. Nonetheless, due to lobbying there is still primarily only one software package to automate the task; see Manjoo (2015b).

Obstacles for realizing benefits from 3D printing

3D printing of objects can save firms the expense of storing spare parts and reduce the need for costly and timely transportation. Factories, carmakers and others who need to repair broken machines or vehicles need only download a blueprint of the item in question. Clearly, 3D printing has the potential to vastly improve efficiency and reduce costs. On a more non-terrestrial note, astronauts printed a tool needed in their space station that was sent digitally from earth.

The comparatively low cost of 3D printing offers the prospect of small series or highly customized products that would otherwise be too expensive. For people who need prosthetic replacements for missing limbs, 3D printing opens a world of lower cost, convenience and individual fit; see Mrozfeb (2015). Moreover, 3D printing has successfully been used by surgeons to create a practice replica ahead of complex surgery, thus reducing the risks during the actual surgery; see Weintraub (2015). Sometime in the future, it may be possible to print spare organs, such as kidneys, livers, or hearts; see Twentyman (2015b).

Against the background of large benefits to firms and numerous health benefits to patients, allowing 3D printing should be a regulatory priority, but there is anecdotal evidence to suggest that approval in the US is slow; see Wright (2014). In part, the issue is that regulators are unfamiliar with the issues and every printed medical product is potentially different than every other.[115] The unfamiliarity extends across wide areas such as catheters for coronary artery procedures regulated by the US FDA and airplane parts regulated by the US FAA.

In the European Union, the challenges from the regulatory framework are somewhat different. Prosthetic limbs made in regular manufacturing are subject to high quality standards and CE-marking, but those made by 3D printers are *not* subject to any particular legislation; see NBT (2015b). This creates an asymmetry in regulation that could become more problematic as 3D printing becomes more widespread.

NBT (2015b) finds no evidence of specific regulatory hurdles as goods and services become more intertwined in the "servification" of the economy. But there are questions

[115] The US Food and Drug Administration controls the approval and marketing of medical devices, such as catheters for coronary artery procedures. The US Federal Aviation Administration regulates airplane parts and such.

as to how to interpret liability for the final product. Dentists using 3D printers to make dental implants provide an interesting example. Is it the software maker, the supplier of the raw material, or the manufacturer of the 3D printer who bears ultimate liability for the safety of the implant?

A similar issue arises when consumers rent 3D printers online; see NBT (2015b). For regular manufactured goods (toys, etc.), the producer is liable for conforming to CE-marking standards, copyrights, patents etc. It is reasonable to ask whether such demands could be put on a firm supplying a 3D-printing service with no particular interest in the object being printed. If this were to be the case, the business model would not be viable and the potential benefits would be lost. This raises a host of questions that are so far unanswered in the EU regulatory framework and that may hinder innovation; see OECD (2015f).

3D printing has tremendous potential but the obstacles are likely to be considerable and it is not yet a disruptive technology; see Sandström (2015).

New ways of self-regulation to create confidence in market transactions

As we discussed in Chapter 2, trust and confidence in transactions are key factors underpinning the market economy. For some time, payments and delivery of goods were challenges that stunted the growth of the digital economy. Some of the first business models were unsuccessful; boo.com, for example, was a fashion apparel digital marketplace that went bankrupt after the dot.com bubble burst. Nowadays, there are many firms successfully selling goods online; the sharing economy is another key example of how digital interactions have matured and found ways to establish confidence.

By and large, confidence has been built up by means of self-regulation and assessment without much influence from governments. Many service providers integrate evaluations into the process surrounding the actual transaction. For providers of services, such as Uber drivers, Airbnb hosts and others in the sharing economy, a good rating is essential to obtaining new customers. By the same token, consumers also may need to maintain a good rating. For example, there have been reports of people unable to get Uber drives because of low ratings; see Streitfeld (2015b). The same might extend to other types of work or services in the sharing economy.

Indeed, ratings in the sharing economy form a system of self-regulation that has been instrumental in building trust and confidence in their services. We may well go in a direction where digital reputations and footprint are more important to business than other forms of identification and recognition. The striking feature of this development is the palpable absence of government. In many areas important to consumers, governments usually exercise some form of regulation but not in all areas. For example, credit ratings of firms and individuals are typically handled by private companies, such as credit reporting agencies.

As digital reputations become more important, whether or not we will see convergence towards some standard is an open question. Will there be a plethora of different platforms where firms and individuals have to establish reputations one-by-one or will there be some 'transferable digital reputation, like a passport? Perhaps in the future reputations might be aggregated or *leveraged* in some way. We are already seeing some early signs of how digital reputations matter. For example, in Agrawal et al. (2015) contract labor that has performed certain tasks are generally able to charge

higher prices the next time, while some small companies are able to borrow money on the basis of invoices sent to large firms with strong credit ratings; see Economist (2015d).

Whatever the evolution of digital reputations, it remains a key area for trust and without establishing broad and credible ways to build up and monitor reputations, businesses and transactions are likely to be constrained.

4.5 Big data and Internet of things

The Internet of Things (IoT) and big data are topics that have received copious attention and voluminous publications and books; see for example Mayer-Schönberger and Cukier (2013), MGI (2011, 2015a) and Greengard (2015) but any search generates numerous hits in books, magazines, and newspapers. To do these topics justice, we will focus only on the economic forces at work rather than the many possible future uses, which are important but also tend to be rather speculative. It is also necessary to discuss personal privacy and the hype surrounding these technologies. Indeed, MGI (2015a) in a major flagship publications purports to go beyond the hype on IoT, but then writes:

> "Our central finding is that the hype may actually understate the full potential of the Internet of Things...(sic)"- MGI (2015a, page vi).

Personal privacy surrounding these technologies is also a big issue, involving ethics, judgment, political freedom, and a host of other aspects. Again, to do the topic justice we will focus only on those forces that may affect how the technology is used in the economy.

4.5.1 IoT and big data: where we stand today

Big data is arguably already here but less so the IoT. MGI (2015a) gives the example of oil rigs equipped with thousands of sensors that generate data but only 1 percent is analyzed. Even though IoT is largely the physical realization of digital technology and big data is the intangible result, ultimately both are about making current tasks better, everything from health care and manufacturing to science. They also tend to share the same obstacles, especially personal privacy and legal issues.

Big data

It would be useful to have a definition of big data, but developments are moving so fast that it may be more trouble than it is worth. What is clear is that big data... is big. Gigabytes are long out of fashion and we are having to use new and non-terrestrial sounding prefixes to describe size: tera-, peta-, exa-, zetta- and yotta- (the latter being the fathomless 1000^8) bytes. Our ability to store media has increased dramatically almost every year and costs have been coming down. Much of this is due to Moore's law about the size of microprocessors but it is also due to expansions in broadband internet, smart phones, and consumer behavior. The technologies have developed in tandem to make big data a reality. For example, without fast internet access, tracking internet behavior would be less feasible and people would also be less inclined to spend time online. Without fast connections, shopping would be a lesser experience, streaming of movies or uploading pictures might not be happening. Online content draws people in, but it is what people do that generates the data. In big data, we – the people – are the commodities.

All the actions we do online can – and are – tracked by various means. Our surfing habits, the computer we use, what we buy, and our social network footprint are all valuable information that can be used to generate value and make more direct advertising. While many services allow people to opt out, for example by not accepting cookies, but in reality, stronger privacy controls often diminish the online experience and most applications assume a fair amount of exposure. Mostly, the battle for online privacy was lost long ago, if indeed it was fought at all. It is fair to say that online collection of data is an area where regulation is far behind. Even if regulators were to decide on some standard for what data could be collected, it might not be possible to turn the clock back. Even limited regulatory changes are difficult enough. The European Union has recently forced Google to implement the "right to be forgotten," by removing links to people's unwanted past. While it may be costly and technically difficult to implement, it is really only a small part of online personal privacy.

The recent development of ad blockers, whereby advertising can be prevented from appearing on tablets and smart phones, has raised a whole set of new questions. Initially, these developments were welcomed as a means to increase privacy and make web browsing less bogged down by unnecessary data. The downside is that a lot of internet content provided free of charge depends on advertising revenue. Should ad blocking grow in size, so might the availability of free content be reduced. These developments are still recent and it may be the case that some new way is found to reduce nuisance ads while not undermining the "free content" model on much of the internet. But the evolution is still ongoing and it is too early to tell.

Deriving benefits from the IoT

Defining IoT is difficult for a similar reason that big data is somewhat elusive: what is classified as IoT is evolving; see OECD (2015c, page 242). For example, IoT may be intelligent thermostats that help reduce energy consumption, sensors in fridges that monitor available food and best-before dates, or sensors in cars that monitor various aspects of the trip and driving style. But IoT is also about sensors in oil rigs and production processes. The gains from IoT may differ depending on the sector in question, but for consumer goods it may well be that the most benefit is derived once the product is being used – generating data and improving whatever process it is a part of. So far, IoT is mostly used for control and detection, not optimization or improvement, but that is likely to change in the years to come.

While IoT is in its infancy, further developments will depend on regulation and agreements of standards for communication and how platforms communicate. Legal and ethical issues will have to be addressed. On the technical side, the proliferation of sensors will require much more reliable bandwidth, an issue that is addressed with the next generation of mobile networks – 5G. While 4G is already fast for many IoT applications, some of the benefits will only be possible with much more reliable connections. There is a big difference in quality demand, comparing a few minor blips in a streamed movie as opposed to the possible consequences of an electronic hiccup for an industrial appliance performing precision work. Ericsson and other telecommunication companies will roll out 5G in the next few years; we may also see the first phones without SIM cards.

These technical changes imply different challenges in the economy. We will discuss a few to exemplify the issues involved: industry, consumer intelligence, and agriculture. But there are vast applications outside these areas, such as health, the public sector, and environmental protection that are not discussed; the interested reader is referred to MGI (2011,2015) and the references therein.

Big data and IoT in industry

The manufacturing industry has long been pushing the forefront of productivity growth ahead of other sectors, especially services. Future advances in robotics, improved organization and management and other innovations will likely continue this trend. Whether this will be enough to counter negative demographic trends and other factors discussed in Chapter 1 is an open question.

In many respects, manufacturing is ideally suited to using IoT. Big data and IoT have the potential to further boost manufacturing performance and productivity, but – as we will discuss further below – there are obstacles along the way and at present a great deal of data receives scant attention. The potential lies in expanding industry's long tradition of measuring and gathering data about production. A more complete data set for all operations could be used to improve processes and even improve throughput in real time, controlling all aspects of production and saving production time.

MGI (2015a) estimates that product development time can be drastically cut and that delays can be reduced by using simulation. Powerful computers can model events and use 3D to streamline performance. While big data is often associated with people, machines generate vast quantities. Self-driving cars have a huge number of sensors that are continuously updated. Commercial flights generate hundreds of terabytes of data. This makes it possible to draw on real world experiences to improve production design.

Many production lines are already digital but often do not communicate with other parts of the process; see MGI (2011). When all aspects of production are integrated with digital technology, it is possible to get a full picture rather than only trying to improve the parts. Each sequence can be properly modeled and strengthened. Major changes in production can be simulated across several factories in models before implementation. A digital map of production might also point the way to areas where research and innovation would do the most good.

The data generated might also be used for so-called *predictive maintenance*, reducing unscheduled production downtime and reducing, if not eliminating, the need for scheduled maintenance. IoT sensors used in logistics operations show how inventory can be tightly controlled, which is also relevant to production lines. The next level in automation may also further reduce the risk of human errors and their possible consequences.

All the arguments point to a considerable upside in productivity but it is hard to assess the outcome and how serious the obstacles are. MGI (2015a) estimates that IoT will have a huge impact. Following the success of Watson, IBM has invested billions of dollars in IoT, cloud computing, weather services, auto insurance, and health; see Lohr (2015a, b, c). Amazon web services provide vast computing power to firms to apply to their production.

For companies in Europe, going more digital is a competitive race against the US, South Korea, and Japan. Notably, Sweden and Germany have several successful multinationals in industry becoming more digital. Acatach (2013, 2015) describe the challenges and issues for German industry to adapt in this regard, which are also relevant to Sweden despite the differences in size. Notably, Germany's *Industrie 4.0* provides a vision for the country up to 2025, outlining issues and challenges.

A particular challenge for Germany is that the very success and fame of German engineering – from heavy machinery to cars – may make it hard to adapt. Changing a successful business model is difficult, especially if the changes initially do not generate profit – the *incumbent's curse* discussed above. Acatech (2013, 2015) argues that digi-

talization will require a change of focus from product to client, with more individualization according to what customers want. Thus, a continued change towards making production more like services is likely. With digital platforms as the key component, the owner of the data may increasingly come into the driver's seat. This may require adapting management structures and procedures and perhaps also collaborating more with other stakeholders, even competitors:

> "Competitors will cooperate with each other and employees will engage in automated interactions with platform operators, meaning that they will no longer be managed by the traditional in-house management structures of the company that employs them." Acatech (2015, page 13).

The notion that competitors may need some cooperation in digital platforms raises new anti-trust questions that need to be addressed. The technology in itself is already bringing some new aspects to competition policy that we are only beginning to understand; see van Gorp and Batura (2015). The combination of increasing returns to scale from network effects and the rapidly evolving nature of these markets raises new issues of how to maintain competition. Markets are *contestable* in ways that we have not seen before, making entry easy but hard to sustain. The technical nature of standards means that small changes can have big impact on competition. For example, bundled packages of digital applications may increase competition in some instances but reduce it in others; see OECD (2015c, page 19).

The changes are driven by consumer demand, but a particular challenge for industry is that it may be hard to charge more money for IoT connectivity. The costs of investing in the technology are paid up front, while the benefits of improving production with big data may come some years down the road. The issue is further compounded by the sensitivity of data (more on this below) and the legal issues involved. This means that US companies that are already *digital first* have an advantage once they enter. German carmakers have been taking an incremental approach, consistent with long traditions of quality and safety, but this also means being less prepared for the next level of automation, such as for autonomous vehicles. In recent interviews, Google indicates such a direction, wanting to "eat the carmakers' lunch," see Waters and Sharman (2015). This refers to the profits that may arise from delivering content and services to the driver – or to the passengers in the car. The smaller the profit margins on the vehicles, the more important it will be to charge for services rendered to the passengers.

Industry has a long tradition of using robots, but it has often been a time-consuming process to get all aspects right when setting up such lines, especially safety issues with very fast movements that could injure humans. With IoT and big data, robots can be programmed to learn and setting up factories can be much quicker; see OECD (2015c). Indeed, robots are beginning to take over production of electronics that has previously been outsourced to Asia. For example, one of the biggest investors in robots is Foxconn in China/Taiwan, which has been involved in production of iPhones and tablets.

The overall effects of digitalization on industry are hard to assess but a few things are clear, in qualitative terms. Industry may be poised for continued productivity growth – if the obstacles can be overcome. IoT and big data bring potential benefits in automation, improving production from huge amounts of empirical data and energy savings. There are also vast synergies possible between different areas of transport, infrastructure, and sanitation.

Increasing possibilities for price discrimination in consumer markets

One of the clear uses of big data already underway is that of understanding customers and their needs. Information on online behavior and profiles can be used to tailor goods and advertising to specific groups in ways that were not possible before. Prices can be set according to willingness to pay based on sophisticated algorithms, what economists otherwise call price discrimination. For example, algorithms can predict when a customer is likely to leave a website without purchase and hence provide a steeper discount to induce a sale anyway; see Tanner (2014).

In Chapter 2, we discussed how Amazon has been noted to change the price of some goods many times during the day, depending on a range of factors, such as what competitors are doing, etc. While the algorithms that analyze data are becoming cleverer, the underlying change driving price discrimination is big data, extracted from our emails and from our actions online. Every search we perform, every phone call, and every mouse click can be tracked and provide information that may be helpful in designing personal deals; see for example MGI (2011) and the Economist (2010).

In 2011 Malte Spitz, a German member of parliament, requested – and ultimately received – the records from Deutsche Telekom that logged his mobile activities.[116] The records turned out to be quite comprehensive and able to provide a fairly detailed account of his life and whereabouts using "meta data" about his location, time of call etc. Knowing the content would provide another layer of information. In Sweden, journalists at *Dagens Nyheter* accessed similar information and received detailed information about their own whereabouts; see Örstadius and Larsson (2015).

But big data cannot only be used to detect and target consumers to sell goods, they can also be used for services. Drivers in the sharing economy can use data to assess where demand is likely to appear, with services such as *SherpaShare*, and choose to be in the right spot at the right moment, perhaps making it less difficult to find a car on a rainy evening; see Singer and Isaac (2015).

Big data can also be used by management to monitor employees to an extent not previously possible, through email and performance assessments in real time; see for example Streitfeld (2015a). This raises some ethical issues that we will discuss in Chapter 5.4.

Agriculture – low productivity growth may be boosted by IoT and big data

Agriculture is an area that was most affected by the Industrial Revolution, with machines replacing human labor. After many years of gradual changes in the last century, the sector is poised for some significant changes once again. As we discussed in Section 3.4.2 in Chapter 3, automation is making further inroads into farming: robots are now sufficiently flexible to also harvest more delicate fruits and displace more manual labor; tractors are self-driving. Indoor farms are making it possible to exercise a much higher degree of control independent of seasons on all aspects of crop growth, such as light conditions, water flow, and fertilizers; see the Economist (2014d). Robots are also replacing simple milking machines, allowing the animals more freedom and autonomy to decide themselves when it is time for *delatte*; see McKinley (2014). Using various sensors and transponders, the quality and quantity of milk is monitored, how much the animals walk, and their overall condition. Smaller farms that do not upgrade may have a hard time competing. Although the operation

[116] His discussion of what led him to request the records and what transpired afterwards can be seen on TED talks, http://www.ted.com/talks/malte_spitz_your_phone_company_is_watching.

may seem a bit Orwellian, the next level of automation may actually improve animal welfare, giving them more freedom and humans more time to care for them.

But the changes in motion are more encompassing than just the next level of automation; see the Economist (2014c) and Lohr (2015e). The notion of planting crops and using experience to improve conditions and yield are particularly well suited to using big data and IoT. Large databases make it possible to derive information about soil quality, weather patterns, and other data that affect yields. Using cheap (IoT) sensors combined with satellite information, farmers can adjust and improve crop yield to a much larger degree. Big data can play a particularly significant role in understanding the features that improve yield by drawing on vastly different data sets: large variation in the underlying variables reduces the uncertainty of their effect on output.[117] By using all available data, the farmer can assess how much nitrogen is in the fields and thus how much fertilizer is needed and by one estimate yield can increase by 5 percent; see Harding (2014). According to another estimate in MGI (2015a), the increase in crop yield from better use of IoT sensors could be in the range of 25 percent. Though such numbers are clouded in uncertainty, it is unequivocally so that much of the guesswork about what works in agriculture is eliminated while inputs are based more on available science.

The benefits of big data in farming are not limited to better crop yield and output, but also better use of land and water. Better use of available resources may improve sustainability and the environment. Making better use of inputs may be particularly important in areas where water is scarce. California, for example, has experienced many years of drought, affecting farming and consumers alike. In developing countries, where unfavorable weather can result in famine, wiser use of resources is not only a matter of productivity gains but also improving basic living conditions.

4.5.2 Personal privacy

Scott McNealy, co-founder of Sun Microsystems, is alleged to have said: "You have zero privacy…get over it." The last few years has been an inexorably march towards people divulging more and more information about themselves, both willingly and unwittingly. The amount of information that can be mined through our online activities easily lends itself to notions of Big Brother in George Orwell's *1984*. The difference compared to the ominous vision from fiction is that it is not the state collecting the information but private companies. For the most part, people willingly share certain information through their activities in trade for the benefits on the internet, such as free services, networking, and so on.

It is not clear whether a typical user actually is aware of just how much information becomes available through online activities, just as it is doubtful that people (in Sweden) are aware of how much tax is paid on their employment when social security contributions are included.

There may be a privacy backlash in the future, but at least for now, it seems that if ever there was a battle for privacy, it was lost before it was fought. There are many issues related to personal privacy that fall outside the scope of this report; see the discussion in Bylund (2013). A report from Sveriges Konsumenter (2014) finds several examples of firms that do not comply with the Personal Data Act that regulates the processing of personal data.[118] There are also big differences in how much information the user is explicitly asked to share without explicit consent.

[117] To get good parameter estimates of a dependent variable, the more variation there is in the independent variables the better.

[118] The Swedish Consumers' Association.

World Economic Forum (2011) argues that personal data is a new asset class and should be treated as such. Meyer (2015) stresses that consumers should get more value from it than simply giving it away. For this to occur, there will have to be a clearer market transaction than is currently the case and new standards will have to be developed. But as technology is evolving rapidly, it is likely to take time before new standards emerge. Advertising on smart phones and tablets is now in its infancy. Google and other firms are vying to supply content. At the same time, ad blocking software is also being created and should its adoption become widespread, perhaps as a response to issues of personal privacy, the fundamentals will change once again. Personal privacy and its effects will be on the agenda for the foreseeable future. In Sweden, government regulation manages the trick of being simultaneously strict and far behind the times.

4.5.3 The hype

Big data and the IoT have great potential. Indeed, the technologies are being implemented in a variety of sectors with promising results. But they are also surrounded by tremendous hype and it is difficult to forecast the implications. "Not everything that counts can be counted, and not everything that can be counted counts" is an old saying that may well apply. There is an incentive for the people who work with these technologies to sell them regardless of how useful they may be, no different than selling overcapacity or surplus items in the past. Firms and consumers need to embark on a learning-by-doing path to discover the measurements that matter. MGI (2015a) highlights the example of the oil industry that has thousands of sensors on its platforms yet analyzes data for only a few. Perhaps more measurement would improve production but it might also be that only a few of the measures are important and the others mainly noise. Of course, until the data is analyzed, we cannot know which.

The complexity of what works has not been an impediment to very precise and bold forecasts:

- $11.1 trillion per year potential economic and consumer surplus from IoT, MGI (2015a).
- Ericsson predicted 50 billion connected devices by 2020, which in June 2015 was roughly halved to 26 billion, see Ericsson (2015).
- Cisco also predicted 50 billion devices by 2020, see Evans (2011).
- OECD (2015c, page 255) predicts 14 billion by 2022.

The range of forecasts of the vast potential of IoT and big data are part of what the tech analyst firm Gartner labels the *hype cycle*.[119] It is reasonable that there will be considerable growth in IoT applications in the next few years, but forecasts for long-run trends of this kind are notoriously difficult to make. The pace of IoT and big data will depend on the pace of overcoming obstacles for the technologies, discussed in the next section.

But apart from forecast uncertainty, which for most institutions is considerable even for the next few months, there are other issues about the value of big data – whether generated by IoT or consumers.

[119] http://www.gartner.com/newsroom/id/2819918.

Big data – correlations are not the same as causal relationships

In most econometrics courses, usually somewhere in the middle, there will be a small section about correlations and causality; there may also be references to data mining, that is, searching for and manipulating data until the hypothesis being investigated is fulfilled. Econometricians also sometimes talk about *collective* data mining. This occurs when several researchers test the same hypothesis on similar data (thus appearing independent but implicitly acting in cohort and thus not truly independently).

The problem with data mining – be it individual or collective – is that the confidence level at which estimates are confirmed or rejected is incorrect. Statistical tables for confidence bands would need to be adjusted for the entire path of estimation choices the researcher has made to arrive at the conclusion.

Moreover, even when a stable correlation is found, it might have nothing to do with an underlying relationship; see Mayer-Schonberger and Cukier (2013). It could either be spurious – occurring just by chance – or the variables may be connected through other variables that are in fact driving developments. The problem is especially profound with time series: take any two times series with trends: they are likely to be correlated simply by either increasing or decreasing over the years; the underlying trend is time and not an inherent stability in their relationship.

The issue of correlation and causality is also tricky for professional economists, but is becoming increasingly important as more data is collected and analyzed. Businesses are going to get a wealth of correlation analysis, some of which might work well for a while but then suddenly become misleading. A lot of digital firms that base assumptions on correlations may be at risk and the huge amount of available data does not help; this may provide false comfort about the precision of estimates. Large data sets can return small error bands but if the underlying test is unsound, the result may be misleading. To alleviate the problem of over interpreting big data, Peysakhovich and Stephens-Davidowitz (2015) stress the need to also base decisions on "small" data from surveys or other sources.

Nobel laureate Robert Lucas highlighted one particular problem related to predicting behavior based on data in a famous 1976 paper: when underlying factors (such as policy or taxes) change, consumer behavior may also change, which may well be the case for data extracted from online behavior. One example is Google's flu predictor, launched in 2008, which was based in part on the number of flu-related searches on their web site. It was initially successful but then overstated the results for several years; see Lazer et al. (2014).

Why were the results wrong and what might be the implications for other big data analysis? Two possible explanations stand out. First, as Google was becoming more widely used, people might search for flu not because of their own symptoms but to find out if flu was approaching their area (i.e., the behavior change that Robert Lucas wrote about in an economic context). Second, as Google continuously tweaks its search engine, the comparison to past data may change. Lazer et al. (2014) also note that it is difficult to improve on the simple model used by the US Center for Disease Control (CDC).

While errors in predicting the flu might seem relatively minor, as IoT and big data become larger parts of our lives – measuring our health, driving habits, consumer preferences, and so on – the potential missteps can become more serious. Research and science have a slow and laborious way of verifying claims and big data with higher precision does not downgrade the importance of being mindful of whether the results are correlations or actual causal relations.

4.5.4 Obstacles

There are three main obstacles that may slow the use and adoption of IoT:

- Institutional inertia
- Government regulation, including in the area of privacy
- Proliferation of platforms – difficulty agreeing on standards

Institutional inertia and risks to business: lessons from the past

While the digital revolution is faster than previous technical changes, not all features involving digital will adapt at the same time. Many of the fastest changes, like the sharing economy and social networks, are consumer-driven. By contrast, some of the IoT benefits accrue to established firms and then changes may be slower. Existing businesses have management and organizations built around a profit generating line; if the line has been successful to date, willingness to change may be muted.

The prime example of this in modern times is Kodak, which practically invented digital photography. From what little is known about internal deliberations, Kodak management knew they needed to change, but was unable to steer the company away from its cash cow of analogue pictures, though the risks were clear even then. Several decades ago, Facit, a Swedish company that made mechanical calculators, was similarly unable to change as technology went electronic. Facit had its core human skills in mechanical engineering and the location of a small Swedish town were obstacles that would have been difficult under most circumstances, and ultimately proved insurmountable; see Sandström (2013). Even with the experience of Facit as a warning sign, a similar fate almost beset Hasselblad, a Danish/Swedish camera manufacturer; see Sandström (2011).

In general, successful businesses will find it especially hard to change when the decisions de facto imply cannibalizing the existing business and main profit lines. This dilemma has been at the forefront of print newspapers that suddenly found themselves faced with the question of how much material to put on their websites for free. Of course, restricting all traffic to pay-per-view was possible but in practice meant fewer viewers, especially newer generations. Making too much free content available, on the other hand, meant losing revenues and risking the alienation of existing print subscribers – why pay when most content is free anyway? The dilemma of how much to charge for media and what to provide free remains to this day and successful magazines and firms have managed to strike a balance, notably the Economist and the Financial Times. Two examples in Sweden are the evening paper *Aftonbladet,* and *Dagens Samhälle*, a weekly paper mainly aimed at local government that has a different payment model, providing very little free of charge – mainly the debate forum – and is able to charge for its print copies.

The free vs pay question lingers over other consumer goods as well, especially gadgets that were previously sold separately but are now often free of charge on smart phones, such as GPS navigation, running apps, and radios.

For industry, the speed of IoT adoption will depend on a number of factors. For one, transforming businesses to IoT and using new technology will be risky and require investments that may only reap benefits far in the future – if at all. This may result in skepticism and risk-aversion at senior management levels. Moreover, technology moves fast and it is easy to be left by the wayside. Ford, for example, recently discontinued its investment in car seats that could measure data from the driver, such as for

the purpose of warning of an impending heart attack. The decision was ostensibly based on an assessment of being too far behind competitors; see Sharman (2015). Moreover, as noted by Acatech (2015), clients may not initially be prepared to pay a premium for IoT applications until they are convinced of the business case – a sort of classic chicken/egg problem.

A second factor is the quality of data. Management in some firms may not trust the existing data; see the Economist (2010). For example, data may be poor due to duplicates or incorrect entries. The risk is then that big data would build a bigger haystack with the same poor hay, making it harder to find the needle.

Third, old-tech companies may face competition from new purely digital firms. This is already occurring in some areas, such as *fintech*, automobiles, and some home appliances. Firms that are digital from get-go are not bogged down by legacy systems and face no organizational inertia of the type that drove Kodak to the grave. Google's recent reorganization as a holding company for a variety of businesses can be seen in the light of the business maturing and requiring more management focus on individual ventures to assuage investors' concerns. Google is known for making big bets and investors may want more transparency concerning their viability, for example for autonomous cars and home appliances; Samsung is already a giant in consumer electronics and can leverage this to IoT applications. In insurance industries, new startups such as Oscar in New York are drawing from the advantages of big data to make better business and provide a simpler interface for its customers; see De la Merced (2015).

Although some industry, such as automobiles, may be subject to competition from digital firms (Google), it seems unlikely that the heavy manufacturing industry will have much to fear – at least in the first phases of the digital transformation. Investors may not have the patience for even extraordinarily successful firms like Google and Amazon to foray into areas far outside their domain unless they generate profits; see Garrahan and Bond (2015); Google Glass (with internet connectivity and camera) was recently ditched and the future may imply greater discipline and focus on core business. Amazon is another example of a firm trying to enter new markets and revolutionize businesses, most recently with plans to deliver ordered goods via drones. IBM's Watson is venturing into health care analytics with its recent acquisition of Merge Healthcare; see Lohr (2015c). We are now seeing a new range of collaboration between tech and medicine, for example, robot surgeons and automated medical advice: "Dr. Google (or Dr. Apple) will see you now" may well become a reality in the not too distant future; see Crow (2015). Depending on the ability to go from concept to consumer acceptance, the profits for digital firms may give more or less leeway to enter other areas. But for manufacturing and pharmaceuticals, where the start-up-costs of entry are large, these specters do not seem imminent.

Government regulation, privacy, and safety

If one goes searching for an area that holds a lot of promise but also an inordinate amount of regulatory miasma, IoT would surely qualify. It has privacy issues, safety issues, commercial applications, military applications, and health issues. Practically all the controversial topics one can think of apply to the IoT in one way or another.

One perception of IoT is that of connected household appliances, such as the fridge, coffeemaker, etc. The idea of an intelligent fridge that knows when you are running low on milk and can order delivery or not, depending on your schedule, is surely a fun gimmick which may or may not be viable commercially. When our heating systems

and thermostats are hooked up, whoever owns or has access to the data knows when we are home and has a great deal of information about our habits. What happens if the fridge and other gadgets are hacked? When gadgets in our homes can be read and manipulated, the temperature on all sorts of privacy issues is bound to rise. Knowing our habits at home could be a gold mine of information – and not all of it will be innocuous.

But even more worrisome is the possibility of hacking IoT gadgets – for fun or for nefarious purposes. Only the imagination can limit the havoc that could be wreaked – everything from disrupting pacemakers to taking over control of cars. Recently, hackers demonstrated how they could take over a car armed essentially only with the IP address; see Tufekci (2015). Another central privacy concern related to IoT gadgets is that of disclosure of medical histories and the issues this poses to insurance premiums and future employment opportunities. Because data may be processed by a lot of companies that are digital security neophytes, data security is an issue; even firms whose core business is actually IT routinely have to issue security patches and updates.

We are likely to see firms having to try different ways to discover what kind of IoT devices are viable – for businesses and households alike. For a lot of people, the benefit of divulging private information via their surfing habits or on social networks perhaps outweighs the costs, at least on the evidence that the practice is so widespread; for the IoT, this remains an open question. The benefits of remote controlling the coffee-maker or washing machine may be small for many people – and the convenience marginal – compared to the risks posed.

The challenge of establishing rules for privacy and protection versus the need for business to use data for new services will remain relevant in the years to come. The European Court of Justice recently ruled against the "Safe Harbor" agreement that has allowed firms such as Google and Facebook to transfer data between Europe and the US on the implicit understanding that it was adequately protected by local legislation; see Robinson et al. (2015). The implications of tearing up this consensus on data protection are still being explored. Morozov (2015) argues that we are just in the beginning of a worldwide fight on how to handle data. These developments make it more difficult to extract benefit from the data, a topic we discuss in a more specific context in the next section – that of data owned or administered by local government.

Obstacles to obtaining benefits from open data in local government

Governmental bodies collect vast amounts of data for a variety of purposes, such as monitoring, tax collection etc. Only some of the data is provided free of charge; most is available only for a fee and some not at all, either for privacy reasons or because it is stored in analog form. The benefits of some data can be substantial, for example information about geography and maps, historical information, and art.

Pricing of the data is sometimes an obstacle. In many countries, governmental bodies charge considerable amounts, notably statistical agencies. Koski (2011) uses data on 15 countries over the period of 2000–2007, including major EU countries, Sweden, and the US, to estimate the effects of pricing. The result is that freely available data or data charged at marginal cost is associated with 15 percent stronger growth for firms; the effects are particularly evident for small and medium sized enterprises, less so for larger firms. In Denmark, one study found that free and unrestricted access to addresses generates high monetary value and the benefits accrue about 30 percent to the public sector and 70 percent to the private sector; see Danish Enterprise (2010).

The value of this data is also emphasized in Vickery (2011) for the European Union as a whole and estimated at about €27 billion. Although there is some uncertainty about how much the market and services for data could grow, most estimates point to substantial benefits; see also SOU (2014b).

There are several obstacles to harvesting benefit from data. To be sure, some of the data may contain sensitive information. Even when data is anonymized on the surface, it may nevertheless still be possible to identify individuals by correlating the information with other sources. These issues are real and need to be addressed, but at the same time are not an argument for not making concerted efforts to extract the benefits for the public and firms. For example, digital maps and information about public transportation and traffic can help commuters and tourists alike. The Stockholm Chamber of Commerce argues that this and other data should be available electronically at little or no charge with clear disclosure of data sources; see Stockholms Handelskammare (2014).[120]

Data protection in the EU – the General Data Protection Regulation

For some businesses the flow of data between borders is important to operations and is likely to become even more so in the future. The benefits of IoT and big data will not accrue to firms if data has to be scrutinized, sanitized or – in a manner of speaking – present a passport at the border. At the same time, there are legitimate questions about how such data is handled, in terms of privacy, copyright etc. The European Court of Justice recently ruled against the Safe Harbor Directive; see Robinson et al. (2015). The potential impact is that data may no longer be sent back and forth between US and Europe, thereby limiting the potential economic benefits while, at least for now, placing emphasis on personal privacy.

This ruling is not likely to be the end of how the overcome the challenge of balancing economic interests against those of privacy. It is vital that the EU continues to address this issue and brings clarity. Data-driven innovation will be essential for new business models; see for example World Economic Forum (2011). Svensk Handel (2015) also emphasizes the importance of:[121]

- Bringing clarity to the rules about what constitutes personal data.
- Reducing uncertainty about joint liability of data processors and data controllers.
- Having a set of sanctions for breaches that is proportional to the severity of infractions and making allowances for warnings if breaches are unintended. The current proposal may unduly deter innovation.

Proliferation of platforms and standards

The hype of connecting data on everything and optimization is based on data being in compatible formats to enable seamless exchange between the traffic system in a city, public transportation, energy and water utilities in the public sector. In the private sector, the benefits also depend on communication up and downstream – from suppliers of intermediate goods to final producers and retail stores. But there is a clear risk that there will be a proliferation of competing platforms. Granted, the process of establishing a winning platform is necessary to find a good market-based solution, but it may take time. The experience from previous platform competitions is mixed. Betamax video was likely a superior format in quality to VHS, but lost

[120] Stockholm Chamber of Commerce.
[121] The Swedish Trade Federation.

anyway. After some years of competition, Blu-ray movies won the HD format war. There is nothing inevitable about the swift emergence of a single platform; even when this is the case, there are also complicated anti-trust issues to contend with; see Van Gorp and Batura (2015).

The winner of the platform race is set to reap big benefits. But clearly, if it takes many years to agree on standards to apply to IoT communication, the benefits of interconnectedness may be a long time coming; see Thomas (2014).

4.6 Summary

Against the background of slow productivity growth, it should be an imperative to ease the obstacles for businesses to grow and create value. The European Commission is working to strengthen the single market and solidify the foundations of the single digital market. While significant progress has been made on the free movement of goods, challenges remain for new business models associated with the digital economy, such as the sharing economy and peer-to-peer platforms, liability, copyright, information requirements, and processing VAT payments.

The pace of reform and clarification on these issues may be too slow for the benefits to help productivity in the short-to-medium term. The dampening macro trends discussed in Chapter 1 arising from aging populations and high public debt are aggravated by the aftermath of the financial crisis, affecting young people trying to enter the labor market as well as middle-aged people who have been laid off or had poor wage development. There is too little urgency to resolve the obstacles and allow productivity the full benefit of the potential of rapid technological change.

Regulators are belatedly trying to set tough standards for privacy, but this arguably amounts to closing the barn door after the horse has bolted. An enormous amount of information is already voluntarily given away to get free services, such as email, maps, etc. Turning the behemoth cruise liner around and away from free digital services in exchange for private meta-data would be inordinately difficult – and probably not even possible. A more interesting question for businesses and regulators to discuss is whether there can be a market for personal information and how that might be balanced against privacy concerns. Can individuals decide to sell varying parts of their information and get value in return? And what is the market price for such data? These are open questions that deserve further attention.

IoT, big data, and 3D printing all hold major promise for future disruption but it is difficult to separate the substance from the hype. The regulatory questions and privacy issues attached to IoT, especially related to people's health, are considerable. Perhaps we will first see IoT being introduced in industry – and especially in agriculture where it is already in use and improving productivity.

Another major obstacle for the benefits of digitalization is the lack of skills. Education systems need to improve and be more responsive to the needs of business. Periods of rapid change also motivate greater focus on in-house training and life-long learning. The notion of one education followed by a lifetime at the same job is more incongruent with each year of increasing life expectancy in Sweden and elsewhere, a topic we discuss further in the next chapter.

5. I robot, you employed, he or she freelance

"In the twenty-first century, stable, long-term employment with a single employer will no longer be the norm, and unemployment or underemployment will no longer be a rare and exceptional situation. Intermittence will increasingly prevail, with individuals serving as wage earners, freelancers, entrepreneurs, and jobless at different stages of their working lives." Colin and Palier (2015).

5.1 Introduction

In this chapter we connect some of the issues in this report to discuss challenges for education, lifelong learning and what this may imply for future work and inequality. Sweden has fallen behind in a succession of PISA studies and skills improvement will be important in the future to Swedish competitiveness in the world economy. Education and inequality are big topics, of course, and for reasons of brevity, we will discuss them primarily in the context of digitalization. But given the risk that more automation may increase unemployment and inequality, this focus brings some clarity to choices concerning regulation and taxation that may make a profound difference for welfare in the next decades.

The effects of digitalization on the economy are broad and we have touched on some of the main developments in this report. In the final section, we will also outline some policy issues that are crucial to the smooth development of welfare while adjusting to a more digital economy. In particular, what features stand out that would mitigate the risk of rising unemployment and inequality? Highlighting the areas that matter most is worthwhile, as this also excludes areas that are less significant and indeed indicate policies that might even be counterproductive.

But first we will begin with a brief overview of Sweden's position as an IT nation and the features that facilitated a strong standing despite being a small country on the periphery of Europe. Will these strengths endure or will other countries catch up?

5.2 Sweden as a great IT nation, is the past any guide?

How did Sweden become a prominent digital nation?

Sweden is among the countries with the highest internet penetration in the world. Fixed broadband is also widely available, though the goal of full coverage has not been achieved and would be prohibitively expensive in sparsely populated areas.

Was the success due to explicit policies or was Sweden just lucky? Frick (2015) discusses the events that led to Sweden's current position:

- Starting in the 1970s, certain key individuals played a significant role in promoting standards and technology
- Among the significant events that gave Sweden a head start was the role these individuals played in developing internet protocol (IP) standards

- The Commodore 64 with 64 kB of memory was hugely popular among early geeks who wanted to tinker and experiment with code (including the author of this report)
- The Compis school computer introduced in the mid 1980s flopped, but may have had positive long term benefits by contributing to the wider spread of digital curiosity
- The "Home PC reform" subsidized household purchases of computers and the government made "broadband for all" a political priority, which, although it met with some success, did not accomplish its goal
- Symbolism at the highest political level when Swedish Prime Minister Carl Bildt sent an email to US President Bill Clinton in 1994

Sweden's IT history is thus not a straight and self-evident path to its destination as a successful IT nation exemplified by firms such as Mojang, Skype, and Spotify. Instead, a combination of various initiatives, often with unclear short-term benefit, led to long-term digital maturity. Frick (2015) stresses the importance of certain key individuals who played a central role from the 1970s and onwards, among them Jacob Palme, Björn Eriksen, Peter Löthberg, and Ragnar Lönn. Also, the period before Sweden acceded to the EU was characterized by a mixture of competition and cooperation between private companies, notably Ericsson, and the state-owned telecom company, in which KTH, the Royal Institute of Technology, played a vital role, see Kaijser (2015).

Benchmark measures of Sweden's standing as IT nation

Sweden typically ranks among the leaders in IT development, sharing the top five or ten positions with Finland, Denmark, Norway, South Korea, the UK, the US, and New Zealand; see SOU (2014a, page 37). The relative rankings of these leading countries have moved only slightly in the last few years and are fairly stable. Sweden remains among the top countries.

Sweden has attracted increasing attention as an IT nation; see for example Powell (2012) and Milne (2014). Established industry has a long tradition of engineering and excellence through ABB, Electrolux, Ericsson, Volvo, and Scania. The largest IT company in Sweden may well be Volvo. As regards new firms in the digital economy, Facebook has located its data center to Luleå where it benefits from low energy costs and a favorable climate for computers that keeps cooling costs down. The data centers provide considerable investment in the local area, estimated by BCG (2014) at SEK 9 billion in total and involving 4,500 full-time workers over the course of ten years throughout the country. However, once built, data centers typically do not require a lot of people in their day-to-day operations.

For a small country, Sweden has produced quite a few successful IT startups. Otherwise, the US and China tend to dominate in digital startups that become very successful; see Foley (2015). The relative success of Swedish startups is explained by a combination of factors. Strong institutions and strong technical community gave Sweden a head start. As a relatively small market, digital Swedish companies often need to consider global expansion from the very beginning; if the company is successful, fewer steps are needed to expand globally. Moreover, the success of the first wave of Swedish digital firms created a strong brand name, attracting more venture capital; see Ahmed (2015b).

Overall, Sweden's standing as a tech nation is well beyond its size in the world economy. But the features that led to this strong development might not necessarily endure. For one thing, other nations are catching up. The value of the initial head

start with Internet Protocol (IP) and network standards will not last forever, especially in the context of the European Union where discussions are underway to establish standards in a variety of different areas, notably in mobile broadband and reducing roaming charges on smart phones.

The increasing dominance of platforms, such as Android and iOS, imply that significant network benefits accrue to the US by default. When digital companies in smaller countries find pockets of inefficiency and expand, they will in many cases have to rely on platforms built in Silicon Valley. A recent survey by Chakravorti et al. (2015) puts Sweden among countries that may either succeed or stall in digital expansion, along with the UK and Canada. One should not give too much credence to the inevitability of decline. The point is rather that Swedish success cannot be taken for granted and Sweden's future standing depends on how institutions adapt and how regulation is updated to accrue greater benefit from digitalization.

5.3 Human capital, digital skills and lifelong learning

Skills in core subjects, such as mathematics, language, and science, is important in the labor market and vital for highly skilled jobs. The lack of a high school/secondary education makes entry into the labor market more difficult and dampens lifetime wage prospects. As discussed in Chapter 3, there are still going to be many jobs that require less formal education, but the possibility of making a career with increasing lifetime prospects will be correspondingly harder. The same holds true to an even greater extent the higher up the skills ladder one aspires.

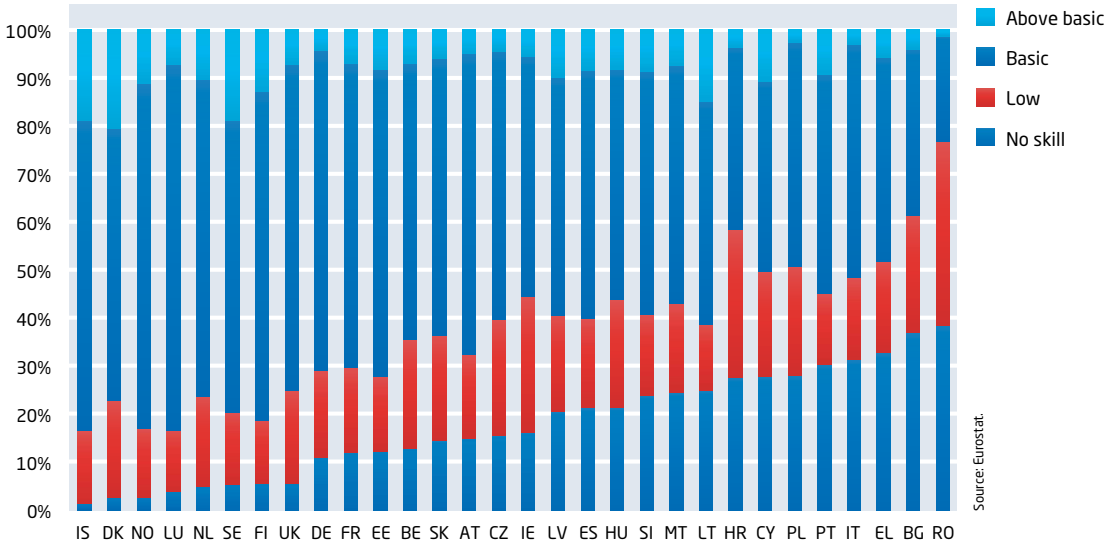
While core subjects are the foundation of requisite skills, digital skills are becoming increasingly important. The number of jobs that require interaction with computers and smart phones is on the rise and includes everyone from truck drivers to baristas and hairstylists. Indeed, there will be few jobs that do not require some form of digital skill, such as handling electronic booking systems, giving feedback en route, or taking advantage of tools that increase productivity at work.

What is the current level of digital skills?

Both the European Commission and the OECD measure the level of digital skills among member states. OECD (2014b) has found large variation, with high internet usage among the adult population in Luxembourg, the Netherlands and the Nordic countries (including Sweden), but low rates in southern Europe, notably Greece and Italy. The Nordic countries are also among the highest in measurements of user sophistication; OECD (2014b, page 81).

Eurostat measures digital skills and in the 2014 survey continue to find that poorer EU countries dominate with "no" or "low" digital skills; see Figure 5.1. Another glaring feature of digital skills in Europe is the large number of people identified as having "basic" skills. Sweden is among the countries with relatively good skills, with about 80 percent of the population in the "basic" or "above basic" categories. While such categories are sometimes sensitive to cutoff points and definitions, the overall view is that there is considerable room for improvement. The "middle" category of digital competence may be particularly vulnerable to the next wave of automation. The countries with lower GDP per capita in the EU also tend to be those with lower digital skills, making the structural change ahead more difficult for those countries.

Figure 5.1 Digital skills in the EU (percent of individuals), 2014



The first publication of the OECD PISA assessment of digital skills on 15 September 2015 give cause of concern for Sweden, as did the poor results in the overall survey; see OECD (2015d). The general findings are that:

- Even countries that have invested heavily in ICT for education have not seen any noticeable improvement in reading, mathematics or science
- The gap between advantaged and disadvantaged children is similar to the gap in traditional PISA tests
- Students who use computers extensively in school do much worse in PISA even when adjusted for social and demographic background, suggesting that computer time is not being spent productively

These findings are worrisome and one conclusion emphasized by OECD is that to reduce inequalities, it is imperative to reduce knowledge gaps in traditional fields first, notably in mathematics, writing and science. Sweden's performance in "digital reading" declined markedly between 2009 and 2012; see OECD (2015d, page 22), and is at about median performance in the OECD despite higher than average internet access. Sweden's decline in digital skills thus mirrors its downward trend in the overall PISA.

Another key lesson from the OECD report is that improving digital skills is not a matter of spending more public money, but how that money is spent. This result is consistent with Vigdor and Ladd (2010), who report no improvement in skills for disadvantaged groups despite subsidies.

Digital skills and the labor market today

In 2013, just under 40 percent of individuals in the EU labor force on average assessed their own computer skills as adequate to allow them to change jobs within a year. Here as well, the Nordic countries and the Netherlands are on top. Just below 60 percent of Swedish respondents judged their digital skills to be sufficient for a job change. The lack of IT skills is, as expected, especially concentrated among people with low education; see OECD (2014b, page 89). OECD (2012) finds that people with the lowest skills are 1.8 times more likely to be unemployed and 1.4 times more likely compared to a reference group.

It is likely that small improvements in skills might make a big difference for employability and wage growth for people who have more rudimentary skills. For example, commercial trucks – a physical good – are increasingly being transformed into services rendered through IT. Drivers who are more able to use this technology will have an advantage,[122] a factor that is likely to hold across many areas in the labor market. Experience from an online labor market shows that even small improvements in skills and reputation can have significant impact on the ability to get contracts; see Agrawal et al. (2015).

The lack of digital skills is of course only one aspect of human capital, but remains important. OECD (2012) estimates that 25 percent of firms in member states are concerned about the availability of adequately trained workers, with markedly worse numbers for Africa, the Pacific, and East Asia. MGI (2015b) discusses the persistent mismatch between jobs and skills at the global level, with about 30–45 percent of the adult population unemployed. Poorer countries especially would benefit from increasing digital skill levels in the population combined with infrastructure that supports digital communication. With online platforms for work, such as Upwork, people from all open economies can supply their services even if there is no demand in the local market. Access to such online platforms could thus provide substantial benefits, but will of course not solve other structural problems in developing economies.

Digital skills and inequality

Inequality as measured by Gini coefficients has increased somewhat in recent years, but Sweden remains among the countries with the lowest level of inequality among all OECD countries. In the OECD as a whole, the gap between rich and poor is at its highest level in 30 years; see OECD (2015e). The biggest driver of inequality is unemployment – especially long-term unemployment. Moreover, unemployment spells that last longer than roughly six months substantially increase the risk of eroding human capital and self-confidence and creating a vicious cycle that further damages employability.

This matters a great deal during regular business cycles but is likely to become even more significant for overall welfare in periods of rapid technological change when the difference between having the right skills or inadequate skills can result in unemployment or slow real wage growth. Since wage growth should follow productivity, people who fall behind in skills may have poor lifetime earning prospects. Notably, in the US this has already occurred for broad groups of low and middle income earners in recent decades (see Chapter 3) with increasing tension, especially among lower paying jobs (the "working poor"). A number of people in low-paying jobs in the US are also receiving food stamps, thus a de facto subsidy from the government to low-wage employers, for example in fast-food restaurants; see Cohen (2015) and Jacobs et al. (2015).

New evidence from Norway shows that broadband adoption in firms complements skilled workers but replaces unskilled workers performing routine tasks; see Akerman et al. (2015). Other findings indicate that lower income children fall even further behind in IT skills and this occurs even when they are provided subsidized computers. Although these children improve their general IT skills, research shows that grades tend to go down; see Stross (2010) and Vigdor and Ladd (2010). One possible explanation for this outcome is that in environments with little parental support for learning, the computers are used too much for entertainment; see also Richtel (2012). This result is also reinforced by the results of the digital PISA study in OECD (2015d).

[122] For example, trucks that have a "black box," similar to that of airplanes, can give feedback on driving/fuel efficiency in real time.

This implies that simple policies aimed directly at children in poorer families do not work on their own and need to be supplemented by other tools or redesigned. It is beyond the scope of this report to discuss specific policies in schools, but it stands to reason that if the environment for studies is inadequate at home, perhaps more organized homework should be done in school at the end of the school day. OECD (2015d) emphasizes that the digital divide in skills between disadvantaged and advantaged children reflects differences in traditional skills in mathematics, language, and science. Notably, more ICT in schools is not enough by itself and the results of the OECD study highlight the importance of teaching children to be critical judges of online content. Moreover, teachers and parents also need to mitigate the risks of internet use related to bullying, privacy concerns and over-consumption of entertainment. Using the computer for more than six hours per day was associated with markedly worse academic performance, not unexpectedly since that means less time is spent on homework.

General skills and digital skills are key to job opportunities and better lives. Professor Alison Woolf has argued in series of books and articles that the general drive for more education has resulted in a quality problem; see for example Wolf (2002, 2011). One argument is that a relaxation of selection criteria and grade inflation have led to lower educational standards and overly optimistic expectations of job opportunities after graduation. Many graduates find jobs for which they may feel they are overqualified or in fact are overqualified. Or in the words of Beaudry et al. (2013), "...having a BA [bachelors' degree] is less about obtaining access to high paying managerial and technology jobs and more about beating out less educated workers for the barista or clerical job."

The "overqualified" barista seems so far to be primarily a US problem. For Sweden, the results in Adermon and Gustavsson (2015) indicate that job polarization has primarily involved an increase in highly paid jobs and not the increase in low paid jobs observed in other OECD countries; see chapter 3. While not conclusive, it is at least indicative that the overeducated barista is not a structural problem in Sweden. Notably, the outcomes of wage negotiations depend on the institutional forms for wage bargaining. The institutions in Sweden are geared towards setting wages according to productivity growth, especially in the export sector subject to global competition. There are also strong elements of equity concerns that so far have likely contributed to preventing wage polarization, but the serious mismatch in available skills identified by firms, especially in highly skilled workers, is a warning of potential changes in the labor market. The lack of workers with the right skills combined with aging populations may increase the incentive to automate work.

Digital skills in the future, complements or substitutes?

Economic history has exhibited periods of deskilling, where workers with lower skills using machines have replaced humans, as well periods in which technology has enhanced and complemented human work, see Chapter 3. Although the last few decades have been dominated by complementarity between work and machine, this is not a law of nature.

What does this mean for the labor market? Brynjolfsson and McAfee (2014) argue that those with low to medium skills face dimmer prospects in the labor market unless their skills imply productivity higher than machines. Those whose productivity is lower than that of the machines risk poor real wage growth or unemployment unless they can improve their skills.

Having the right skill has of course been imperative for good prospects in the labor market for a long time but two trends are now changing the nature of this dynamic. The speed of technological change implies that the "best-before" date for certain skills acquired in school comes *sooner* in our working lives. In addition, the fact that we live longer implies a longer share of our working lives may be lived with a rusty skill set, especially when it comes to digital skills.

A key lesson from the recent OECD (2015d) survey is that more computers are not always better and that some students have done worse in other subjects when they use computers too much or unproductively. This taken together with the results of Akerman et al. (2015) showing that digital skills tend to become complementary for advantaged groups, but not for disadvantaged, groups could well be an indication of further polarization in the labor market.

The Swedish Digitalization Commission emphasizes the variety of digital competence in its report SOU (2015a), including digital skills required to interact socially, with local government, and at work. The report also stresses the need for lifelong learning and improving digital skills. It also notes that computers are used widely in the private sector and that this has increased markedly in the last decade. More than 98 percent of firms with more than ten employees use computers and digital tools. Earlier reports on the challenges facing smaller and medium sized firms highlighted the lack of skills and the time it takes to acquire those skills as a problem.

While we concur with the recommendation on lifelong learning in SOU (2015a), the figures presented above on computer use in business may provide false comfort. Having a computer at work may mean using it for anything from writing documents only (as an advanced typewriter) to using it for 3D modelling or tweaking production processes. If computers are used as in the former case, Professor Robert Gordon would be right about the future of productivity growth; see Chapter 1. The benefits of electronic documents have already been gained long ago and will not budge future growth.

Instead, we need to find ways to replenish knowledge, especially digital skills, throughout our working lives. But the benefits of digital skills will be hampered unless the school system as a whole is able to reverse its negative trend. As highlighted by OECD (2015d, f), digital skills do not exist in a vacuum and need to be supported by other knowledge.

How we improve skills and lifelong learning, again, especially digital skills, is a topic beyond the scope of this report, but some general comments can be made. With longer working lives, it is more reasonable to spend time in education throughout lives, either to acquire new knowledge or prepare for changing careers; see Blix (2013a, b) for an extensive discussion of this. The more general the skills, the more reasonable it is to have public financing as the main option. Sweden is already one of the countries that places the most emphasis on adult education and thus has many of the elements in place that need to be utilized. For skills that are more specialized or firm-specific, private sector funding should continue to be the main source of financing in conjunction with more favorable tax treatment of the investment.

The UK Tech Partnership is one example of public/private cooperation aimed at raising skills in firms and boosting digital learning in schools, especially for girls. The initiative is something that could very well be explored for Sweden. Anecdotal evidence from the US suggests that people who have general skills and upgrade them with some digital training in areas like Web design or programming, improve their chances of finding well-paid work; see Manjoo (2015c). It is likely that people with skills in

specific areas can strengthen their chances in the labor market by improving their digital skills and that this lesson holds widely true in the economy as a whole.

To highlight the importance of improving skills in the workforce, the tax system could be much more supportive of its treatment of investments in human capital. More specifically, investment in physical capital and human capital can be put on more equal footing; see Almega (2014). Today, firms have to expense the costs of investments in training education the same year and cannot spread the cost across several years as is possible with other types of investment.

5.4 Risk sharing in the economy, digital version

How many jobs will be automated in the future is a key question in the debate, the answer to which will have impact on the extent of job and wage polarization. In Chapter 3 we discussed the various forces that will accelerate or dampen the speed of automation, including profits and institutional inertia. From an overall perspective, demographic trends may have huge impact.

In countries with aging populations, such as Sweden, the rate of entry into the labor force is slowing down compared to exit; see Blix (2013a,b)[123]. Moreover, firms report a skills mismatch for available jobs. These developments will increase the incentive to automate tasks but also make adjustment easier since there will be fewer entrants to the labor market searching for fewer available jobs. At the same time, the matching of skills and available jobs may continue to be an issue and is a challenge to make the period of adjustment less *rugged* in terms of risks to social welfare.

Young people entering the labor market will have higher digital skills than their immediate predecessors but this may not be enough as long as polarization continues in the labor market. The middle-income earners have been reduced as a group and many of the tasks they perform are increasingly amenable to automation. With some oversimplification, one can envisage a risk that the labor market will continue to polarize in the years to come, with entrants either to the right of the skills scale with good prospects for a strong wage trajectory and others who risk experiencing stagnant productivity and wage growth.

The key to welfare during this period of change is a flexible, equal opportunity labor market. More overall agility would help smooth structural change and reduce risk of higher structural unemployment during the transition. The sharing economy discussed throughout this report can provide some of the agility needed – if it is allowed to flourish. It will allow people to shift between freelancing/education/regular employment; see Hall and Krueger (2015). And when regular employment is not available, it will also provide a source of income that reduces the risk of increasing inequality.

For the sharing economy to function well, the safety nets and social security systems need to be adapted. The systems in Sweden and many other countries are designed around full time employment at one institution or firm. People working freelance as self-employed or in small companies do not fit easily into this box, a topic discussed in several reports and governmental commissions.

[123] This is discussed on page 133 in the Swedish text and page 139 in the English version.

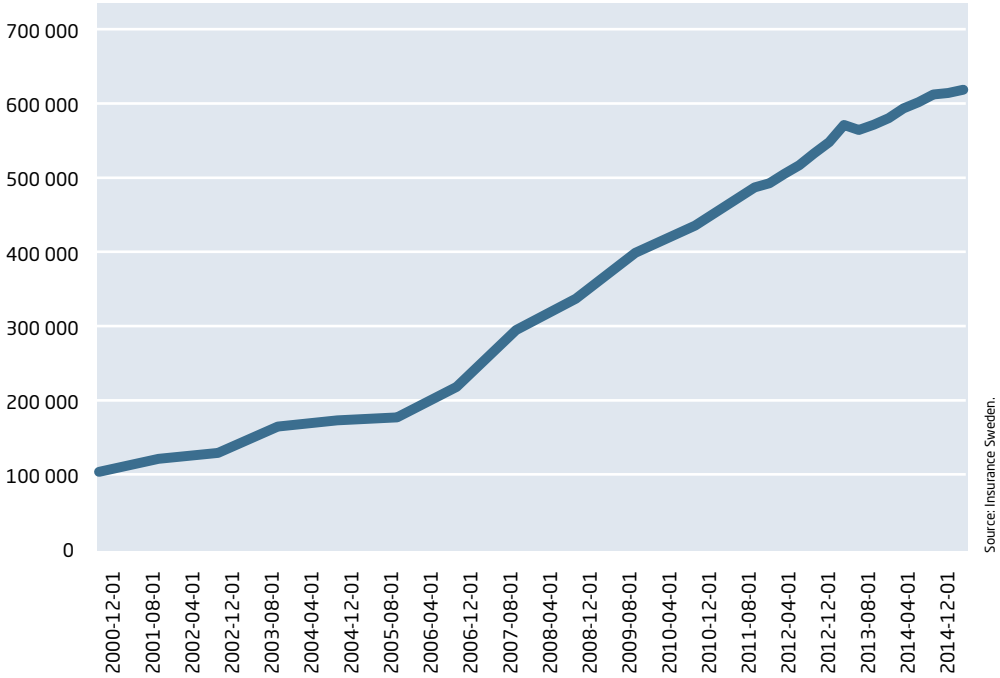
The issue is not that the risk of being an entrepreneur should be taken down to a lower level, closer to that associated with being an employee. Self-employed people take higher risk for a variety of reasons, such as being driven by an idea, preferring more freedom, or seeking the rewards that can come with success. The issue is rather that the asymmetry between self-employment and being an employee is particularly large in Sweden. The self-employed pay into social security to qualify for the universal safety net, but are not able to draw on those benefits to the same extent because the entire structure is built around employee status, with all the concomitant rights and benefits (parental leave, paid vacation, additional pension rights, job security). According to one calculation, employees get 88 percent of the money back over a life-time of the social security contributions paid by their employers; the corresponding figure for the self-employed is about 49 percent; see Sandanji (2012); see also SOU (2015b, page 962). Due to the nature of business commitments in small firms, self-employed people are less able take sick days or parental leave since there may be no one else to take up the slack. The effects on the bottom line might be lower profits or indeed endanger the long-term viability of the firm.

The same holds true for parental leave. Self-employed people can, in theory, be on parental leave on weekdays, perhaps with some limited work in the evenings, and try to catch up on work during the weekends with some help, e.g. from a spouse, but then they get lower benefits. To get full benefits, parents must use seven days of leave per week, including the weekends, which is typically not sustainable for someone trying to keep a business afloat; to work on a day for which parental leave benefits are paid is a breach of the rules. Notably, the lower number of self-employed women is probably largely explained by the asymmetry between employee vs self-employed status in social security; see Sandanji (2012) and Företagarna (2014).

There are also other differences that may be significant, especially for newly started businesses. In the event of sickness, payment is based on the so called SGI measure of income. For the self-employed, this measure is calculated on the basis of the equivalent pay an employee would receive but there is an inevitable area of judgment involved on the part of the authorities. To reduce this uncertainty, the boundaries between self-employed, employee and small incorporated firms would need to be better defined but this is difficult to do in practice and may create unintended side-effects; see SOU (2015b, page 963–966). The uncertainty may be the greatest in the transition from employee to self-employed when the risk of failure of the firm may also be highest; SOU (2015b, page 962). Overall, the benefits systems are thus geared towards being an employee and people who are self-employed have to pay twice if the want to reduce the level of risk by investing in supplementary private insurance.

Despite paying twice for insurance, private insurance has become increasingly popular in Sweden; see Figure 5.2. The ability to get faster services is often important to small business owners for whom absence is especially problematic.

Figure 5.2. Private health care insurance increasing, number of persons



Source: Insurance Sweden.

Unionization and reducing risks, digital version

Organized labor, unions, originated from the desire to improve working conditions in industry and services. The same forces are now at work in the digital era. A number of organizations are developing to support and give guidance to freelancers in the sharing economy, including www.faircrowdwork.org in Germany and www.peers.org in the US. There are also various digital services that help freelancers improve their income, pay taxes, smooth income and cash flow, such as www.sherpashare.com and even.me. As freelancing is rising in importance, these organizations and the services they provide are trying to meet a demand for help and security not met elsewhere; see Giridharadas (2015), Singer and Isaac (2015).

Through the app *Even*, for example, freelancers can even out their income over time for a fee, not unlike the idea behind risk-sharing provided by the public sector in many countries. These developments may indicate a search for better risk-sharing in the economy between people in regular employment and freelancers. In Sweden, social security benefits are supplied through contributions in the tax system and many of the other factors affecting work are decided in collective bargaining agreements between the unions and employers' organizations. The Swedish system will not be immune to the need to reexamine how risk is shared in the economy and between generations. The legitimacy of the system may hinge on large groups not being excluded – or less fully covered – by the established social safety nets.

Surveillance and ethical issues at work

Also for employees, age-old issues about monitoring at work are coming into a new light. It is now possible to monitor and survey employees to a degree hitherto impossible. More specifically, digital tools can provide data about performance, health, anxiety, and other issues, 24/7. For example, reports have highlighted working conditions at Amazon where employee performance is monitored and assessed continuously in real time; see for example O'Connor (2013) and Kantor and Streitfeld

(2015). An editorial in the Financial Times (August 17, 2015) posits that white-collar workers at Amazon choose to work in the competitive environment it embodies in exchange for the potential monetary rewards for those who succeed or the experience that might help open other job opportunities in the labor market. Sandbu (2015b), also writing in the Financial Times, points out that the argument about being free to leave hinges on such practices not becoming the common standard elsewhere. Of course, employee monitoring has always been a feature of competitive workplaces, including banks, law firms, and other workplaces where high pay and benefits accrue to those who make the grade. Sales forces, logistics professionals, and other sales-oriented professions have a long tradition of being measured on performance, since measurement has been easy and is directly related to performance.

Digital monitoring, however, can take surveillance to a new – and potentially problematic – level. Notably, when employees wear digital devices throughout the day, employers can become privy to their levels of anxiety, sleep deprivation, and other factors that may affect performance; see for example O'Connor (2015c), Scheiber (2015) and the Economist (2015h). In an experiment, 31 employees at the firm Profusion volunteered to wear *fitbits* for ten days. The data generated made it possible to divide the employees into various categories (such as "busy and coping" and "irritated and unsettled"); see O'Connor (2015c). How much of this will be voluntary and what invasions of privacy are we prepared to accept? While the practices mainly come from American companies, the tools thus developed are beginning to be used in many places. In Sweden, municipalities have used the *Paragå* system in smart phones to detect fraud or inefficiencies; see Eriksson (2015). For countries in Europe with other traditions in law and privacy issues, the questions raised should concern everyone: employees, firms, unions, and employers' organizations alike. The boundaries between work and leisure have become more blurred with the use of smart phones and email and digital tools are now taking these issues to another level.

Strong pressure for automation in public sector administration due to aging populations

We have not discussed the outlook for employment in the public sector in this report, nor the challenge of financing public welfare, which is a very broad topic and a challenge for most OECD countries. While the health care sector is likely to need more labor in the future, especially in providing elder care services, the overall cost pressures on supplying those services will likely imply strong needs to cut costs elsewhere, especially in administration where it is likely that much more automation is possible (see Chapter 3). To ease such a process, it will be especially important to provide opportunities for the people affected to learn new skills throughout their lives so that they can remain competitive in the labor market. Facing middle age with dwindling job prospects in a shrinking public administrative sector is not a far-fetched scenario and action to avoid and smooth the process would be desirable.

5.5 A future with jobs

The position taken in this report is that there will be work in the future, just as there has been in the past. But the path may be more or less challenging for people in terms of welfare and risk, depending on how our institutions react. The continued thinning of the middle class and further job polarization are likely – but not inevitable. Bad policy and protectionist responses exacerbate the risks of bad outcomes for work and welfare, and may even lead to the onset of wage polarization in Sweden – in contrast to the last two decades of high real wage growth.

Our social welfare is affected by many factors. Digitalization is one of the major trends affecting the economy, but not the only one. Industry has been working for a long time to streamline productivity by using more and better machines, a trend that digitalization continues. Rising incomes have implied demand for new services, all from household sector areas, from more forms of entertainment to personal trainers. In some areas, such as the financial sector, increased complexity of regulation may actually create work (for lawyers) even as other segments of banking are shrinking. While each sector may be affected by the different trends discussed in Chapter 1 (globalization, the shift from goods to services, technology, and urbanization), the overall trend towards aging populations will have gradual but significant impact on the entire labor market. In particular, it will not be long before fewer young people are entering the labor market than the number of retirees leaving.

Together with the challenge of skills mismatch in the labor market, demography will increase the need for automation in some areas over and above the incentive to improve and streamline work. In some areas, demography may be the most important factor, such as health care. In Chapter 3 we discussed the rapid pace at which automation is making it possible to replace labor – even skilled labor – in many areas. But the speed of automation is likely to be slower than what is technically feasible because the pace will be slowed by regulatory obstacles as well as habits and preferences (see "Box 3.2. Demand-related issues with further automation"). It would be a serious mistake to view such obstacles as a way to rescue work; indeed, the situation is quite the opposite. With protectionist responses and slow regulatory overhaul that prevent realizing the benefits of digitalization, the results would be worse on all fronts: slower productivity growth, higher risks of technological unemployment, and rising inequality (as illustrated in Scenario 2 in "Box 2. Scenarios for Sweden" in the Extended Summary). The key to prosperity has always been to ensure good conditions for new jobs to be created in the private sector. And that is not going to change.

A future of work without further rise in inequality is possible – but needs help from policy (Scenario 3 in Box 2 in the Extended Summary). Five general points stand out that would make structural change more unrugged:

- Reduce taxes on labor (Chapter 3). Expand tax reductions for household-related services (the RUT and ROT programs in Sweden) to cover more areas than today, including professional services such as IT support, in line with a proposal in SOU (2015a)
- Embrace the sharing economy and the flexibility it implies by reducing regulatory uncertainty. Allow competition to flourish with emphasis on lowering unnecessary standards for *all* rather than by raising the bar for entrants (Chapters 3 and 4)
- Take more strategic steps towards lifelong learning and improving skills, especially digital skills. Focus on quality rather than quantity (this chapter)
- Reduce the asymmetry between employee/freelancer in terms of risk by making it easier for freelancers to use and benefit from social security (this chapter)
- Establish principles of regulatory overhaul that can be used to apply to each individual area to speed the process (Chapter 4)

The last point concerns productivity growth from new technology (IoT, 3D printers, etc.), which may be held back unless regulatory obstacles are removed faster than the usual slow pace. Against the background of macroeconomic headwinds discussed in Chapter 1, it is imperative that the microeconomic innovations from digitalization are allowed to counter the effects of aging populations and rising public debt that may check productivity growth; see for example Blix (2015).

The reasoning behind the other points is relatively straightforward, even though the mechanisms at work may be complicated. The basic idea is to make people more employable and earn higher incomes after tax while simultaneously reducing the risk of rising inequality. The thrust of policies should be aimed at countering the risk that the rapid pace of change will result in large groups falling behind and becoming less productive than machines, as argued in Brynjolfsson and McAfee (2014). If skills are improved throughout people's working lives and taxes on labor are reduced, the incentive to automate will be weaker. Higher skills then imply that more people will complement rather than replace machines (see Section 3.3 in chapter 3).

The period ahead in the labor market may still be tough, but would be eased by more flexibility. The greatest risk of rising inequality lies in increasing and lasting unemployment. In this regard, the rise of the sharing economy that allows people more freedom to work and combine work with parenthood or studies will be a crucial element. While the sharing economy has become significant in the US, it may be even more so in European countries where there are strong protections for labor market insiders. For the sharing economy to serve this function of increasing flexibility without worsening inequality, the risks of freelance work should be addressed in the social security systems, not by according employment status but by reducing the inherent asymmetries that favor employees over the self-employed.

If all these policies are implemented, we are likely to see increased productivity growth and continued high employment without increasing inequality. There *will be jobs in the future*, but our institutions need to address the challenges to make it happen.

I robot, you employed, he or she freelance...

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