Where is Technology taking the economy?

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We are creating an intelligence that is external to humans and housed in the virtual economy. This is bringing us into a new economic era—a distributive one—where different rules apply.

One year ago in Oslo Airport I checked in to an SAS flight. One airline kiosk issued a boarding pass, another punched out a luggage tag, then a computer screen showed me how to attach it and another where I should set the luggage on a conveyor. I encountered no single human being. The incident wasn't important but it left me feeling oddly that I was out of human care, that something in our world had shifted.

That shift of course has been going on for a long time. It's been driven by a succession of technologies—the Internet, the cloud, big data, robotics, machine learning, and now artificial intelligence—together powerful enough that economists agree we are in the midst of a digital economic revolution. But there is less agreement on how exactly the new technologies are changing the economy and whether the changes are deep. Robert Gordon of Northwestern University tells us the computer revolution "reached its climax in the dot-com era of the 1990s." Future progress in technology, he says, will be slower.

So in what way exactly are the new technologies changing the economy? Is the revolution they are causing indeed slowing—or is it persistent and deep? And if so how will it change the character of the economy?

I argued a few years back that the digital technologies have created a second economy, a virtual and autonomous one, and this is certainly true. But I now believe the main feature of this autonomous economy is not merely that it deepens the physical one. It's that it is steadily providing an external intelligence in business—one not housed internally in human workers but externally in the virtual economy's algorithms and machines. Business and engineering and financial processes can now draw on huge "libraries" of intelligent functions and these greatly boost their activities—and bit by bit render human activities obsolete.

I will argue this is causing the economy to enter a new and different era. The economy has arrived at a point where it produces enough in principle for everyone, but where the means of access to these services and products, jobs, is steadily tightening. So this new period we are entering is not so much about production anymore—how much is produced; it is about distribution—how people get a share in what is produced. Everything from trade policies to government projects to commercial regulations will in the future be evaluated by distribution. Politics will change, free-market beliefs will change, social structures will change.

We are still at the start of this shift, but it will be deep and will unfold indefinitely in the future.

The third morphing

How did we get to where we are now? About every 20 years or so the digital revolution morphs and brings us something qualitatively different. Each morphing issues from a set of particular new technologies, and each causes characteristic changes in the economy.

The first morphing, in the 1970s and ’80s, brought us integrated circuits—tiny processors and memory on microchips that miniaturized and greatly speeded calculation. Engineers could use computer-aided design programs, managers could track inventories in real time, and geologists could discern strata and calculate the chance of oil. The economy for the first time had serious computational assistance. Modern fast personal computation had arrived.

The second morphing, in the 1990s and 2000s, brought us the connection of digital processes. Computers got linked together into local and global networks via telephonic or fiber-optic or satellite transmission. The Internet became a commercial entity, web services emerged, and the cloud provided shared computing resources. Everything suddenly was in conversation with everything else.

It’s here that the virtual economy of interconnected machines, software, and processes emerges, where physical actions now could be executed digitally. And it’s also here that the age-old importance of geographical locality fades. An architecture firm in Seattle could concern itself with the overall design of a new high-rise and have less expensive workers in Budapest take care of the detailing, in an interactive way. Retailers in the United States could monitor manufacturers in China and track suppliers in real time. Offshoring took off, production concentrated where it was cheapest—Mexico, Ireland, China—and previously thriving home local economies began to wither. Modern globalization had arrived and it was very much the result of connecting computers.

The third morphing—the one we are in now—began roughly in the 2010s, and it has brought us something that at first looks insignificant: cheap and ubiquitous sensors. We have radar and lidar sensors, gyroscopic sensors, magnetic sensors, blood-chemistry sensors, pressure, temperature, flow, and moisture sensors, by the dozens and hundreds all meshed together into wireless networks to inform us of the presence of objects or chemicals, or of a system’s current status or position, or changes in its external conditions.

These sensors brought us data—oceans of data—and all that data invited us to make sense of it. If we could collect images of humans, we could use these to recognize their faces. If we could "see" objects such as roads and pedestrians, we could use this to automatically drive cars.

As a result, in the last ten years or more, what became prominent was the development of methods, intelligent algorithms, for recognizing things and doing something with the result. And so we got computer vision, the ability for machines to recognize objects; and we got natural-language processing, the ability to talk to a computer as we would to another human being. We got digital language translation, face recognition, voice recognition, inductive inference, and digital assistants.

What came as a surprise was that these intelligent algorithms were not designed from symbolic logic, with rules and grammar and getting all the exceptions correct. Instead they were put together by using masses of data to form associations: This complicated pixel pattern means "cat," that one means "face"—Jennifer Aniston's face. This set of *Jeopardy!* quiz words points to "Julius Caesar," that one points to "Andrew Jackson." This silent sequence of moving lips means these particular spoken words. Intelligent algorithms are not genius deductions, they are associations made possible by clever statistical methods using masses of data.

Of course the clever statistical techniques took huge amounts of engineering and several years to get right. They were domain specific, an algorithm that could lip read could not recognize faces. And they worked in business too: this customer profile means "issue a $1.2 million mortgage"; that one means "don't act."

Computers, and this was the second surprise, could suddenly do what we thought only humans could do—association.

The coming of external intelligence

It would be easy to see associative intelligence as just another improvement in digital technology, and some economists do. But I believe it's more than that. "Intelligence" in this context doesn't mean conscious thought or deductive reasoning or "understanding." It means the ability to make appropriate associations, or in an action domain to sense a situation and act appropriately. This fits with biological basics, where intelligence is about recognizing and sensing and using this to act appropriately. A jellyfish uses a network of chemical sensors to detect edible material drifting near it, and these trigger a network of motor neurons to cause the jellyfish to close automatically around the material for digestion.

Thus when intelligent algorithms help a fighter jet avoid a midair collision, they are sensing the situation, computing possible responses, selecting one, and taking appropriate avoidance action.

There doesn't need to be a controller at the center of such intelligence; appropriate action can emerge as the property of the whole system. Driverless traffic when it arrives will have autonomous cars traveling on special lanes, in conversation with each other, with special road markers, and with signaling lights. These in turn will be in conversation with approaching traffic and with the needs of other parts of the traffic system. Intelligence here—appropriate collective action—emerges from the ongoing conversation of all these items. This sort of intelligence is self-organizing, conversational, ever-adjusting, and dynamic. It is

also largely autonomous. These conversations and their outcomes will take place with little or no human awareness or intervention.

The interesting thing here isn't the form intelligence takes. It's that intelligence is no longer housed internally in the brains of human workers but has moved outward into the virtual economy, into the conversation among intelligent algorithms. It has become external. The physical economy demands or queries; the virtual economy checks and converses and computes externally and then reports back to the physical economy—which then responds appropriately. The virtual economy is not just an Internet of Things, it is a source of intelligent action—intelligence external to human workers.

This shift from internal to external intelligence is important. When the printing revolution arrived in the 15th and 16th centuries it took information housed internally in manuscripts in monasteries and made it available publicly. Information suddenly became external: it ceased to be the property of the church and now could be accessed, pondered, shared, and built upon by lay readers, singly or in unison. The result was an explosion of knowledge, of past texts, theological ideas, and astronomical theories. Scholars agree these greatly

accelerated the Renaissance, the Reformation, and the coming of science. Printing, argues commentator Douglas Robertson, created our modern world.

Now we have a second shift from internal to external, that of intelligence, and because intelligence is not just information but something more powerful—the *use* of information—there's no reason to think this shift will be less powerful than the first one. We don't yet know its consequences, but there is no upper limit to intelligence and thus to the new structures it will bring in the future.

How this changes business

To come back to our current time, how is this externalization of human thinking and judgment changing business? And what new opportunities is it bringing?

Some companies can apply the new intelligence capabilities like face recognition or voice verification to automate current products, services, and value chains. And there is plenty of that.

More radical change comes when companies stitch together pieces of external intelligence and create new business models with them. Recently I visited a fintech (financial technology) company in China, which had developed a phone app for borrowing money on the fly while shopping. The app senses your voice and passes it to online algorithms for identity recognition; other algorithms fan out and query your bank accounts, credit history, and social-media profile; further intelligent algorithms weigh all these and a suitable credit offer appears on your phone. All within seconds. This isn't quite the adoption of external intelligence; it is the combining of sense-making algorithms, data-lookup algorithms, and natural-language algorithms to fulfill a task once done by humans.

In doing this, businesses can reach into and use a "library" or toolbox of already-created virtual structures as Lego pieces to build new organizational models. One such structure is the blockchain, a digital system for executing and recording financial transactions; another is Bitcoin, a shared digital international currency for trading. These are not software or

automated functions or smart machinery. Think of them as externally available building blocks constructed from the basic elements of intelligent algorithms and data.

The result, whether in retail banking, transport, healthcare, or the military, is that industries aren't just becoming automated with machines replacing humans. They are using the new intelligent building blocks to re-architect the way they do things. In doing so, they will cease to exist in their current form.

Businesses can use the new opportunities in other ways. Some large tech companies can directly create externally intelligent systems such as autonomous air-traffic control or advanced medical diagnostics. Others can build proprietary databases and extract intelligent behavior from them. But the advantages of being large or early in the market are limited. The components of external intelligence can't easily be owned, they tend to slide into the public domain. And data can't easily be owned either, it can be garnered from nonproprietary sources.

So we will see both large tech companies and shared, free, autonomous resources in the future. And if past technology revolutions are indicative, we will see entirely new industries spring up we hadn't even thought of.

Reaching the 'Keynes point'

Of course there's a much-discussed downside to all this. The autonomous economy is steadily digesting the physical economy and the jobs it provides. It's now a commonplace that we no longer have travel agents or typists or paralegals in anything like the numbers before; even high-end skilled jobs such as radiologists are being replaced by algorithms that can often do the job better.

Economists don't disagree about jobs vanishing, they argue over whether these will be replaced by new jobs. Economic history tells us they will. The automobile may have wiped out blacksmiths, but it created new jobs in car manufacturing and highway construction.

Freed labor resources, history tells us, always find a replacement outlet and the digital economy will not be different.

I am not convinced.

Erik Brynjolfsson and Andrew McAfee of the Massachusetts Institute of Technology point out that when automotive transport arrived, a whole group of workers—horses—were displaced, never to be employed again. They lost their jobs and vanished from the economy.

I would add another historical precedent. Offshoring in the last few decades has eaten up physical jobs and whole industries, jobs that were not replaced. The current transfer of jobs from the physical to the virtual economy is a different sort of offshoring, not to a foreign country but to a virtual one. If we follow recent history we can't assume these jobs will be replaced either.

In actual fact, many displaced people become unemployed; others are forced into low-paying or part-time jobs, or into work in the gig economy. Technological unemployment has many forms.

The term "technological unemployment" is from John Maynard Keynes's 1930 lecture, "Economic possibilities for our grandchildren," where he predicted that in the future, around

2030, the production problem would be solved and there would be enough for everyone, but machines (robots, he thought) would cause "technological unemployment." There would be plenty to go around, but the means of getting a share in it, jobs, might be scarce.

We are not quite at 2030, but I believe we have reached the "Keynes point," where indeed enough is produced by the economy, both physical and virtual, for all of us. (If total US household income of $8.495 trillion were shared by America's 116 million households, each would earn $73,000, enough for a decent middle-class life.) And we have reached a point where technological unemployment is becoming a reality.

The problem in this new phase we've entered is not quite jobs, it is access to what's produced. Jobs have been the main means of access for only 200 or 300 years. Before that, farm labor, small craft workshops, voluntary piecework, or inherited wealth provided access. Now access needs to change again.

However this happens, we have entered a different phase for the economy, a new era where production matters less and what matters more is *access* to that production: distribution, in other words—who gets what and how they get it.

We have entered the distributive era.

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