US economy: The productivity puzzle

By Robin Harding

Long-term prosperity depends on the capacity of every American to increase output constantly. Can they?

To glimpse the miracle of productivity growth there is nowhere better to look than the bountiful fields of the US Corn Belt. A hundred years ago, an army of farmers toiled to produce 30 bushels an acre; now only a few hands are needed to produce 160 bushels from the same land.

The rise of modern civilisation rested on this trend: for each person to produce ever more. For the past 120 years, as if bound by some inexorable law, output per head of population increased by about 2 per cent a year. That is, until now.

There is a fear – voiced by credible economists such as Robert Gordon of Northwestern University – that 2 per cent is no law but a wave that has already run its course. According to Prof Gordon’s analysis, 2 per cent could easily become 1 per cent or even less, for the next 120 years.

The US Federal Reserve is already edging down its forecasts for long-term interest rates. “The most likely reason for that is there has been some slight decline . . . of projections pertaining to longer-term growth,” said Janet Yellen, chairwoman, at her most recent press conference.

Yet there are also techno-optimists, such as Erik Brynjolfsson and Andrew McAfee of the Massachusetts Institute of Technology, whose faith in new discoveries is such that they expect growth to accelerate, not decline.

Then there are more phlegmatic economists, whose answers are less exciting but also less speculative – and come in a bit below 2 per cent for growth in output per head.

The productivity question is of the greatest possible consequence for the US economy, affecting everything from when interest rates should rise to where they should peak, from the sustainability of US debt to what is the wisest level of investment for every business in the country.
The answer depends on companies such as Climate Corporation, which fights the battle for agricultural productivity growth from its new front line, in the office buildings of Silicon Valley.

Climate Corporation, which was bought last year by Monsanto for $930m, works on “precision agriculture”, bringing the power of data science to bear on farming.

For example, the company says that by combining fertiliser use, soil type, weather data and other information in a single database, it can tell farmers exactly how much nitrogen is in a field and thus how much fertiliser they need to apply.

The boost to yields could be as much as 5 per cent – and that is just the start. “We’ve identified about 40 different decisions a farmer makes where there’s potential to apply data science,” says Anthony Osborne, the company’s head of marketing.

Whether computers can keep making broad contributions to productivity is one of the most important immediate issues.

But it is not the only issue. Growth in gross domestic product, the familiar statistic by which all economies are measured, can come about in several ways: more workers, with better skills; more capital such as factories, roads and machines, or new technology. Leaving aside the latter category, the consensus among economists is that most of these will not contribute as much to economic growth as they have in the past.

To start with, US population growth is at its lowest since the 1930s, having fallen from about 1.2 per cent a year in the 1990s to 0.7 per cent in recent years. This does not affect growth in living standards – it means fewer consumers as well as fewer workers – but adding less extra labour will slow the headline GDP growth rate that the Fed worries about.

On top of that, demographics will also slow growth in GDP per capita, which does affect living standards. Ageing will mean fewer active workers per head of population; most women have now joined the US labour force so that source of extra workers is running out.

Prof Gordon estimates that demographics could knock 0.3 percentage points off the long-run trend of 2 per cent growth.

“Everybody is pretty much in agreement in expecting slower growth in hours worked relative to what we’ve seen in the last 50 years,” says John Fernald, a senior research adviser at the Federal Reserve Bank of San Francisco.

The truest measure of economic progress, though, is the growth of GDP per hour worked. For every hour of human toil, how much is created? Here too, some factors that drove growth in the past are weakening, such as skills and education.

The expansion of primary, then secondary and then college education has helped the economy grow for generations, but average years of education have now reached a plateau. “The US is slipping back in the league tables of college completion and high school completion,” says Prof Gordon, suggesting this will account for another 0.2 percentage points off per capita growth.

That leaves technology. “I agree with much of what he says about the slowing demographics,” says Prof Brynjolfsson. “Where he and I differ is prospects for future innovation.”

Growth in GDP per hour worked depicts an interesting pattern over time. According to Prof Gordon, at a rate of 2.4 per cent, it was fast from the 19th century until 1972. It then slowed to 1.4 per cent a year until 1996.

The internet boom pushed the rate up to 2.6 per cent – it was this period that led Alan Greenspan, former Fed chairman, to talk about a “productivity feast” – but by 2004, well before the financial crisis, the surge was over. Since 2004, barring a measurement problem, growth in output per hour has been 1.3 per cent.

The dispute is this: in the coming decades, should we expect growth like that which we experienced from 1996 to 2004, at 2.5 per cent, or like the period since 2004, of 1.3 per cent? While Prof Brynjolfsson has Star Trek visions of utopian technological progress, Prof Gordon is more of a cyberpunk, imagining a world in
take the labour input to zero you get a pretty astronomical productivity number which the computers may become more powerful but living standards for average humans improve only slowly.

Computation is the root of Prof Brynjolfsson’s optimism: his book with Prof McAfee is called The Second Machine Age and argues that the impact of information technology has only just begun to be realised.

Exponential expansion in computing power, and the ability to diffuse innovations rapidly, could mean growth like that of the late 1990s.

“The reason I’m optimistic is that I don’t rely primarily on extrapolating past economic trends,” says Prof Brynjolfsson. After visiting labs, he says, “I just come away astonished at what’s in the pipeline. Most of it has not yet reached commercialisation.”

Rather than referring to historical data, he points to Google’s self-driving car, to the potential for computer systems that diagnose disease and answer legal queries, and the growing flexibility of robotics. Such automation will free up a host of labour for new tasks, just as other innovations did in the past. “Whether it’s robotics or software for knowledge work, if you take the labour input to zero you get a pretty astronomical productivity number,” he says.

By contrast, Prof Gordon expects a lower pace of productivity growth, perhaps in line with that achieved in the past 10 years. To hit even that target, he points out, means keeping up a steady stream of new creations such as smartphones.

The heart of his argument is that the discoveries of the past – running water, the internal combustion engine, the electric lightbulb – were simply more important than those of today. From 1870 to 1972, he points out, American homes went from lightless, isolated places of drudgery to buildings of air-conditioned comfort, with a dishwasher in the kitchen and a car in the garage.

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Prof Gordon is also dismissive of the potential productivity gains from inventions such as driverless cars: being able to answer email instead of turning the steering-wheel, for example. “The real productivity gains would presumably come from driverless trucks,” he says, but then points out that a UPS delivery van would still need a driver to remove the parcels from the vehicle.

He is more impressed by the potential of robotics but less convinced the moment has arrived when they are sufficiently powerful to supplant humans. “Think of every employee you’ve had contact with in the last two or three days, and think, is that person going to be replaced by a robot in the next 20 years?”

One curious aspect of both professors’ arguments is how uneconomic they are. Their focus is more about what is left to discover than the economy’s ability to make those discoveries. Prof Gordon’s approach would struggle to explain the 1996 acceleration in productivity growth, while Prof Brynjolfsson’s has little to say about the slowdown after 2004.

Yet economics has quite a lot to say about the process of making discoveries, based on the less than revolutionary insight that breakthroughs depend on the effort put into researching them.

In a recent study, Mr Fernald and Charles Jones of Stanford University break down the inexorable 2 per cent growth in US output per person from 1950 to 2007 in a different way. They find almost none of it comes from more capital per worker.

About 0.4 percentage points comes from human capital (better education). But by far the largest contribution – 1.6 percentage points of the total – comes from the fact that more people are working on research and development.

To sustain that magical run of 2 per cent growth in output per person, the US may need more Silicon Valleys to emerge in China and India

In part, that is because there are more people (and thus more bodies to do research). But mainly it is the result of devoting a steadily larger portion of the total population to work on research and development.

This analysis allows for a more grounded forecast than speculation about what technologies remain to invent. “The pessimistic part of that equation for the future is human capital,” notes Mr Fernald, as the contribution from better education is petering out. It is also impossible for the US to keep devoting ever more of its population to working in research and development.

But this is not true of the world as a whole. Huge populations in China, India and elsewhere are joining the global economy, improving their education systems and putting more researchers to work at the scientific frontier. Any discoveries they make can be used in the US as easily as anywhere else.

In that case, the improvements that come from scientific discovery may be sustainable. Productivity growth need only slow to about 1.6 per cent. Add in some modest increase in population and the economy as a whole could expand at 2 per cent per year or a little more. Mr Fernald’s long-run forecast is 2.1 per cent. This suggests that the Fed open market committee’s latest projection of 2.2 per cent is not far off.
Climate Corporation shows how innovative the US still is – and how computers can yet boost productivity in unexpected ways. To sustain that magical run of 2 per cent growth in output per person, however, the US may need more Silicon Valleys to emerge in China and India, and add their heft to the eternal pursuit of another bushel of corn from the same acre of land.

**Intel, clock speed and the measurement of productivity growth**

Is the recent slowdown in productivity growth nothing but a statistical mirage? A recent study by economists David Byrne, Stephen Oliner and Daniel Sichel notes a fascinating discrepancy between price and performance data for microprocessors (see chart above). This is important because the rapid progress of processing power is what drives the technology revolution.

Moore’s Law – the trend identified by Intel co-founder Gordon Moore that computer power doubles every two years – has continued apace. But at the same time, whereas the measured price of computing power was falling at a rate of 70 per cent a year between 1998 and 2000, the pace of decline more recently has slowed to 3 or 4 per cent. That translates into a slower pace of measured productivity growth.

Mr Oliner, currently at the American Enterprise Institute, a Washington think-tank, has a few ideas about what may be happening. One is an increase in Intel’s market power. “Starting in about 2006, which is when the break occurred, Intel really solidified its market position relative to AMD,” its main competitor, he says. Less competition may mean slower price declines for its older products.

In about 2006, Mr Oliner continues, “Intel itself had a major breakthrough and developed multi-core chips.” Instead of driving up “clock speed”, the most familiar way of measuring the processing speed of a chip using megahertz or gigahertz, it started including multiple copies of the basic processor within the same chip. If computing power were still measured using clock speed, however, the pace of improvement would appear to suddenly decline.

The US Bureau of Labor Statistics uses a range of tools to measure computing power. One argument in favour of its data – which suggests the pace of progress in computer chips has slowed massively – is that consumers seem to be replacing their desktops less frequently.