

Cracks in the Great Stagnation

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For the last 60 years, we've seen consistently low productivity growth rates in the US and across the Western world. Meanwhile, recent scientific discoveries seem to be less fundamental to our understanding of the world than previous breakthroughs have been. While the growth of digital technology has been tremendous since the 1990s, it's the only significant part of our world that seems to have been changing. To look up from our smartphones is to see a physical environment that looks basically the same as it did in 1970. Innovation has been constrained to the world of bits and left the world of atoms mostly untouched.

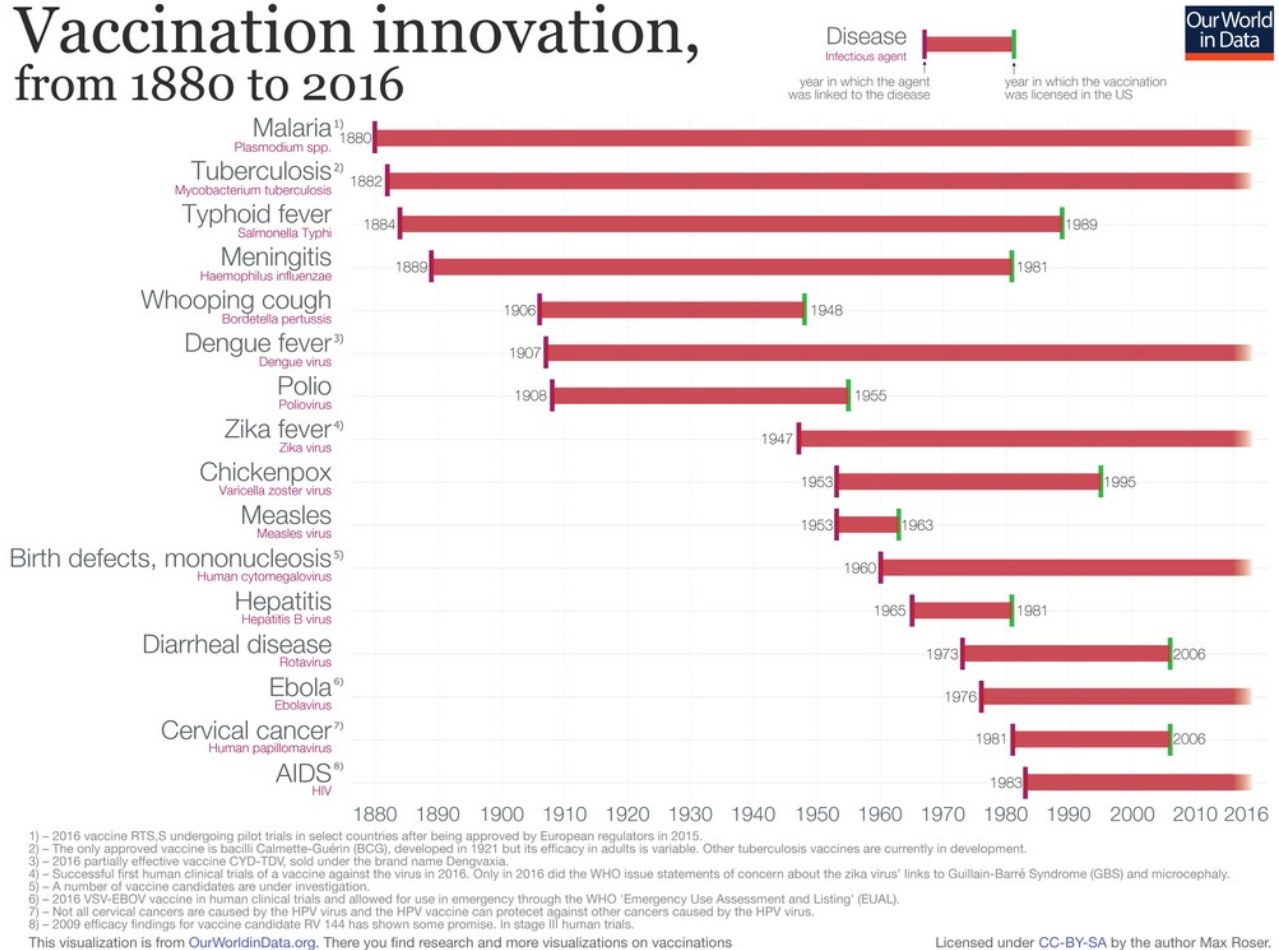
This might finally be changing. Last month, the economist Tyler Cowen speculated that we may be seeing signs that this Great Stagnation is ending. Since his article was published, we've already seen almost a dozen announcements that have only driven home the point further. There seem to be cracks in the Great Stagnation and light is peeking through on the other end.

Innovation in the physical world

Most obviously, the recent announcement of the successful development of several vaccines to the novel coronavirus are a sign that America (with some help from Germany) is still capable of achieving Big Things when we are pushed to it. Despite consistent failings of the US regulatory state in delaying the adoption of face masks and in slowing the rollout of mass testing, the US essentially bet the farm that our strong biotech clusters would be able to create a vaccine to a new disease in record time, and it looks like we're going to be able to do it in under a year!

It's worth highlighting just how speedy this development timeline is when compared to the vaccines for diseases like polio and measles.

Vaccination innovation, from 1880 to 2016



<https://ourworldindata.org/vaccination>

And not only did we develop a new vaccine, we developed a new **type** of vaccine. mRNA vaccines have long been speculated to work, but this is the first instance of a successful vaccine application in humans using this technique.

In transportation, the promise of driverless cars has long been a centerpiece for a tech-optimistic vision of safer roads, better-designed cities, and eliminating the drudgery of a morning commute through traffic. But the technical delays of the last few years (when compared to the most optimistic timelines) have become a rallying cry for the tech-skeptic as well.

It seems like they may finally be getting here. A few weeks ago, Waymo announced that their long-running pilot program in Arizona is going to be open to the public without any safety driver in the front seat. Days later, Elon Musk and Tesla rolled out a new self-driving beta program.

These two guys used a drone to make a video of Tesla's new "full self-driving" software in action. The drone, the self-driving car, and the global video-streaming service were all been science fiction when I was born. Living in the future is neat.

<https://t.co/4QqGcjFXsc>

— Timothy B. Lee (@binarybits) October 27, 2020

This is a remarkable engineering feat, especially on Waymo's end. It shows the company

can successfully lead product development in an industry that relies on more stringent safety-critical engineering instead of the release-and-iterate model that its parent company grew up with. Waymo is evidence that Silicon Valley can “move at a moderate pace and not break things” when it needs to.

Granted, it's unclear how long until and at what pace deployment of AVs to the rest of the country and the world will happen. If the Waymo model looks to be successful, it will be a steady, resource-intensive process of region-by-region expansion as the cars learn to handle new operational design domains and are rigorously validated in each city before the keys are turned over to the AI. In other words, expansion could look more like a cell phone coverage map than a software update that is instantaneously available everywhere.

But still, this is a significant, tangible mile marker that the industry has passed. AVs are operating in the wild now. We get to talk about *when* we reach the driverless future, not *if*.

In addition to the almost ho-hum daily progress in solar, wind, and battery technology where prices have fallen 90, 70, and 87 percent over the last ten years, we've also started to hear very promising reports about the development of more fundamental breakthroughs. The NYT reports that a compact nuclear fusion reactor is “Very Likely to Work” after a major theoretical advancement. There was also a fantastic David Robert's deep dive into geothermal energy and the promise of advanced geothermal (whereby water pumped into the ground through a closed loop reaches a high enough temperature that it becomes “supercritical” and can carry 10x more energy per unit mass), in particular. Either technology, if perfected, would provide abundant, zero-carbon, baseload energy that is available anywhere around the world.

Cowen mentions briefly the huge market growth we've seen in lab-grown meat and plant-based alternatives. A few weeks ago it was announced that Impossible Foods, one of the largest actors in the industry is doubling their R&D team as they seek to take on plant-based milk, steak, and fish as well as improve the supply chains for plant proteins. In tandem, McDonald's just announced that in 2021 they are going to be testing out a new McPlant menu.

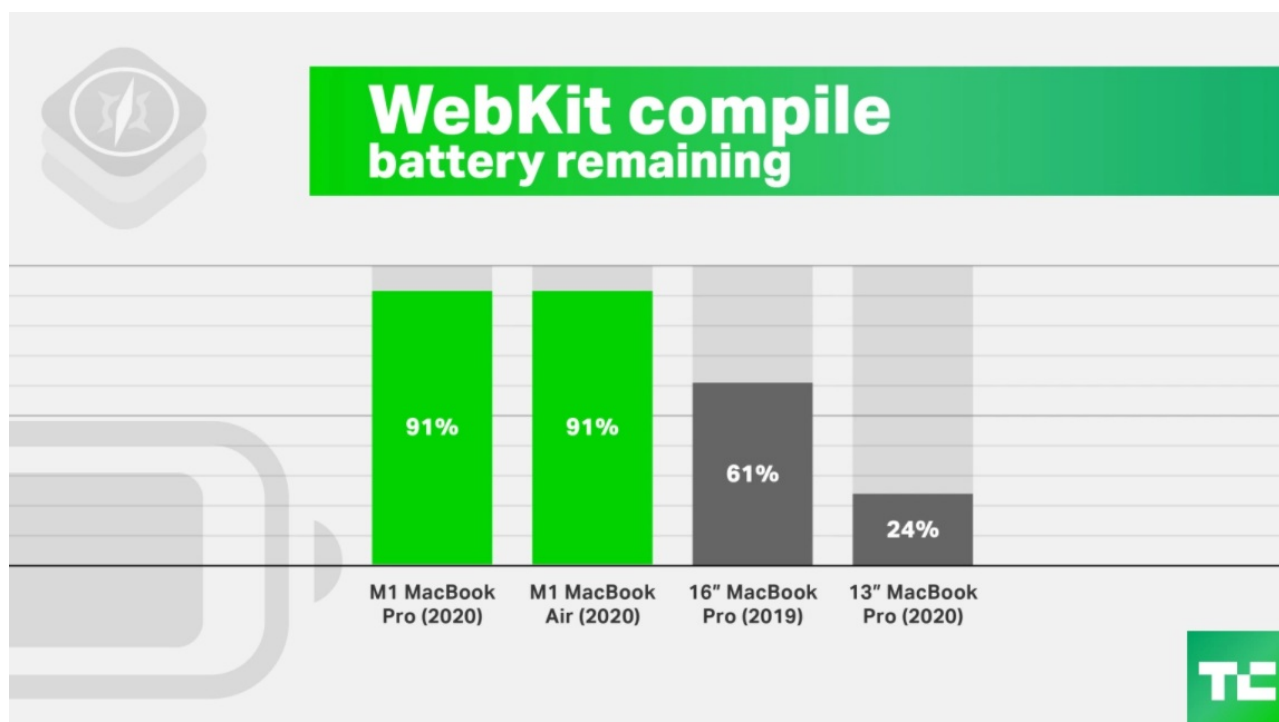
Digital innovation continues apace

Not to be left out, in the digital world we've been seeing impressive progress as well. AI techniques like deepfakes which have been heralded as the death knell for democracy are now being deployed by NVIDIA to increase video fidelity while cutting bandwidth transmission for video calls by a factor of 10. In general, techniques to reduce bandwidth use are greatly underrated, and it's going to be exciting to see the ways in which smarter compression can perhaps bring similar efficiency gains across the board.

And now factor in the steady rollout of 5G network technologies which promise to increase the raw bandwidth available to all mobile devices. With the combination of smarter compression and vastly increased bandwidth we could be looking at a baseline 50x increase in network capacity over the next decade. It's hard to predict ahead of time what new applications will be enabled by all this new capacity, but in retrospect it could look like another example of parallel innovation that both enables and is driven by the growth of VR/AR, driverless vehicles, and telehealth.*

**For those who are skeptical that increased capacity will generate new applications because a few cities have tried gigabit broadband without much effect, I would argue that both hardware and app developers are optimizing for the baseline user experience and we won't see a ton of investment in new applications until we've changed the baseline capacity that developers can expect a sizeable user base to have.*

Equally as impressive, Apple's new M1 chip that was launched on November 10th seems to have taken the world by storm. As John Gruber summarizes: "To acknowledge how good they are — and I am here to tell you they are astonishingly good — you must acknowledge that certain longstanding assumptions about how computers should be designed, about what makes a better computer better, about what good computers need, are wrong." Just as interesting is how they did it. By miniaturizing the whole system architecture and integrating it onto a single chip (no discrete RAM, graphics card, etc.) Apple has managed to pump out massive efficiency gains both in processing power and in battery life. (There's perhaps a metaphor here for the value of integration for large tech firms as well...)



<https://techcrunch.com/2020/11/17/yeah-apples-m1-macbook-pro-is-powerful-but-its-the-battery-life-that-will-blow-you-away/>

Finally, the virtual reality space has seen its most impressive entrant in years with the arrival of the Quest 2 from Facebook on October 13th. There is no VR headset that matches it on a performance/cost basis, and the relative simplicity and elegance of the system makes it an ideal entry point. The deliberately low entry barrier of \$299 is meant to entice a large enough user base that it kickstarts the virtuous cycle of having a significant enough market for dedicated VR developers to make significant investments in new applications, which then drives new user growth. Facebook believes we finally have a minimum viable product for VR that means this kind of two-sided market is possible, and it is betting billions of dollars to make it happen. Early signs seem to show that it is working as intended with pre-orders reportedly 5x larger than the original Quest, popular applications like Beat Saber seeing record growth, and all this with the upcoming holiday rush and a massive advertising blitz to come.

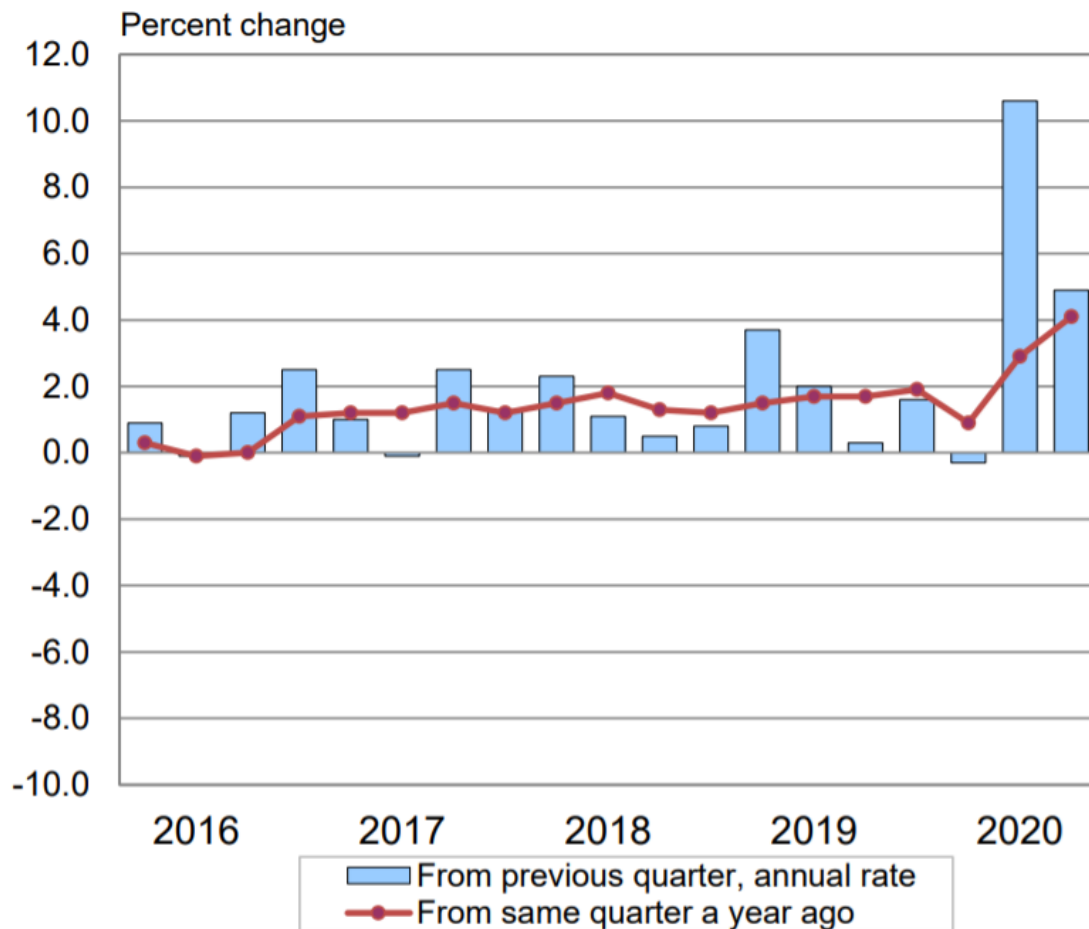
Notably, all of these announcements/developments I've outlined have occurred in just the last few months. This is by no means a comprehensive look at the exciting progress being made in many other fields. But the sheer scope and pace of tangible changes to our physical and digital worlds is something to be excited about.

A few caveats

Some of these innovations will boost productivity in the traditional ways that show up in economic growth statistics. We should strive for and celebrate those achievements. But some of these innovations won't necessarily, instead they make human civilization more durable and sustainable in a variety of ways. In response, we should start to think of increased sustainability as a type of productivity.

A vaccine to the COVID pandemic is the most obvious example. While economic statistics won't show a boost in productivity compared to the pre-COVID economy because of the vaccine, the ability to return to trend is itself incredibly valuable. In fact, measured labor productivity from the vaccine will likely fall as lower-wage service sector workers return to the labor force.

Chart 1. Labor productivity, nonfarm business, 2016Q1 – 2020Q3



<https://www.bls.gov/news.release/pdf/prod2.pdf>

But true productivity will perhaps be at record highs as this new vaccine technology essentially unlocks millions of employees that wouldn't otherwise be able to work.

Similarly, clean energy that hypothetically has the exact same energy density and cost as fossil fuels but doesn't entail the same social cost of carbon mostly shows itself in the avoided counterfactual of a worse world with even more severe climate change disasters. Moving away from animal-based proteins simultaneously reduces carbon emissions while also lessening the large, unpriced animal welfare harm that industrial factory farms are causing.

If you think about the broad timescale of human society, progress can be attained in the growth *rate* and the growth *length*. How good is our civilization, and how long does it last? Many of these innovations we developed between the 1930s and 1970s aided the rate, and many today are increasing the length. Both are vitally important, but they will be measured differently.

Another caveat here is to what extent these innovations are one-time payoffs for investments we've been making for decades, or whether some of these can be general-purpose technologies that inspire further technological growth.

If VR is mostly a gaming console, if driverless cars never fully work without humans in the driver's seat, if meatless burgers are just a fad, if we fail to address climate change because abundant clean energy never materializes, and if 50x bandwidth only lets us stream Netflix in 8K, then the Great Stagnation will have had a much deeper hold than we think.

But perhaps VR/AR can become the next consumer electronic platform with a whole suite of specialized productivity-enhancing features, similar to the previous waves of computers and mobile phones. It seems plausible that many future vaccines will be made more quickly using this same mRNA technique that (we hope) works for COVID. Maybe specialized AI manages to find 20 to 40% improvements to basically every informationally complex task we do. Finally we could see driverless cars/trains/trucks fulfill their promise and reshape American cities in a more healthy and human-centric way. With advanced geothermal or nuclear energy we would not only have clean energy, but abundant energy too cheap to meter, with all the economic applications downstream benefiting from that.

If some combination of those things happen, we will look back at the roaring 20's as the decade which broke through the Great Stagnation.

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