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Money is weird now.

When we were settling in on the theme for this issue, I decided to buy an NFT of an Olive Garden for my friend Katie, who really loves Olive Garden. It was also an attempt to try to better understand NFTs. Each of the “Non-Fungible Olive Gardens,” really just a photo of a restaurant, was minted for $19.99 and listed on the NFT trading platform OpenSea—the amount tethered to the price of a Tour of Italy menu item. The NFTs were not associated with the actual Olive Garden (though each one corresponds to a real-life location). But still, it seemed like a bargain!

I tried to plunk down my $20, but OpenSea didn’t accept credit cards. I would need to buy some of the cryptocurrency Ether to complete the transaction. Okay! I’m game. Ether in hand (or wallet, more precisely), I went back to OpenSea and tried to make a purchase. Except those initial drops had already seemingly sold out. The price had gone up. Way up. Secondary sellers, who perhaps saw the same Twitter threads I’d seen, were now trying to flip their OG NFTs. With grim resignation, I bought some more Ether and tried again. That’s when I found out about gas fees, a service fee charged by miners to verify transactions. Being cheap, I lowballed this fee. My transaction never went through. The price of Olive Gardens was still going up. I tried again, paying market rate this time. Success!

Except ... have you ever tried giving someone an NFT? I needed to pay even more in gas fees to make the transfer. All in, the jokey purchase I had initially thought would cost me $20, and later reassessed to maybe $75, ultimately set me back nearly 300 bucks.

But hey, my friend Katie was now the owner, kind of, of a JPEG of a photo of an Olive Garden in a mall in Louisville, Kentucky, on the Ethereum blockchain. What a great gift!

That is, it was a great gift until just over a week later, when the real Olive Garden’s attorneys sent OpenSea a copyright notice, and all those non-fungible Olive Gardens vanished into the, uh, ether. Poof.

Like I said, money is weird now. And so this issue dives into the way technology is shaping our financial future.

Whether it’s a biometric-based universal cryptocurrency meant to underpin Web3, cities built by Bitcoin, digital currencies that are replacing cash, or the way iBuying is transforming the housing market, technology is fundamentally changing the ways we buy, spend, and save money. Even the way we gamble.

We hope you enjoy this issue, and that it reveals something new to you about the present that helps you better understand and prepare for the future. Even if that’s just budgeting in your gas fees in advance.

Thank you for reading. And I always appreciate your feedback—as does our new editorial director of print, Allison Arieff. She’s at allison.arieff@technologyreview.com and I’m at mat.honan@technologyreview.com. On Twitter we are, respectively, @aarieff and @mat.
“They were able to unlock and monetize all of our data that was trapped in legacy systems.”

— Kmart
From the Editor

THE DOWNLOAD

What AI can teach us about psychedelics; a man communicates by thought alone; how Russia may balkanize the internet; a desk made for Zoom; the limits of carbon capture; book reviews; Mazacoin and the nerd’s revenge

The secret police

Our investigation reveals how cops built a shadowy surveillance machine in Minnesota after George Floyd’s murder. By Tate Ryan-Mosley & Sam Richards

We can’t afford to stop solar geoengineering research

It is the wrong time to take this strategy for combating climate change off the table.

In praise of the dollar bill

Is it time to reconsider cash?

CBDCs go global

Central-bank digital currencies could change how money moves. By Casey Crownhart

Q&A with Jennifer Doudna

Undeterred by an unfavorable patent decision, the Nobel laureate is optimistic about the future of CRISPR. By Antonio Regalado

AI’s inequality problem

New digital technologies are exacerbating inequality. Here’s how scientists creating AI can make better choices. By David Rotman

The information broker

MIT Digital Currency Initiative director Neha Narula serves as a crucial link between cryptocurrency developers and central banks around the world. By Ashley Belanger

Debt disruptors

Would you take a loan from a blockchain app? By Tisya Mavuram

Spilling Silicon Valley’s secrets, one tweet at a time

Jane Manchun Wong’s reverse-engineering skills are keeping tech companies on their toes. By Tanya Basu

A casino in every pocket

In Kenya and elsewhere in Africa, the rapid spread of smartphones and mobile money has fostered a stubbornly persistent vice. By Jonathan W. Rosen

Coin of the realm

A startup called Worldcoin is giving out small bits of its currency to new users—if they agree to hand over a slew of biometric data. By Eileen Guo

iBuyer beware

Instant buying accounts for tens of billions of dollars in home sales—but who’s really benefiting? By Matthew Ponsford

Money changes everything

Sometimes it’s been hard to tell if our shift toward transactions via machine has been a promise or a threat.

On the Cover

Illustration by Michael Byers
“Banking with First Republic saves me a great deal of time. Wherever I am in the world, they take care of what I need.”

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Virologist, Columbia University Irving Medical Center

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Now scientists are using AI to figure it out. A team at McGill University in Montreal recently used natural-language processing—the technique that allows voice assistants or search engines to work—to study written reports of drug users’ experiences. The work could shed light on how hallucinogens trigger specific mental states.

Danilo Bzdok, who co-led the research, says, “It’s the largest study of its kind on psychedelics of all time.”

Instead of a randomized clinical trial, which can be slow and expensive, Bzdok’s team used natural-language processing to assess 6,850 written accounts of hallucinogenic drug use. Each account was written by a person who took one of 27 drugs—including ketamine, MDMA, and LSD—in the real world rather than in a lab-based experiment. The accounts were accessed from the website of Erowid, a member-supported drug information organization.

Bzdok’s team then integrated this data with records indicating which receptors in the brain each drug is known to interact with. Together, these steps allowed the team to identify which neurotransmitter receptors are linked to words associated with specific drug experiences. For example, words linked to mystical experiences, such as “space,” “universe,” “consciousness,” “dimension,” and “breakthrough,” were associated with drugs that bind to specific dopamine, serotonin, and opioid receptors.

Bzdok says the approach could provide new starting points for drug development.

What do psychedelic drugs do to our brains? AI can help us find out

The words people used to describe their trip experiences could lead to better drugs for mental illness.

by Jessica Hamzelou

Psychedelic drugs have long been touted as possible treatments for mental-health disorders like depression and PTSD. But very little is really known about what these substances actually do to our brains—and it can be hard to find out. Understanding how they work could help unlock their potential.

Read the full stories from The Download at www.technologyreview.com.
A man communicates by thought alone

In a world first, the man was able to ask for a beer, and even talk about his son for the first time since becoming paralyzed.

By Jessica Hamzelou

A completely paralyzed man has been able to communicate entire sentences using a device that records his brain activity. The man was able to train his mind to use the device, which was implanted in his brain, to ask for massages, soup, and beer, and to watch a film together with his son. It is the first time a completely locked-in person—one who is conscious and cognitively able but completely paralyzed—has been able to communicate in this way, say the researchers behind the work.

Brain-computer interfaces record the electrical signals inside a person’s brain and convert them to commands that control a device. In recent years, BCIs have enabled partially paralyzed people to control prosthetic limbs or communicate a simple “yes” or “no” by thought alone. But this is the first time someone who is completely locked in, and unable even to control eye movements, has used a BCI to communicate full sentences.

No one knows how long the electrodes will last in the man’s brain. Other studies have found that similar ones are still functioning five years after being implanted in other people. But for a locked-in person, “a single day can make a difference,” says Kianoush Nazarpour at the University of Edinburgh, who was not involved in the work. “That is a fundamental opportunity for them to regain choice and control of their lives,” he says. “A day of high quality could be really important for that person.”

Nazarpour thinks the technology could be routinely offered to similarly locked-in individuals within the next 10 to 15 years. “For a person that has absolutely no communication, even a ‘yes’/’no’ is potentially life-changing,” he says.

Russia may balkanize the internet

If Russia disconnects from—or is booted from—its governing bodies, the internet may never be the same again for any of us.

By James Ball

Russia’s disconnection from the online services of the West has been as abrupt and complete as its disconnection from real-world global trade routes.

Facebook has been blocked entirely by Russian authorities, while Twitter is almost completely cut off. Russia is rapidly joining the likes of Iran as a digital pariah state.

The European Union is seeking to all but wipe certain Russian outlets from the internet—with guidance on new bans of state-owned RT (formerly Russia Today) and Sputnik suggesting not only that the sites should be blocked, but that search engines should hide or delete any post repeating content from said sites.

But all these are just services that use the internet, rather than the technologies or agreements that power it.

More profound splits are in the cards. Russia is withdrawing from international governance bodies such as the Council of Europe and has been suspended from the European Broadcasting Union. If such moves were replicated with the internet’s governing bodies, the results could be seismic.

The changes have raised fears of a “splinternet” (or Balkanized internet), characterized by a number of national or regional networks that don’t speak to one another and perhaps even operate using incompatible technologies.

That would spell the end of the internet as a single global communications technology—and perhaps not only temporarily. China and Iran still use the same internet technology as the US and Europe, even if they have access to only some of its services.

If such countries set up rival governance bodies and a rival network, only the mutual agreement of all the world’s major nations could rebuild a global system. The era of a connected world would be over.
Patent depending

Illustration by Steven Johnson

Futurist Steven Johnson couldn’t have known that the multifunctional Lazy Susan Desk he sketched back in 1984 would turn out to be distressingly perfect for today’s remote workers. With Zoom confining so many of us to our desks all day, this absurdist piece of furniture proffers a rotating array of tableaux: whether you’re dining, dishwashing, or emailing, you never have to leave your chair. Johnson, who has been visualizing the future (a dashboard toaster oven, Robo-taxis, a pedal-powered clothes dryer) with uncanny prescience for nearly six decades, posts his latest inventions at patentdepending.com.

The oceans might not be our CO₂ hero

New studies suggest that adding minerals or growing seaweed might be limited or costly ways of removing carbon dioxide.

By James Temple

The world’s oceans are amazing carbon sponges. They already capture a quarter of human-produced carbon dioxide when surface waters react with the greenhouse gas in the air or marine organisms gobble it up as they grow. Their effectiveness has prompted growing hopes that we could somehow accelerate those natural processes to boost the amount the oceans draw down, helping to slow climate change.

One idea gaining attention and investments is to add minerals that could lock up carbon dissolved in the oceans.

But a recent study in the journal Frontiers in Climate suggests there may be limitations to one promising version of the strategy, which relies on a volcanic mineral known as olivine. In theory, adding ground-up olivine should increase the seawater’s alkalinity, which helps convert carbon in the water into a stable form and allows the oceans to take up more carbon dioxide from the atmosphere.

Researchers at the GEOMAR Helmholtz Centre for Ocean Research in Germany recently dissolved fine-grained sand made up primarily of olivine in artificial seawater. Over a period of 134 days, they found, the water’s alkalinity actually decreased. This and other factors reduced the amount of carbon removed by a factor of five compared with olivine’s theoretical potential, according to the researchers.

Other research groups have also recently found that dissolving olivine in filtered and artificial seawater produced less of an increase in alkalinity than expected, the study noted. Still another recent preprint paper found similarly confounding results for other minerals that had been expected to boost ocean alkalinity. Meanwhile, several additional studies recently raised doubts about a different ocean-based approach: growing seaweed and sinking it to suck up and store away carbon.

Finding viable ways to pull down greenhouse gases will be vital in the coming decades. A National Academies report in December on ocean-based carbon removal noted that the world may need to suck up an additional 10 billion tons annually by midcentury to limit warming to 2 °C.
Boosting ocean alkalinity could theoretically remove tens of billions of tons each year on its own, according to the research group Ocean Visions. But the National Academies panel noted that it will require extracting, grinding, and shipping rocks on roughly similar scales, all of which would have substantial environmental consequences as well.

The new studies haven’t delivered the final, definitive word on whether any of these methods will be feasible ways of helping to reach those carbon removal targets.

But Michael Fuhr, one of the authors of the olivine study and a doctoral student at GEOMAR, says their findings do suggest that this approach is “not as easy as expected until now.” He adds that it may work well only in certain places where the ocean chemistry is right. That could include areas where the waters are low in salinity but rich with organic sediments, which will increase acidity.

Fuhr and others say that additional lab experiments and fieldwork will be needed to determine how well this method works in the real world, what the ideal conditions are, or whether other materials are more promising.

Maria-Elena Vorrath, a researcher at the Alfred Wegener Institute for Polar and Marine Research, said in an email that the study shows the olivine process doesn’t work the way we assumed. But she stressed that the mineral remains “one of the most permanent and promising methods nature gives us.”

“We just need to understand and read the manual,” she wrote, noting that water mixing and other variables in the actual oceans could alter results seen in the lab. Meanwhile, the National Academies panel has called for setting up a $125 million US research program to study whether we could develop ways to scale up or accelerate these processes, identify environmental side effects, and figure out how to reliably measure and verify whether carbon removal is occurring.

“Ocean geochemistry is fraught with complexity,” says Wil Burns, a visiting professor at Northwestern University who focuses on carbon removal. “We’re going to need to do a lot of iterations of this research, under very different conditions and different scales, to draw conclusions that we could do these at large scales and monetize them.” Read the full story at www.technologyreview.com ■

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**Book reviews**

**Pure Colour**
by Sheila Heti
(Farrar, Straus and Giroux, 2022)

“You must admit, we don’t understand completely how the universe works,” says Mira, the millennial protagonist of Heti’s often infuriating, other times profoundly moving, novel on the nature of love, loss, and existence. Most affecting are her musings on the loss of her father and the necessity of books to her very existence.

**Ways of Being**

Animals, Plants, Machines: The Search for a Planetary Intelligence
By James Bridle
(Farrar, Straus and Giroux, 2022)

When cities and refrigerators are described as “smart,” trees communicate with one another, and bonobos are making complex tools, can we still understand intelligence as being unique to humankind? Artist and writer Bridle suggests we develop an ecology rooted in the interrelationships between technology and the world: “The world is a computer made out of crabs, infinitely entangled at every level and singing, full-throated, the song of its own becoming. The only way forward is together.”

**The Brain in Search of Itself**
Santiago Ramón y Cajal and the Story of the Neuron
By Benjamin Ehrlich
(Macmillan, 2022)

Santiago Ramón y Cajal (1852–1934) described neurons as “the mysterious butterflies of the soul whose beating of wings may one day reveal to us the secrets of the mind.” Widely thought of as the founder of neuroscience, Cajal originally wanted to be an artist, but his father pushed him toward science. He managed to combine both pursuits, using his artistic skills to create groundbreaking drawings of the human brain and other nerve tissues. He received the Nobel Prize in medicine in 1906.

**When We Cease to Understand the World**
Benjamin Labatut, translated from the Spanish by Adrian Nathan West

From the first paragraphs, you’ll be powerless to resist this dizzying confluence of Prussian blue dye (of which Zyklon B is a by-product), Schrödinger’s cat, matrix mechanics, and the suffering of plants. The exuberance that comes with scientific discovery is too often destroyed by the agony of unintended consequences: as the theoretical mathematician Alexander Grothendieck warns here, “The atoms that tore Hiroshima and Nagasaki apart were split not by the greasy fingers of a general, but by a group of physicists armed with a fistful of equations.” ■
MazaCoin and the nerd’s revenge

For the creator of MazaCoin, the dream of a sovereign monetary system for indigenous people is still alive. It just doesn’t look the way it did 10 years ago.

By Tate Ryan-Mosley

Payu Harris wanted to create a cryptocurrency for his grandma. For all grandmas, he would say, or uncis in Lakota—especially the impoverished ones living on the outskirts of Pine Ridge Indian Reservation in South Dakota, with little access to electricity or the internet. He’d argue that MazaCoin could be called a success if she used it every day. If that seems an unlikely prospect, it is—and MazaCoin has had its ups and downs since he conceived the idea. But 10 years on, Harris’s dream is clearer than ever, albeit a bit more complicated than it was at the start.

Harris was working at the mall near Pine Ridge when he first learned about Bitcoin from a friend. During the day, he’d leave his laptop running to mine coins, checking in during smoke breaks. His story is like that of many other crypto fanatics. Harris grew more invested in the Bitcoin hype, learning to code and reading white papers on his days off. Eventually, along with a coder known only by the pseudonym AnonymousPirate, he built a digital currency, then called the Oyate Initiative, for the Oglala Sioux, a subtribe of the Lakota Nation. He was intent on providing his reservation with a more independent economy.

In a 2013 Forbes profile of the project, Harris called it the “nerd’s revenge.” Native groups like the Lakota, the same one devastated in the Wounded Knee Massacre over 100 years ago, have deliberated creating an indigenous currency since the early days of the reservation system. Though no such movement has ever really taken hold, the thinking is that a sovereign currency could offer increased independence from the American regulatory system, as well as more control over economic development.

MazaCoin initially seemed like one of the golden children of the cryptocurrency world. Harris describes the first few months post-launch, in 2014, as something like a sunny press tour: while he rang the opening bell at New York’s Bitcoin Center and attended a meeting at the Facebook offices, MazaCoin soared to a market cap of $6.8 million. But the currency fell almost as fast as it rose, which Harris attributes to controversial coverage claiming that the Lakota leaders knew nothing of the project.

From the outset, Harris set aside 10 million coins as reserve for a Lakota development fund. Apart from the reserve, little sets MazaCoin apart technically from Bitcoin, making it a bit of a hard sell as an appealing “alt coin.” But Harris isn’t looking to court a wide array of investors. He says he didn’t even need the soaring valuations seen at the beginning; he just wants to build a system that can deliver value to native people, starting with the Lakota on Pine Ridge and expanding to other tribes and reservations from there.

MazaCoin’s challenges today are very different from those it encountered a few years ago. Harris and his team realized that in order to establish a national currency, the tribal council needed the ability to set monetary policy. “I was coming at this from the sovereignty aspect,” he says, “but having a currency structure of our own and a vibrant, comprehensive monetary policy is how we’re going to build our economy, it is how we’re going to build our markets, and it’s how we’re going to build for the future—it’s how we’re going to get away from federal funding. Period.”

Currently, indigenous nations use the US dollar, making them dependent on policies set forth by the Federal Reserve, the Treasury, and Congress. But as “domestic dependent” nations, tribes have some freedom from US regulations, meaning that new policies targeting crypto might not affect MazaCoin. Harris hopes this insulation could make MazaCoin more appealing in the near future, given renewed federal appetite for crypto regulation.

In the meantime, Harris has found other uses for all his technology. He’s been working on tokenizing natural resources owned by the tribe, such as unmined gold in the Black Hills or coal reserves that could be commoditized. Harris is also storing tribal treaties, documents, and historic assets on the blockchain to establish an indigenous system of recordkeeping. For him, it’s all about finding new ways to assert sovereignty and pump money back into the reservation.

But MazaCoin is still trying to sort out the basics—courting buy-in from tribe members and trying to raise its value. Harris is appealing to the new interim tribal president to establish an official cryptocurrency office. With covid restrictions lifted, he’s planning a road show to pitch MazaCoin across the tribe and to educate people on crypto basics, like setting up a wallet.

Harris says he’s noticed an uptick in interest lately as crypto and digital assets like NFTs become topics of more mainstream discussion, but the price isn’t increasing in the same way. “People ask me where I want to see MazaCoin go. It’s not really up to me,” he says. “It’s up to the tribes.”

Tribes have some freedom from US regulations, meaning that new policies targeting crypto might not affect MazaCoin.
The secret police

An investigation by MIT Technology Review reveals how cops built a shadowy surveillance machine in Minnesota after George Floyd’s murder.

By Tate Ryan-Mosley & Sam Richards

Law enforcement agencies in Minnesota have been carrying out a secretive, long-running surveillance program targeting civil rights activists and journalists in the aftermath of the murder of George Floyd in May 2020. Run under a consortium known as Operation Safety Net, the program was set up a year ago, ostensibly to maintain public order as Minneapolis police officer Derek Chauvin went on trial for Floyd’s murder. But an investigation by MIT Technology Review reveals that the initiative expanded far beyond its publicly announced scope to include expansive use of tools to scour social media, track cell phones, and amass detailed images of people’s faces.

Documents obtained via public records requests show that the operation persisted long after Chauvin’s trial concluded. What’s more, they show that police used the extensive investigative powers they’d been afforded under the operation to monitor individuals who weren’t suspected of any crime.

MIT Technology Review’s investigation includes thousands of documents and more than two dozen interviews with Minnesota state employees, policing experts, and activists. Taken together, they paint a picture of a state operation intent on identifying participants through secretive surveillance operations. Though it was undertaken by nonmilitary governmental agencies using public funds, large swaths of its inner workings have gone undisclosed. We found evidence of a complex engine of surveillance tailor-made for keeping close tabs on protesters and sharing that information among local and federal agencies, regardless of whether the subjects were suspected of any wrongdoing.

Operation Safety Net (OSN) was announced in February 2021, a month before Chauvin’s trial was set to begin. At a press conference also attended by Hennepin County sheriff David Hutchinson, Medaria Arradondo, then Minneapolis’s police chief, described the effort as a unified command that would enable law enforcement officials to mount a regional response in case protests turned violent.

Publicly, OSN acknowledged that federal agencies would assist in monitoring for threats of violence and activity by out-of-state extremist groups, and that an “intel team” would be established to help share information surrounding these threats. Our investigation shows that federal support for OSN was in fact extensive, involving the US Department of Homeland Security and the Federal Bureau of Investigation. At least six FBI agents served in executive and intelligence roles for the program.

According to OSN’s website, which was shut down on January 19, the program’s mission was to “preserve and protect lawful First Amendment nonviolent protests and demonstrations before, during, and after the trial of Chauvin, who was charged in George Floyd’s death.” The site added, “Operation Safety Net is also dedicated to preventing violent civil disturbances, assault /assaultive actions, property damage, fires, and looting to government buildings, businesses, and critical infrastructure.”

The week Chauvin’s guilty verdict was issued in April 2021, officials told the public that the program was “ramping down,” and in an email to MIT Technology Review in October 2021, spokesperson Doug Neville said OSN is “not an ongoing operation.” However, according to emails obtained and reviewed as part of our investigation, the operation appears to be actively ongoing, with regular planning meetings of the executive and intelligence teams —where it has been referred to as “OSN 2.0”—and sharing of intelligence documents. No information about the goals or extent of the new engagement has been publicly disclosed, and officials contacted about the program denied that it had been formally renewed.

Documents unearthed as part of this investigation shine a light on secretive surveillance programs, new technology vendors, murky supply chains used to arm riot police, and several watch lists, as well as other previously unreported information. Taken together, they reveal how advanced surveillance techniques and technologies employed by the state, sometimes in an extra-legal fashion, have changed the nature of protest in the United States, effectively bringing an end to Americans’ ability to exercise their First Amendment rights anonymously in public spaces. Read the full story at www.technologyreview.com
Op-Ed

We can’t afford to stop solar geoengineering research

It is the wrong time to take this strategy for combating climate change off the table.

By Holly Jean Buck

In December, I attended the American Geophysical Union meeting in New Orleans, where 26,000 geoscientists convened in person and virtually to share the latest Earth and climate science. Perhaps a hundred of those people were there to talk about research on solar geoengineering—the idea of reflecting a fraction of incoming sunlight to cool a warming planet.

Research on the topic is anemic; it has been more or less stuck for several years. I saw presentations given to nearly empty conference rooms. At the poster session, I saw the same idea I had seen at an AGU meeting five years ago: preserving Arctic ice with reflective, hollow glass microspheres. The climate intervention aisle was quiet. Meanwhile, one aisle over in the cryosphere area, people were jammed shoulder to shoulder—despite the pandemic—to hear about the collapsing “doomsday” glaciers.

It was in this context that a group of more than 60 senior scholars released the International Solar Geoengineering Non-Use Agreement in January. The group argues that the technology cannot be governed fairly and poses “an unacceptable risk.”

A non-use agreement on solar geoengineering sounds prudent at first glance. Since the concept is so immature and theoretical, we should have a moratorium on its use; the science isn’t there to understand what reflecting sunlight would do to ecosystems, climate, or human systems. Nor is it a new idea. Leading researchers proposed such a moratorium nearly 10 years ago in the journal Science.

Unfortunately, this agreement is far more expansive than a simple ban on use. And that’s a problem, because solar geoengineering might actually have significant benefits. It could substantially offset global temperature rise and potentially mitigate serious secondary impacts, such as reduction in crop yields and increased frequency and intensity of hurricanes and typhoons. We don’t know everything about what it would do. But there is a strong humanitarian case for learning more, even if learning more reveals that the downsides outweigh the benefits.

The non-use proposal fails to adequately distinguish research from development or deployment. It’s a thinly veiled attempt to stifle research on the topic. Last year, the authors wrote a letter to Nature, objecting to an editorial titled “Give research on solar geoengineering a chance.” Their stance? “We call on our governments and funding agencies to halt the normalization of research into planetary solar geoengineering technologies.”

The non-use agreement calls for a commitment to banning outdoor experiments and barring national funding agencies from “supporting the development” of solar geoengineering technologies, both domestically and through international institutions. It further says that countries should “object to future institutionalization of planetary solar geoengineering as a policy option in relevant international institutions, including the Intergovernmental Panel on Climate Change.” So we would not be able to know how the foremost body of climate scientists appraises the science.

The group envisions a future in which philanthropic foundations, universities, science associations, civil society organizations, parliaments, and more express their support for non-use. The idea is to create such intense social pressure that no serious research group would want to spend time on solar geoengineering for fear of criticism. Philanthropies and government agencies would hesitate to fund such research for the same reason.

Two methods of solar geoengineering
Intense social pressure to cease solar geoengineering research won’t mean that all such research will end. It means that researchers who care about openness and transparency might stop their activities, and the ones who continue might be less responsive to public concerns. They will be supported by funders that don’t care about public opinion—perhaps private actors or militaries—and we might not hear about all the findings. Autocratic regimes would be able to take the lead—and we might have to rely on their expertise in the future if we’re not successful in phasing out fossil fuels. And scientists in developing countries—already disadvantaged in terms of participating in this research—may be even less able to do so if international institutions and philanthropies are not providing funds.

Solar geoengineering research needs public funding through national science agencies. This can help ensure several important things. It can maintain public oversight and enable the design of research programs where social scientists and governance scholars are integrated from the outset, producing the critical type of interdisciplinary research this topic demands. What’s more, public funding can be designed to encourage international scientific cooperation. For example, a paper presented at AGU that looked at the impact of solar geoengineering on crop yields included researchers from Norway, the US, South Korea, and China. We want to continue this kind of cooperation, not stifle it.

Perhaps most important, national funding agencies can structure research programs to examine the potential risks and benefits in a comprehensive way. Without this systematic approach, what gets published may be a trickle of studies showcasing only the most stellar results, making solar geoengineering look better than it is.

No scientist is happy about the prospect of solar geoengineering. But we are going to need a pipeline of thoughtful, experienced people who understand both the science and the governance issues. If we disincentivize people from developing that expertise, we may not like the results.

Good science takes years to develop. If we put off research until the 2030s, we could find ourselves in a world that’s made some uneven progress on the reduction of greenhouse-gas emissions but not enough, with temperatures still headed toward 3 °C of warming. We can’t then suddenly hope to produce rigorous science that would help us understand whether solar geoengineering is advisable. For a start, the US should follow the well-thought-out recommendations set up by the committee that recently grappled with this at the National Academies of Sciences, Engineering, and Medicine, and fund a modest, careful research program now.

Holly Jean Buck is an assistant professor of environment and sustainability at the University at Buffalo and the author of Ending Fossil Fuels: Why Net Zero Is Not Enough.

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**In praise of the dollar bill**

Digital payments increase convenience but exacerbate inequality. Is it time to reconsider cash?

BY LANA SWARTZ

“We are cashless,” proclaims a sign on the gleaming glass door of the cafe I frequent. The sign predates the glossy list of covid-19 measures taped beside it, but together they present a united declaration of touchless efficiency—the promise of experiencing public space, social interaction, and consumer exchange with utmost convenience and cleanliness. Yet for all the friction that the cashless coffee shop aims to eliminate, it reproduces far weightier social barriers and inequalities.

For individuals and communities, transactional technologies—digital wallets, mobile payments, and the like—can increase their autonomy in decision-making, their flexibility and resilience in times of crisis, and their ability to fight victimization, exploitation, and indignity. Trust in these technologies builds the capacity for long-term planning and building—of wealth, of infrastructure, of the foundations of prosperity for future generations—as well as for experimentation and risk. Of course, the corollary is also true: malign versions of these tools can rob communities and individuals of their agency.

Cash is the best transactional tool for increasing community and individual autonomy that we have invented so far. It offers many affordances that prove hard to replicate. Cash does not need someone else’s signature to spend. It does not specify where you can spend it, or on what. It is anonymous: no one needs to know who you are for you to spend it. It generates no data about your transaction, but together they present a united declaration of touchless efficiency—the promise of experiencing public space, social interaction, and consumer exchange with utmost convenience and cleanliness. Yet for all the friction that the cashless coffee shop aims to eliminate, it reproduces far weightier social barriers and inequalities.

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What happens if cash goes away?

There are some lessons from history that are worth paying attention to. Cash—defined as a universal, public, printed monetary medium—is a relatively new technological and political achievement. Historically, money has been, more often than not, private and plural. In the United States, state-issued currency was not fully consolidated until after the Civil War. Previously, foreign currencies, private bank notes, and scrip produced by railroads, insurance, companies, and other private businesses circulated alongside currency issued by the US Treasury.

This monetary cacophony meant that everyday spending required considerable street smarts. Bills might have come from a failed or fictitious bank or might have been a counterfeit copy of a note from a functioning, real bank. Bills that were accepted at face value in one city might have been accepted only at a lower value in others. Daily life involved navigating a messy, complex monetary media environment.

The chaotic situation also created highly stratified transactional communities. While the wealthy used notes issued by stable banks and redeemable for letters of credit and bullion, the poor were more likely to use low-value bronze or copper “petty coin” or depreciated bank notes.

The future of transactional media might look something like its past. An industry consultant once told me that “in the future cash will be the ‘c word,’ not something nice people use.” Indeed, the future is likely to be cash-light rather than fully cashless. Those relegated to cash-only status will transact on unequal terms.

Today, cash is a universal, print technology—a mass media form. But it does have major flaws. Cash can be lost, destroyed, stolen. Most important, perhaps, it can’t be spent online, and therefore it does not move at the speed of the rest of our communicative lives.

We don’t yet know the shape of tomorrow’s transactional media or the terrain of its transactional communities. We might work to prevent money that acts like today’s social media platforms: privatized and rooted in data-driven business models.

In the cryptocurrency community, I often hear variations on the phrase “If cash were invented today, it would be illegal.” The point here is that cash is low cost, difficult to censor, and difficult to surveil. At a time when nearly all of our communication, transactional or otherwise, is channeled through monopolistic and controlling platforms that collect rent in the form of fees, data, or both, it’s hard to argue with this line of thinking.

At the same time, we need to ensure that new forms of money are reliable and stable in value, something that has proven difficult for cryptocurrency to achieve. For all its unique affordances as a transactional medium, cash—and whatever its digital inheritors are—must be stable in value in order to work well.

So as I pay for my cortado, I look at that “We are cashless” sign with a researcher’s eye. The stakes are high. We are empowered or disempowered by the transactional tools to which we have access. As we imagine money for the internet era, the big question is how to design payment media in the public interest. We need something that does all the things cash does well—as well as the things cash doesn’t.

Lana Swartz is an assistant professor of media studies at the University of Virginia.
A central-bank digital currency, or CBDC, is issued by a government, like cash. But instead of creating physical bills and coins, the government issues a token—a digital version of money—that lives in an app or digital wallet. Today, from Nigeria to China, governments are experimenting with this new way of minting currency digitally.

Dozens of countries are working on CBDCs. Motivations vary widely, as does the design of each digital currency. “It’s not a one-size-fits-all thing,” says Josh Lipsky, director of the GeoEconomics Center at the Atlantic Council, an international affairs think tank that’s been tracking CBDCs around the world. (The map at right is based on the group’s work.)

Some CBDC projects are focused on payments between countries. But most are so-called retail currencies designed for everyday financial transactions. Retail CBDCs can help bring more people into the banking system, increasing financial inclusion. That’s a significant motivation in places like Nigeria, says Lipsky, where a large portion of the population lives outside of urban centers, or the Caribbean, where getting cash to dozens or even hundreds of small islands can be tricky.

Even in more-connected countries, increasing financial inclusion could have a significant impact—in the US today, about 5% of households don’t have access to a bank account. CBDCs could provide a democratized way to access the digital economy.

Central-bank digital currencies are on the rise, and they could change how money moves

By Casey Crownhart
Map by Arthur Mount
1.7 billion people (about 30% of adults): The number who lack a bank account.

16 million digital yuan (about $315,000 US): The amount exchanged each day in China’s CBDC experiment during the 2022 Olympics.

1.7 million transactions per second: The volume reached by experimental code for a potential US CBDC.

1.7 billion people worldwide (about 30% of adults): The number who lack a bank account.
Undeterred by an unfavorable patent decision, the Nobel laureate is optimistic about the future of CRISPR.

By Antonio Regalado

“Honestly, look, I’m carrying on with my research.”

The day I spoke to Jennifer Doudna was a tough day: the US Patent Office had just stripped her university of a US patent on CRISPR's most important uses, handing the commercial rights to her rivals at the Broad Institute of MIT and Harvard.

Doudna is the co-discoverer of CRISPR editing, the revolutionary method for engineering genes that, 10 years after her original breakthrough, is now making its way into human trials. There’s an expanding list of applications in diagnostics and engineered plants; already researchers are exploring potential treatments to cure sickle cell disease, blindness, and liver disease. In 2020, she shared a Nobel Prize with fellow scientist Emmanuelle Charpentier. The two became the sixth and seventh women to win the award in chemistry.

Doudna heads the Innovative Genomics Institute at the University of California, Berkeley, and the work coming out of her laboratory continues to focus on the molecular details of how the CRISPR system works. Perhaps more than anyone, she has been able to relay to the public the formidable power of versatile gene editing as well as the possible downsides of the technology. I spoke to her about this and other issues, including the surprising reality of a legal system where the key patent could go to someone other than the one accepting a Nobel for the discovery.
AR: Just yesterday the patent office ruled against Berkeley in a long-running patent case over CRISPR. What are your reactions to that?
JD: It doesn’t really make sense to me, [but] I’m pleased that we have our 45 issued patents, our 40 pending patents, all in the US. And our 30 European patents are unaffected by the ruling. And honestly, look, I’m carrying on with my research.

AR: I always thought the origin of the patent fight was not about money. My own reading of why it was so strongly fought was that it was not over commercial control but over credit—who did the science—and the truth.
JD: That’s your speculation. It’s hard to say, isn’t it? I don’t know what others’ motivations may have been. Obviously, it will be appealed. Obviously, we don’t agree with the decision. And obviously, 30 countries and the Nobel Prize Committee also don’t agree, if you’re talking about who invented what, at first.
AR: What does it tell you about how the patent system operates that there could be one person accepting a Nobel Prize but then the patent going elsewhere? Should that make sense to people?
JD: It doesn’t really make sense to me. I don’t know if it makes sense to other people. In the scientific community I don’t think there’s much question about what happened.

AR: Changing topics ... you have been the subject of a book by Walter Isaacson, who also wrote biographies of Steve Jobs and Leonardo da Vinci. What was it like to participate in your biography?
JD: Humbling and a little bit terrifying, if I’m honest. Although I have to say I felt fortunate that someone as talented as Walter was interested in the story, because he’s a wonderful writer. He did a great job of trying to capture the feeling we all had of being part of this incredible transformation that happened with CRISPR.

AR: You recently became the chief science advisor to a Wall Street firm called Sixth Street. What are you planning to do there, and why did you take on that role?
JD: I’m excited that at Sixth Street we can identify the right teams, the right opportunities, the right openings where financing could really accelerate the science and the business opportunities. One area where I think there’s a lot of potential is using machine learning to analyze data that are coming out of CRISPR. We know that one of the important opportunities with CRISPR in the future is to understand genomics, meaning the function of genes. And frankly not individual genes but whole sets of genes and pathways and different cell types comprehensively. The types of data that come from those efforts clearly contain a huge amount of information, much of it subtle. And so using machine learning algorithms to mine those kinds of data sets, I think, will be very powerful. You could imagine using that type of strategy to understand the genetics of disease—our individual susceptibilities—and to identify new therapeutics.

AR: I always think of you as sort of a scientist’s scientist. I once saw a picture of you leaning over a student’s shoulder, and that’s who you are in my mind. But this is asking you to do something a little bit different. Why do you think you could be good at picking technologies for commercial investment, as opposed to the most intriguing scientific questions?
JD: I love science, and my best days are when I am leaning over a student in the lab looking at data. But I’ve come to appreciate that for CRISPR to have an impact in the next decade is going to require real capitalization of the right teams.

AR: A survey in Harvard Business Review found that only 2.3% of VC money was going to startups led by women. Were you shocked to learn that?
JD: Disappointed, maybe; not shocked, though, because I’ve been in that
world long enough now to see it up close and personal.

AR: You have a couple of former students, Rachel Haurwitz, the CEO of Caribou Biosciences, and Janice Chen, one of the cofounders of Mammoth Biosciences. Those are prominent examples of women who’ve gone on to start CRISPR companies. What’s your understanding of how the challenges or barriers for women differ in industry and academia?

JD: Women are often not as connected in the biotech and venture worlds. It’s hard to exactly explain or understand quite why that is, but it seems to be the case. So one of the things that we’re seeking to do at the institute here is support female entrepreneurs. We just had an announcement about our Women in Entrepreneurial Science program. This is a philanthropy-funded opportunity where we’re hoping to support more diversity, in biotech especially. It’s to give women the kind of connections they are going to need—the kind of training that will help them make good pitches to venture groups, build teams, assume leadership roles, and feel confident in their abilities to run teams. I think these are all things where we can be helpful.

AR: What is the state of commercialization of CRISPR right now? How’s it been going?

JD: Amazingly. It’s just an incredible time. A number of companies that started up over the last decade have already gone public, and many more are at various stages of building their efforts. We’re seeing very exciting announcements from clinical trials and seeing sustained, long-lasting impact on patients. Increasingly we’ll see exciting advances in other sectors as well. Agriculture comes to mind.

There’s been a lot of focus on clinical medical uses of CRISPR. However, I suspect that over the next decade, when we think about global impact and impact on daily lives, that’s where the uses in agriculture and even to address climate change will potentially have a much broader impact.

Pam Ronald, who is a professor at UC Davis and one of our affiliated faculty at the IGI, has been able to use CRISPR to engineer drought-tolerant rice and is in the process of field-testing these plants here, locally, in California. Something that’s farther out, but I think also potentially very high impact, is using CRISPR in microbial communities, in the soil or in water, that will allow us to enhance their capabilities for carbon capture.

AR: I wanted to ask two questions about hereditary genome editing. CRISPR babies. From what I understand, you’ve never been in favor of that. But you’ve also not wanted to sign on to attempts to ban it. What’s been the evolution of your thinking?

JD: My feeling about it has been consistently that it should not be used clinically right now. I think we’re still at a point where it’s not appropriate to use CRISPR in human embryos for the purpose of creating a pregnancy. And why not? Well, because the technology is not well vetted in that system. And I don’t think we’ve seen a clear argument for a real medical need for that approach. Thirdly, there hasn’t been an opportunity for widespread societal consideration of the implications of that type of use to make heritable changes in human beings.

AR: It’s hard to identify a necessary medical use. But it’s quite a bit easier to identify a speculative enhancement use. For instance, there probably are versions of genes that protect people against Alzheimer’s. If I could give my child one of those, that would be great. What are your thoughts about the future use of CRISPR to improve people by, say, increasing their resistance to disease?

JD: I think it’s very possibly a direction that CRISPR could go. I’m quite interested in it for the reasons that you just stated. Not for so-called enhancements, but to improve the quality of life for people, whether it’s in a disease like Alzheimer’s that is so destructive for so many families, and has a huge economic impact, or something like cardiovascular disease, with a similarly huge impact socially and financially. If there were a way in the future to use CRISPR to protect people, generally, from susceptibility to those types of diseases through genetic changes, I think that has to be considered.
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The money issue

Illustration by Lauren Simkin Berke
MONEY IS ONE OF HUMANKIND’S MOST remarkable innovations. It makes it possible to trade products and services across great geographic distances, between people who may not know each other and have no particular reason to trust each other. It can even be used to transfer wealth and resources over time. Without money, trade and commerce—all human economic activity, really—would be severely constrained in terms of time and space.

The privilege of issuing money is synonymous with economic power. So it should come as little surprise that history is replete with examples of currency competition, both within countries and between them. In China, home of the world’s first paper money, currencies issued by private merchants and provincial governments competed for many centuries. Indeed, banknotes issued by governmental and private banks coexisted in China as late as the first half of the 20th century.

What finally, decisively ended this competition was the emergence of central banks, which were given the exclusive privilege of issuing legal currency and tasked with maintaining its stability. This shift happened quite early in Sweden; the world’s oldest central bank, the Riksbank, was established there in the 17th century. In China, competition closed with the founding of the People’s Bank of China in 1948, shortly before the formal creation of the People’s Republic of China. Since the central banks

Digital technology is poised to change the very nature of money

By Eswar Prasad
stepped in, competition has been mostly international, with the relative value of currencies depending on the reputation and stability of the central banks issuing them.

We now stand at the threshold of another era of upheaval. Cash is on the way out, and the digital technologies that are replacing it could transform the very nature and capabilities of money. Today, central-bank money serves at once as a unit of account, a medium of exchange, and a store of value. But digital technologies could lead those functions to separate as certain forms of private digital money, including some cryptocurrencies, gain traction. That shift could weaken the dominance of central-bank money and set off another wave of currency competition, one that could have lasting consequences for many countries—particularly those with smaller economies.

IN ANCIENT SOCIETIES, OBJECTS SUCH AS shells, beads, and stones served as money. The first paper currency appeared in China in the seventh century, in the form of certificates of deposit issued by reputable merchants, who backed the notes’ value with stores of commodities or precious metals. In the 13th century, Kublai Khan introduced the world’s first unbacked paper currency. His kingdom’s bills had value simply because Kublai decreed that everyone in his domain had to accept them for payment on pain of death.

Kublai’s successors were less disciplined than he was in controlling the release of paper currency. Subsequent governments in China and elsewhere gave in to the temptation of printing money recklessly to finance government expenditures. Such wantonness typically leads to surges of inflation or even hyperinflation, which in effect amounts to a precipitous fall in the quantity of goods and services that a given sum of money can buy. This principle is relevant even in modern times. Today, it is trust in a central bank that ensures the widespread acceptance of its notes, but this trust must be maintained through disciplined government policies.

To many, however, cash now seems largely anachronistic. Literally handling physical money has become less and less common as our smartphones allow us to make payments easily. The way in which people in wealthy countries like the United States and Sweden, as well as inhabitants of poorer countries like India and Kenya (see page 50), pay for even basic purchases has changed in just a few years. This shift may look like a potential driver of inequality: if cash disappears, one imagines, that could disenfranchise the elderly, the poor, and others at a technological disadvantage.
In practice, though, cell phones are nearly at saturation in many countries. And digital money, if implemented correctly, could be a big force of financial inclusion for households with little access to formal banking systems.

Cash still has some life in it. During the covid pandemic, even as contactless payments became more prevalent, the demand for cash surged in major economies including the US, presumably because people viewed it as a safe form of savings. Many states in the US have laws in place to make sure that cash is accepted as a form of payment, something that would protect people who cannot or do not want to pay through other means. But consumers, businesses, and governments have generally welcomed the shift to digital forms of payment, especially as new technologies have made them cheaper and more convenient.

The decline of physical cash, once valued as the most definitive form of money, is but a small feature of the rapidly changing financial landscape, though. One of the most dramatic forces of change has been the rise of cryptocurrencies, which have shaken long-held precepts about money and finance.

**Bitcoin, the cryptocurrency that started it all, may not have much of a role to play in this monetary future.**

Bitcoin was designed to enable people to complete transactions pseudonymously (using only digital identities rather than real ones) and without the intervention of a trusted third party such as a central bank or financial institution. In other words, anyone with a computer could conduct transactions—no credit card or bank account necessary. Coins are issued and transactions validated through a computer algorithm that runs autonomously; the identity of its creator remains unknown to this day.

The timing of Bitcoin’s introduction in early 2009, when the global financial crisis had decimated trust in governments and banks, could not have been better. But even as it gained in popularity, Bitcoin stumbled in its basic uses. The volatility of Bitcoin’s value, with wild price swings from one day to the next, has made it an unreliable method of payment. Moreover, it turns out that the cryptocurrency does not guarantee anonymity—users’ digital identities can, with some effort, be connected to their real identities (in some ways this is a good thing, as Bitcoin transactions that once fueled the dark web, where unsavory and illicit commerce is conducted, have fallen sharply). Today, Bitcoin and other cryptocurrencies like it have mostly become speculative financial assets, with little intrinsic worth and sky-high valuations that are not backed by anything other than investors’ faith.

A new generation of cryptocurrencies is emerging that promises to fix many of Bitcoin’s flaws. Stablecoins, cryptocurrencies whose stable value comes from being backed by reserves of US dollars or other reputable fiat currencies, are proliferating. Stablecoins are billed as reliable, easily accessible digital payment systems that will make both domestic and international payments cheaper and quicker. However, unlike Bitcoin, which is fully decentralized, they require transactions to be validated by
the issuing institution—which could be a bank, a corporation, or just an online entity. This means users must trust that institution to validate only legitimate transactions and hold adequate reserves, and regulators currently do not require independent verification of either of those actions. Thus, despite their laudable goal of meeting the demand for better payment systems, stablecoins have raised a raft of concerns.

Even with all these growing pains, the cryptocurrency revolution has expanded the frontiers of digital payment technologies and helped light a fire under central banks. Long viewed as conservative institutions resistant to major change, many are now entering the digital race.

**FACED WITH THE INCREASING IRRELEVANCE** of their paper currencies, many central banks around the world are looking to issue their money in digital form. Major economies such as China, Japan, and Sweden are experimenting with central-bank digital currencies (CBDCs), which in effect are just digital versions of the currencies they now issue as notes and coins. The Bahamas and Nigeria have already rolled out their CBDCs nationwide. Countries including Brazil, India, and Russia are in the process of initiating their own experiments (see map on pages 18-19).

Some countries see CBDCs as a way to broaden access to the formal financial system—even households without bank accounts or credit cards would gain access to a safe and inexpensive digital payment system. Other countries are pursuing CBDCs to increase the efficiency and stability of digital payment systems. Sweden’s e-krona is being pitched as a backstop in case the payment system managed by private-sector companies, which might work perfectly well under most circumstances, should fail because of either technical problems or confidence issues.

CBDCs could also help maintain the relevance of central-bank retail money in countries where digital payments are becoming the norm. China, for example, is pursuing its digital renminbi at a time when two financial titans, Alipay and WeChat Pay, are striving to dominate the payment landscape.

CBDCs have many other advantages, too. They could bring certain types of economic activity out of the shadows and into the tax net (unlike cash transactions, which often go unreported to tax authorities), reduce counterfeiting, and make it harder to use official money for illicit purposes such as money laundering, drug trafficking, and financing of terrorism. But they could threaten whatever minimal vestiges of privacy we still enjoy—after all, everything digital leaves a trace. Transactions using CBDCs are likely to be auditable and traceable, as no central bank would want to allow its money to be used for illicit transactions.

**WHAT WILL THE WORLD OF MONEY LOOK like in five or 10 years’ time?** We could envision a world where many people hold digital wallets with a mix of money in traditional bank accounts, stablecoins managed by private companies, and perhaps one or more CBDCs, moving them around...
depending on global conditions. Then again, no one knows how well stablecoins and CBDCs will coexist. Meta (formerly Facebook), for example, had planned to roll out its own stablecoin. But the project was quashed by US regulators, who were concerned about Meta’s objectives and about the possibility that the stablecoin could be used to finance illicit transactions within and across national borders.

The basic case for stablecoins as more efficient and easily accessible forms of digital payment could be undercut by CBDCs. For the moment, stablecoins seem to be holding their own—there were more than 30 in circulation as of March 2022, with a total value of about $185 billion. And there is the possibility that stablecoins built on top of large-scale commercial ecosystems such as Amazon’s could gain significant traction as means of payment. At any rate, insofar as their stability depends on their being backed by fiat currencies, stablecoins are unlikely to become independent stores of value. In other words, they would be used primarily because they would be cheaper or more convenient means of payment.

However it plays out, the digital-currency revolution is going to have implications for the international monetary system. Take cross-border payments, which are inherently complicated because they involve multiple currencies, institutions using different technological protocols, and varying sets of regulations. All this makes international payments slow, expensive, and difficult to track in real time. Cryptocurrencies, which can be shared freely across borders, will reduce these impediments, enabling nearly instantaneous payment and settlement. Even CBDCs could ease the frictions if they are made available for use internationally and gain widespread acceptance.

More-efficient international payment systems will bring a host of benefits. For one thing, they will make it easier and cheaper for economic migrants to send remittances back to their home countries—a process that currently costs an average of 6% of the transaction amount, according to the World Bank. The estimated costs are even higher for remittances going to low-income countries, many of which depend on such inflows for a large share of national income.

In principle, financial capital will be able to flow more easily within and across countries to the most productive investment opportunities, raising global economic welfare—at least as measured by GDP and consumption capacity. But easier capital flows across national borders will also pose risks for many countries, making it much harder to manage their exchange rates and their economies. The resulting challenges will be especially thorny for smaller and less developed countries.

National currencies issued by their central banks, particularly those currencies seen as less convenient to use or more volatile in value, could be displaced by private stablecoins and perhaps also by CBDCs issued by the major economies. This would result in a loss of monetary sovereignty: less prominent central banks would lose control over the circulation of money in their economies.
The phenomenon of “dollarization,” wherein a trusted foreign currency supplants a volatile domestic currency (long the bane of many Latin American countries), could be intensified by the proliferation of digital currencies. In places such as Iran and Turkey, we have already seen people use cryptocurrencies to get around restrictions on capital outflows when currencies were plunging in value, enabling them to spirit funds out of their countries and into safer investments abroad.

Even for the major reserve currencies, there are some shifts in store, though the long-standing dream of many governments around the world—knocking the US dollar off its pedestal as the dominant global reserve currency—will probably remain just that for the foreseeable future. Indeed, it is likely that stablecoins backed by the dollar will gain widespread acceptance relative to stablecoins backed by other currencies, indirectly increasing its relative prominence. But the digital renminbi is poised to gain traction as a method of payment, and even a gradual and modest increase in the renminbi’s use, along with a rise in stablecoins, could reduce the importance of other reserve currencies, including the euro, the British pound sterling, the Japanese yen, and the Swiss franc.

**When it comes to money’s function as a medium of exchange, we can expect more competition between private and fiat currencies. In principle, this should lead to payments that are cheaper and quicker—benefiting consumers and businesses—while also motivating issuers, whether private or official, to exercise discipline in order to preserve the value of their currencies.**

But it is worth keeping in mind that technology can have unpredictable consequences. Rather than leading to a proliferation of private and official currencies that compete on a level playing field, the digitization of currencies could make economic power even more concentrated. If major currencies such as the dollar, the euro, and the renminbi are easily available worldwide in digital form, they might displace the currencies of smaller and less powerful nations. Digital currencies issued by large corporations, taking advantage of the companies’ already dominant commercial or social media ecosystems, might gain traction too. Unless they are quashed by governments, they could one day turn into independent stores of value by giving up their fiat-currency backing. This could create even more monetary instability if individual countries wound up having multiple issuers of money, with competing domestic currencies fluctuating in value relative to one another.

All that is certain is that the international monetary system is on the threshold of momentous change wrought by the digital revolution. It remains to be seen whether this ultimately benefits humanity at large—or exacerbates existing domestic and global inequities.

Eswar Prasad is a professor in the Dyson School at Cornell University, a senior fellow at the Brookings Institution, and author of *The Future of Money: How the Digital Revolution Is Transforming Currencies and Finance.*
Communities are grappling with how to manage cryptocurrencies' costs.

By Lois Parshley

Above: Computers mine cryptocurrency in a former Alcoa aluminum plant in Massena, New York, near the Canadian border.
If, in 2017, you had taken a gamble and purchased a comparatively new digital currency called Bitcoin, today you would be a millionaire many times over. But while the industry has provided windfalls for some, local communities have paid a price.

Cryptocurrency is created by computers solving complicated mathematical equations—a process that took off after a Chinese company called Bitmain started selling a machine in 2016 with

Above: Plattsburgh, New York, had some of the cheapest power in the United States, thanks to hydroelectricity from the Niagara Power Authority.

Photographs by Gabriela Bhaskar
application-specific integrated circuits that made it possible to do this specialized computing much more quickly. “Almost overnight,” says Colin Read, a professor of economics and finance at the State University of New York at Plattsburgh, “a crypto-mining arms race began.”

People began scouring the world for cheap sources of energy to run large Bitcoin-mining farms using these circuits. Cryptocurrency notoriously devours electricity; each Bitcoin transaction consumes 1,173 kilowatts—more than the average American uses in a month. In 2020, the world’s crypto mining required more energy than the whole of Switzerland. At the time, Plattsburgh had some of the least expensive power anywhere in the United States, thanks to cheap hydroelectricity from the Niagara Power Authority.

It didn’t take long for a subsidiary of the popular mining firm Coinmint to lease a Family Dollar store in Plattsburgh. The city’s building inspector, Joe McMahon, remembers that the man who signed the lease, Prieur Leary, wanted everything done quickly. “Overnight, he wanted power on,” McMahon says. “We were all uneasy about it but didn’t know the harm.”

Coinmint filled the building with servers, running them 24 hours a day. When the miners wanted to expand into a nearby shopping center, Bill Treacy, the manager of the Plattsburgh municipal lighting department, told them that they would have to invest $140,000 in new infrastructure. He was surprised when they weren’t discouraged. Soon, the company was regularly drawing over 10 megawatts, enough power for about 4,000 homes.

Other miners were quick to follow. Treacy recalls one prospector calling to see if he could get five gigawatts—“I said, ‘Excuse me. That’s a quarter of what New York state uses on a given day!’” Plattsburgh was soon receiving a major mining application every week.

In January 2018, there was a cold snap. People turned up their heat and plugged in space heaters. The city quickly exceeded its quota of hydropower, forcing it to buy power elsewhere at much higher rates. McMahon says his Plattsburgh home’s energy bill jumped by $30 to $40 a month. “People felt there was a problem but didn’t know what to attribute it to,” he says.

As the long winter began to thaw, neighbors noticed a new disturbance: mining servers generate an extreme amount of heat, requiring extensive ventilation to avert shutoffs. Those fans generated a constant, high-frequency whine, McMahon says, “like a small-engine plane getting ready to take off.” It wasn’t just the decibels, but the pitch: “It registers at this weird level, like a toothache that won’t go away.” Carla Brancato lives across the river from Zafra, a crypto-mining and hosting company owned by Plattsburgh resident Ryan Brienza. She says that for several years her condo vibrated from its noise, as if someone were constantly running a vacuum upstairs.

Meanwhile, the automated nature of these servers meant that the new mines provided few local jobs. “I’m pro-economic development,” Read says, “but the biggest mine operation has fewer jobs than a new McDonald’s.”
Each Bitcoin transaction consumes 1,173 kilowatts

Lois Parshley is an investigative science journalist.
If sheer square footage of advertising space is any indication, crypto has arrived. Crypto billboards surround the Bay Area and line LA highways, and you can’t catch a train in NYC without running into an ad for a coin or exchange. A-listers like Gwyneth Paltrow are pushing crypto platforms, and this year’s Super Bowl broadcast was studded with big-budget crypto spots, each trumpeting the opportunity to strike it rich and “make history,” as LeBron James told a smooth CGI’d version of his younger self.

But despite their ubiquity and lavish expense, these ads routinely omit any description of what crypto is or what any of the crypto companies that have paid to

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plaster our landscape—a group that includes currencies like Bitcoin and exchanges such as FTX, Coinbase, and Crypto.com—are actually selling. There’s a good reason for that. While the industry has been good to lucky speculators with the disposable cash to risk and the time to figure out how to do so, it has little to offer the average person today.

The term “crypto” has become something of a catch-all for technology that runs on a blockchain. It’s often just referring to cryptocurrencies, like Bitcoin or Ether, but it can also more broadly mean a suite of tokenized web applications collectively referred to as Web3, most of which run on the Ethereum network. Much of it is deeply weird, some of it is potentially promising, and there’s a good bit that seems like little more than a scam. Regardless, crypto attracted more than $30 billion in VC investment last year and has drawn nearly $4 billion this year so far. New crypto funds like former federal prosecutor Katie Haun’s $1.5 billion venture are sprouting up, fresh crypto startups are boasting billion-dollar valuations months after founding, and Paris Hilton has boosted her NFT investments on The Tonight Show.

Ready or not, cryptocurrencies are coming for us all. Crypto enthusiasts claim that the industry will revolutionize financial systems by decentralizing commerce, grabbing the reins from the grip of the banks that have betrayed us in the past and the Big Tech gatekeepers that have held creators and innovators hostage with biased algorithms and hefty fees. The populist mantra of crypto believers is “WAGMI,” or “We’re all gonna make it,” and the community has deployed it in Discords, on Twitter, and in a cringeworthy Randi Zuckerberg music video to encourage commitment to the cause through crypto’s wild price swings.

But so far, the crypto industry has not made good on that democratizing promise. “Historically, claims like these often originate from groups of people with a
significant amount of power and privilege already, who are seeking to reconsolidate and enhance that power in a new realm," says Mar Hicks, a historian of technology, gender, and labor and the author of *Programmed Inequality*. Indeed, apart from a few lucky players, the crypto riches seem to be flowing mostly toward crypto executives and longtime Silicon Valley VCs, who need regular people to continue to invest in the industry so that it can keep growing. As of September 2021, almost 9 in 10 Americans polled had heard of cryptocurrencies but just 16% of those had used them; meanwhile, billions of dollars have already been lost to crypto fraudsters and scammers.

There is no clear picture of exactly how crypto will change the future of finance or the web, and little that can actually be done with cryptocurrencies should you buy some. Nevertheless, the crypto industry has ballooned into a shape too big to ignore. You may be able to block out the litany of paid messaging, but we all will likely feel the effects of crypto's impact on society, whether we choose to engage or not.

And there are some beneficial changes happening, hiding under the star-studded bluster. The distributed blockchain protocol on which cryptocurrencies rely is winding its way into the back ends of industries like traditional finance and pharmaceuticals, offering real but mostly behind-the-scenes benefits like speed and transactional transparency. Look past the utopian rhetoric, the regulators playing catch-up, and the potential reshuffling of web platforms, and you’ll see that crypto’s most lasting positive contribution to history may be something closer to an invisible protocol like Bluetooth than a worldwide financial revolution.

To understand the crypto industry, we first have to pull apart its three main pieces—work that those Super Bowl ads avoided in favor of platitudes and Larry David in period costume.

The first element is cryptocurrencies. There are more than 10,000 of them globally, the most popular being Ether (ETH) and Bitcoin (BTC). Cryptocurrencies can be either coins or tokens. It’s a distinction that might seem a few syllables away from a hand wave, but in essence, tokens represent an asset (access to a lecture, for instance, or a digital representation of a physical item like a contract). By contrast, coins have purchasing power—the ability to buy tokens and, one day, a wide variety of other goods.

The second is the blockchain, which—despite the singular form—isn’t just one thing. It’s a type of back-end protocol that uses “consensus mechanisms” (in place of traditional authorities like banks) to approve changes, and visible ledgers (rather than private recordkeeping) to log those changes. The history of blockchain is intertwined with that of crypto; a pseudonymous engineer—or group of engineers—called Satoshi Nakamoto used the protocol to devise Bitcoin in 2008, in the midst of the US financial crisis. Bitcoin was to be a new, decentralized system that would allow “any two willing parties to transact directly with each other without the need for a trusted third party,” eliminating middlemen like banks. With a blockchain, Nakamoto wrote, finance could be purely peer-to-peer, with each transaction added to an immutable record.

The third piece of this story is Web 3.0, or Web3, a term coined in 2014 by Ethereum Project co-founder Gavin Wood. Expanding on Nakamoto’s ideas, Wood envisioned a fully decentralized internet, where individuals could use digital tokens to do business online instead of relying on Big Tech platforms like Amazon or Google to manage security, storage, payments, and everything else that keeps the internet running. Web3 is a container concept for crypto and blockchain, positing a whole new digital economy where individuals carry a variety of cryptocurrencies in a digital wallet to buy goods and services from other individuals, or just to tip the creators of content they enjoy. In this (still theoretical) vision, the Web3 world resembles an enormous mall, with each shop taking payment in gift cards that you must purchase with real money before stepping inside. Many companies are purportedly working to realize the vision, but the biggest “Web3” businesses today are still cryptocurrency exchanges, cryptocurrencies, or the tooling to support them—although with so much funding sloshing around, that may soon change.

What is a regular person to make of all this? Should you be brave, as Matt Damon suggests in his Crypto.com TV ad, and turn your real money into Bitcoin? Should you choose from the more than 150 crypto wallets available to start your journey into the mall of the future? If you want to do anything with your money—buy tickets to a movie or split a bill among friends—the answer is no, not yet. And especially not if you don’t have the financial cushion to lose it all.

Fourteen years after Bitcoin first came to be, regular people can mostly engage with crypto only by investing in cryptocurrencies. That means buying coins or tokens and waiting for them to increase in value. The purchase requires using a third-party crypto exchange platform like Coinbase or FTX, which all charge trading fees and have different levels of security.

Besides investing in coins, consumers can now use cryptocurrencies to buy NFT art—unique or “nonfungible” tokens that often appear as an image or video, but could also be audio. NFT art is an investment too; until recently, there’s been little one can do with it besides display it as an avatar or deploy it in a video game (now you can also use it to gain access to exclusive crypto communities). Regardless, it has exploded into the zeitgeist. Martha Stewart launched a Christmas collection of NFT photos of her farm, Justin Bieber spent more than a million dollars on a Bored Ape NFT, and Reese Witherspoon’s production
company, Hello Sunshine, announced it would adapt NFT collections for movies. NFTs could potentially be used to make secure and traceable digital contracts for real-world assets like cars and houses. But these applications still remain rare apart from a few buzzy experiments; legal requirements make those processes difficult to fully replace.

Crypto can also be used to donate to charities like Save the Children and the United Way (facilitated by third parties like The Giving Block, which charge their own fees), or even to nations; Ukraine received more than $50 million in crypto donations after the country’s official government Twitter account posted its Bitcoin and Ethereum wallet information. And TurboTax recently announced that it will let users automatically reinvest their tax refunds in crypto through a partnership with Coinbase. But it’s important to note that no one’s promising a way to pay those taxes in crypto. In fact, there is little about crypto that resembles a currency today.

When consumers buy crypto, it’s added to their wallet, a word that promises the same kind of everyday spending power of credit cards and cash. But sending crypto from one individual to another, or between individuals and small businesses, is still expensive and unwieldy. Both parties need to have compatible wallets—you can’t send bitcoin from an Ethereum wallet, for example—and the sender must enter the receiver’s wallet ID, which is usually more than 20 characters long. Sending crypto to another wallet can take from a few minutes to hours, depending on how busy the network is, and there are no security measures to ensure you’ve reached the correct person; if you accidentally miss a digit and drop coins in the wrong wallet, you’re out of luck.

And then there are the fees. It costs money to set up a wallet, and more to send crypto or exchange dollars for coins. Ethereum, for example, has “gas fees,” measured in gwei, that users pay to transact and miners collect for adding the transactions to the blockchain. In addition to the differences between cryptocurrencies, fees vary by transaction type, speed and security preferences, wallets, and exchange platforms—and they can fluctuate on the basis of congestion, the price of the currency, and changes to company policies. All this makes costs extremely hard to predict before diving into a transaction. And for smaller transfers, a user could end up spending a huge percentage of the original amount in fees. At the time of writing, moving $5 worth of bitcoin between Coinbase—which hosts a popular wallet—and a traditional US bank account cost about $1; transferring $5.13 worth of ETH (.0017 ETH) from one wallet to another cost a whopping $4.46 in gas fees. Because Ethereum fees can be so high, savvy investors sometimes wait to do transactions in the middle of the night when traffic is sluggish.

Some companies, like the YCombinator startup Paymobil, are working on making small transfers easier and cheaper. Paymobil’s goal is for its users to be able to send any form of currency to a phone number or email address—it would be an international Venmo with crypto running silently under the hood. But that’s not a trivial prospect. When the startup began, in 2020, processing fees for Ethereum—the network the company uses—were about 20 cents on small transfers. But as Ethereum has become more popular, the fees have become prohibitive for what Paymobil wants to do. Founder Daniel Nordh says the company is currently subsidizing the user transaction fees and working out how to move forward. Ethereum is developing more cost-effective tooling that might work, and Bitcoin has a different approach with lower fees but less security.

“We’re probably still another generation away from the

$625 million

The amount (per the exchange value at the time) stolen in a single blockchain hack, reported in March.
technology being ready for these kinds of low transac-
tion fees," he says.
Bigger players haven’t figured out peer-to-peer crypto either. PayPal and Venmo (which PayPal owns) have claimed to support crypto since early 2021. But a closer look at their services reveals that though the platforms allow US customers to buy, sell, or trade crypto—invest, basically—they can’t pay for purchases or send crypto to other users. If “the future of money is here,” as Coinbase claims on its website, apparently there’s not much regular people can do with money in the future.

Despite the fact that it’s difficult to spend cryptocurrency, it’s still pretty easy to lose it, and as the industry grows, so do the losses. Without the protections set up in traditional financial systems (such as the Know Your Customer, or KYC, protocols that require identity verification for financial transactions), fraudsters cost crypto investors—mostly individuals like the targets of all those ads—more than $14 billion last year, almost twice the amount lost the previous year. The losses keep mounting. In late March, for example, Sky Mavis reported that a hacker had stolen cryptocurrency then valued at $625 million from the blockchain behind its pay-to-play game Axie Infinity.

Even if their wallets are not hacked or their crypto assets liquidated, individuals face risk from the extreme volatility of crypto markets; Bitcoin’s value dropped more than 20% in a single day multiple times in just the past six months.

“I worry about access; I worry about misuse,” says Afua Bruce, a social policy and technology expert and the author of *The Tech That Comes Next*. “When we’re developing new technologies, we have to figure out who are the communities we’re building for. Can they use it? What does sustainability look like? How is it actually empowering the communities we say we’re building for? I don’t know if those questions have been asked and answered for blockchain.”

In fact, the crypto industry’s relationship with its community seems to be a predatory one. The “we” in “WAGMI” is a small group of predictable players who are getting rich off the risks taken by regular people. Indeed, as of December 2021, .01% of Bitcoin holders controlled 27% of the currency—a far more skewed ratio than for dollar ownership in the US, which is not a flattering statistic to begin with. And because they are not backed by any real asset, cryptocurrencies increase in value as the demand for them rises. When more individuals choose to buy in, VCs and crypto executives watch their own portfolios trend up and to the right. There are plenty of uses for marketing in tech: it can raise awareness of a new technology or help build a user base before monetization. Both those things are happening in crypto. But if marketing persuades enough people to turn real money into crypto coins, it can also literally pay the industry’s bills.

Crypto companies have already made people on their executive teams into billionaires—like Sam Bankman-Fried, the 30-year-old CEO of FTX, who started his short career in traditional finance and is now worth an estimated $24 billion. Bankman-Fried is currently the richest American in crypto, but there were six other “crypto billionaires” on Forbes’s 2021 list of the richest Americans. And that’s only in the US; Binance CEO Changpeng Zhao, who has found a new base in Dubai since China banned crypto, was worth $96 billion at the end of 2021 /parenleft.casebut had dropped to $63 billion by the beginning of April/parenright.case. While the Web3 pitch may promise an egalitarian utopia, the current distribution of crypto wealth aligns more closely with late-stage capitalism. “Capitalism is very happy to sell a real product and make a small
Ripple, a company with more than 500 employees in nine offices worldwide, is one example. Like a much, much larger version of Paymobil’s crypto-powered money-transfer service, Ripple uses its own blockchain token as a bridge between currencies, allowing hundreds of corporate customers, including Bank of America, Santander, and Japan’s SBI Remit, to reduce operational costs caused by time zone differences and manual settlement processes.

Contrary to the radical rhetoric of its crypto contemporaries, Ripple is using the speed afforded by digitized currencies to improve legacy banking processes, not replace them. In line with this reform—not-replace attitude, RippleX general manager Monica Long sees regulation and even CBDCs as a part of the evolution of blockchain for businesses—and finance operations more generally—over the next few years. “Customers and consumers alike will benefit from improved infrastructure, user experience, regulatory clarity, and interoperability as crypto becomes a critical element of the new normal in finance,” she says.

The most industry-transforming use case so far—although perhaps the one with the least sizzle—might be the MediLedger Network and its custodian organization, Chronicled. In 2013, the US government passed the Drug Supply Chain Security Act, stating that by 2023 the pharma industry must create a digital system to track prescription medicine in order to prevent counterfeiting. Health care and the life sciences are notorious for ancient, non-interoperable systems, and the act’s requirements demanded an entirely new way of doing business. Chronicled’s CEO, Susanne Somerville, wondered if a private blockchain—a closed, permissioned system, unlike public blockchains such as Bitcoin—could offer a secure, shared environment in which pharma players like Pfizer and Gilead might work together. After years of working through business rules and goals, Chronicled launched the MediLedger Network, a group of major pharma companies, in 2019. Chronicled provides a range of services for them, like a spoof-proof index of verified product IDs and access to real-time public pricing updates. These narrow solutions may not be what people typically associate with blockchain technology, but they’re critical within pharma. “Almost everyone’s thinking of these super- lofty ideas, and it’s hard to get there,” says Somerville. “But there’s a lot of less sexy stuff that is actually foundational.”

Ripple and MediLedger’s uses of the blockchain could mean safer drugs and faster money transfers for regular people, without requiring anyone to create a digital wallet or exchange coins. As for consumer crypto? If the industry’s deafening pitch for a financial revolution sounds too good to be true, that’s because it is. Until it can offer affordable, everyday uses for new coins and expansive protections against fraud and scams, we are all better off sticking with cash and traditional banking systems than joining the parade of crypto boosters marching across our screens and cities.

“Never underestimate the power of a lot of money and scam verbiage to persuade a lot of people to do something.”

Rebecca Ackermann is a writer, designer, and artist based in San Francisco.
Every day, a repurposed garbage truck ferries visitors up El Salvador’s Conchagua Volcano to an ecotourism retreat. The vehicle thunders along a cratered road, tossing passengers from side to side. At the summit, they spill out into the sun-dappled forest and are rewarded with sweeping vistas of the deep blue Gulf of Fonseca. The retreat is named El Espíritu de la Montaña (Mountain Spirit) to reflect the indigenous Lenca belief that a holy presence inhabits the dormant volcano, sometimes manifesting as a butterfly or eagle. Owner Luis Diaz began developing the site seven years ago. But the serenity he found there may not last. The president of El Salvador, Nayib Bukele, announced in November 2021 that the volcano will become home to a glittering new Bitcoin City. A vast construction project to remodel virgin forest into a vibrant metropolis could soon be underway.

Renderings shared by the government show a circular conurbation emanating from a B-shaped central plaza, and a technicolor street plan that looks like what you might see squinting into a kaleidoscope. The idea is that the local economy will run on Bitcoin, and the city will be powered by geothermal energy from the volcano. The only taxes residents will pay will be on the goods and services they purchase.

To fund the city, El Salvador is selling $1 billion worth of debt in US dollars as “Volcano Bonds.” Half of the money invested in the bonds will fund the construction of Bitcoin City and Bitcoin mining operations, and half will go toward buying Bitcoin—which could someday be used to pay off the bonds if the price of Bitcoin goes up.

Salvadoran finance minister Alejandro Zelaya said in early April that the bonds had attracted $1.5 billion in demand and would be issued soon following delays. Most bonds are expected to be purchased by crypto investors—some of whom, if they pay up to $100,000, may be granted Salvadoran citizenship.

If it’s ever built, Bitcoin City will be a shining realization of crypto’s world-building aspirations. The dream doesn’t stop there, though. A growing number of crypto investors are also trying to persuade other governments to create semi-autonomous zones that double as laboratories for economic experimentation, claiming it will stimulate growth and enrich nearby communities.

But in Central America, foreign investors have parachuted in with promises of prosperity before, only to grab land and extract value for themselves. The region has a long history of economic exploitation—the most glaring example being the “banana republics” of the first half of the 20th century, when the United Fruit Company controlled vast swaths of land and seized political power in Honduras, Guatemala, and Costa Rica. More recently, “export processing zones” carved out for international garment-making companies have become home to sweatshop-style factories that have abused workers’ rights.

While some politicians and residents believe in crypto’s potential to jump-start the economy, others see history repeating itself.

By Laurie Clarke

Illustrations by Michael Byers

Crypto millionaires are befriending politicians and underwriting private cities in Central America.
As El Salvador’s experiment takes shape in the form of Bitcoin City, a similar development is already underway in Honduras—but backlash from locals has put its future in jeopardy. Proponents hope to spawn a hundred more Bitcoin Cities, but others question who these projects are really for, and whether the countries serving as test beds will truly benefit.

The pitch

“Bitcoin citadels” have long captivated early crypto investors and entrepreneurs. Some see it as inevitable that crypto will explode in value and the fiat currency system will crumble, forcing wealthy investors to sequester themselves in fortified compounds to keep the barbarians at bay. Others, inspired by the chance to decouple from the concept of nationhood, see crypto as a way to exit a traditional financial system tethered to antiquated notions like taxation and public expenditure.

Libertarian attempts to create autonomous mini-civilizations go back at least to the 1960s, but crypto is reinvigorating this old dream with a fresh infusion of cash and hype.

Crypto enthusiasts have tried to construct their own utopias before, with lackluster results. Examples include the ill-fated MS Satoshi (named for pseudonymous Bitcoin creator Satoshi Nakamoto), a cruise ship that a group of libertarians bought to serve as a kind of floating business park before being forced to sell it less than six months later; the much-mocked Cryptoland, a failed $12 million bid for a Fiji island billed as a paradise for crypto enthusiasts; and Akon City, the R&B singer Akon’s $6 billion planned crypto-powered settlement, which is yet to start construction in Senegal.

These missteps haven’t stopped a wave of investors from making bold plans to build crypto-friendly communities in countries around the world. Their plans often involve setting up areas known as special economic zones. The basic premise is simple: carve out a quasi-independent jurisdiction with loose regulation, little government oversight, and minimal taxes, and let the free market do its thing. Evangelists highlight Singapore, Dubai, and Shenzhen as successful examples (labor rights abuses and inequality aside).

The reality is more complex. Because there are so many special economic zones (5,000 across 70 countries) and myriad contextual factors, it’s difficult to calculate their impact on a country’s economy, says Thibault Serlet, head of research at Adrianople, an advisory firm focusing on these zones. A 2015 Economist article noted that of the special economic zones established at that time, a few were highly successful, but many didn’t benefit the wider economy, while some had been abject failures. El Salvador’s ambitious plans promise to capitalize on a formula that has shown mixed results at best.

Bukele first pitched Bitcoin as a means for Salvadorans abroad to send remittances to family members at home—saying it would save citizens $400 million in fees every year and give the unbanked a way into the financial system. The nation, with a population of about 6.8 million, announced last year that Bitcoin would henceforth be accepted as legal tender.

Adoption among the general population has been slow, but as a marketing exercise to entice the global crypto elite, Bukele’s pitch has proved more successful. Bitcoin City is integral to that pitch. Drawn by Bukele’s bold pronouncements, a parade of aspiring crypto city planners have begun fraternizing with the Salvadoran government.

According to the Salvadoran newspaper El Faro, one of the most prominent suitors was Brock Pierce. As chairman of the Bitcoin Foundation, a nonprofit set up in 2012 to promote the cryptocurrency, Pierce spearheaded the attempted transformation of Puerto Rico into a cryptopia—a tax haven for crypto millionaires that would somehow solve the economic woes inflicted by the country’s debt crisis and the devastation...
caused by Hurricane Maria. Recent news reports suggest that soaring real estate prices constitute crypto’s major impact on Puerto Rico to date. Grand promises to rebuild the island’s economy on the blockchain have fallen by the wayside. Today, mugshots of cryptocurrency investors including Pierce decorate Puerto Rico’s capital city, captioned “This is what our colonizers look like.”

Undeterred, Pierce is eager to replicate the Puerto Rico experiment elsewhere. Bitcoin Foundation delegates have met with representatives from El Salvador, Honduras, Panama, Ecuador, and Guatemala in the past year. (The Bitcoin Foundation and Pierce didn’t respond to interview requests.)

“I’m quite bullish on what’s happening in Latin America,” says Peter Young, managing director of the Free Private Cities Foundation and a self-described “Bitcoin maximalist.” “You’ve got lots of smaller nation-states that are looking for solutions and are willing to try new things.”

Young’s foundation supports the development of so-called private cities around the world. His organization has encouraged the Salvadoran government to run Bitcoin City on a private governance model, placing it in corporate rather than public hands. Government officials have been receptive so far, says Young. The organization has reportedly pitched the same idea to the Brazilian government.

Meanwhile, a coterie of Bitcoin advocates have become close advisors to Bukele. These include Volcano Bond architect Samson Mow, who recently left his role as CEO of the blockchain technology company Blockstream to promote Bitcoin adoption to nation-states. Journalists and crypto investors Max Keiser and Stacy Herbert also appear to have become part of Bukele’s inner circle. While polls indicate that Bukele enjoys huge support in the country, some Salvadorans are ruffled by the influence foreign crypto investors appear to be exerting over the president. They expressed indignation upon seeing Keiser, Herbert, and Mow fly over the Bitcoin City site in a military helicopter—and again when Mow tweeted plans to draft new laws for the Volcano Bonds before anyone in the Salvadoran government did so. Mow has since tweeted that Bukele endorses his bid to become mayor of Bitcoin City.

Free for all
For an idea of what a corporate-run Bitcoin City might be like, look to a burgeoning project called Próspera, supported by the Free Private Cities Foundation in Honduras. While it’s not explicitly billed as a crypto community, a heavy emphasis on the crypto industry and the backing of heavy-weight Bitcoin investors place Próspera in the same ideological milieu—a fusion of crypto evangelism and libertarian credos.

Próspera (Spanish for “prosperous”) occupies a small enclave on the Honduran island of Roatán. The developers have been handed the chance to model a society from scratch, including its own health, education, policing, and social security systems. Próspera’s advisors include Oliver Porter, founder of Sandy Springs, Georgia—a type of special economic zone in an existing state but managed by another nation’s government. Considered one of his more outlandish ideas, they reflect his theories about how to promote foreign investment and alleviate inequality. Honduran ZEDEs are among the first tests of this concept, though Romer has held talks with some other governments.

Romer collaborated with the Honduran government at first, but they parted ways following disagreements over how his idea was being implemented. (Romer didn’t respond to a request for comment.)

Próspera, which broke ground in 2020, plans to implement ultra-low taxes, source services typically managed by the public sector, establish an “arbitration center” in place of a court, and charge an annual fee for citizenship (either physical or e-residency) that involves signing a “social contract” the company hopes will discourage misbehavior.

When I visited the site in February, a central office was one of the few completed buildings. There was no private Próspera police force, but on the front desk was a number for Bulldog Security International, a private security company engaged by hotels on the island that consider the local police force inadequate. A pair of two-story buildings housed office workers. The rest was largely a construction site, although a residential tower block is underway.

A rendering of the future Próspera shows apartments that appear to take inspiration from the shells of the island’s indigenous conch—soft curves in pearly coral, cream, and glass. A strip of white sand separates the apartment block from the gentle lap of the Caribbean Sea.

The businesses most likely to be drawn here are those keen to escape regulation in their own countries—Próspera’s chief of staff, Trey Goff, highlights medical innovation, health tourism, and just about every facet of the cryptocurrency industry.

“There’s an automatic degree of overlap with the crypto industry and what we’re doing,” he says. “Because they see themselves as at the forefront of financial innovation, and we want to enable that.”

Some people who work in tech and crypto have already set up in the jurisdiction remotely through its e-residency program. Businesses can freely transact in whichever cryptocurrency they choose, and five have been approved for use at the government level.

Próspera’s advisors include Oliver Porter, founder of Sandy Springs, Georgia—until recently a fully privatized city in the US that Próspera’s outsourcing model will mimic. So far, Próspera says, Silicon Valley venture capitalists and private investors have put $50 million into the project, with another $100 million fundraising round underway.

The amount raised so far includes money from billionaire Peter Thiel, venture capitalist Marc Andreessen, and investors Roger Ver and Balaji Srinivasan through Pronomos Capital. Pronomos Capital told
Bloomberg in 2018 that it had discussed setting up semi-autonomous cities in countries including Ghana, Honduras, the Marshall Islands, Nigeria, and Panama.

**Broken links**

If you continue along the road that leads to Próspera, you’ll soon encounter a village of about 100 people called Crawfish Rock. Hunkered down in a piece of patchy woodland on the coast are a collection of wooden houses, painted in fading pastels and propped up on stilts. Chickens scratch in patches of weed sprouting under palm trees. It’s a long way from the glaring white of Próspera’s air-conditioned boardroom.

In Crawfish Rock, I’m greeted by Luisa Connor, head of the village’s Patronato, or community board. She belongs to the Garifuna community—descendants of slaves brought to the island by British colonizers in the late 1700s. Sitting in plastic chairs in her yard as her young daughter plays nearby, we discuss the pushback against Próspera, which has mutated from a community-led effort into a national repudiation of ZEDEs. Connor paints a picture of deception on the part of Próspera, saying it portrayed itself as a regular tourism development when it asked the community to sign a document of consent, promising that villagers would be offered the first jobs on the site.

Villagers soon discovered, however, that the project would be something quite different, and relations swiftly frayed. Connor says Próspera CEO Erick Brimen offered to buy Crawfish Rock outright; she declined on behalf of the village. But residents grew concerned that Próspera would seize their land because they want to start a new country.

Eventually, Connor blocked Brimen’s number. The village no longer has any dialogue with Próspera, she says, Goff tells it differently: “We have very much focused on, from very early on, building strong community relations with that community.”

Since Próspera launched, the political climate has changed. Amid growing backlash against ZEDEs based on concerns like those raised at Crawfish Rock, the new Honduran president, Xiomara Castro, ran on a platform that promised shutting them down, putting Próspera’s longevity in question.

**“We are just an experiment”**

Ground hasn’t yet broken on Bitcoin City, but Conchagua Volcano is already home to several settlements, raising the specter of displacement, says Salvadoran economist José Luis Magaña—especially given that only about a fifth of the farmers in the region own the land they work on. The government says the project is intended to provide jobs to the poor neighboring town of La Unión, but Magaña says socioeconomic disparities between the town and El Salvador’s bigger cities make gentrification the more likely outcome.

Unlike Próspera, Bitcoin City has the backing of the current government. But an influx of foreign investors and the displacement of local people could eventually stoke a similar backlash. Three days after Bitcoin City was announced, El Salvador passed a new law that would allow the government to expropriate land for public use.

To prevent speculators from driving up land prices, the exact location of Bitcoin City remains vague. But real estate companies from Europe, wealthy Salvadoran businessmen, and cryptocurrency companies have offered to buy the land that El Espíritu de la Montaña sits on from Diaz for three to five times the price he paid. Diaz is adamant that he won’t sell: “This is a life project for me.” He supports Bukele and believes Bitcoin City will stimulate economic growth in the area, although he notes that people he knows in La Unión are concerned about being forced to move.

Back in Honduras, researcher José Luis Palma Herrera sees ZEDEs and projects like them as a modern twist on the region’s painful history of corporate colonialism. “The promise of ending poverty and improving lives has been used to get citizens to accept these enclaves of corruption and exploitation,” he says. “However, most of the profits from the enclaves go outside the country, [with] no real development in the regions where they’ve been.”

Besides Próspera, there are three more ZEDEs in Honduras. Less radical private city projects are now underway in Malawi and the US. Ethereum creator Vitalik Buterin has been involved in talks with the Zambian government about setting up a crypto-powered special economic zone.

“We’re trying to help create an entirely new kind of industry … the industry of building cities,” says Goff. He says he’d like to see a couple of hundred developments around the world one day—“bright spots of prosperity all working together to create a brighter future for humanity.”

Not everyone is sold on the dream. In Roatán, Rosa Daniela worries about the impact on her community and others like it. “They come to us, these adventurous guys, in the name of liberty,” she says. “They want to start with us; we are just an experiment. If they find success here, they will move to your country and other countries in the world.”

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Hitchhiking in the cab of a sand truck late one Saturday night in 2018, Bill Kirwa had almost forgotten about the bet. The wager he’d placed that afternoon had been a long shot: to win, he’d need to correctly pick which team was ahead, at both halftime and full time, in four soccer matches on three continents. On the road and broke, Kirwa had been so preoccupied with finding a ride home he didn’t notice that the first three games had turned out just as he’d predicted. Then, 5,000 miles away at the Stadio Olimpico in Rome, Lorenzo Insigne launched a ferocious shot on goal that secured his squad, Napoli, a 2-1 win in the team’s first contest of the Italian Serie A season. Kirwa had gotten this one right as well and as the lorry he’d flagged down lurched through Kenya’s western highlands, his Infinix smartphone dinged with a notification. The bet of 3,500 Kenyan shillings he’d placed with mobile money, then worth approximately $35, had just turned into nearly $8,500. He almost let out a yelp, but glancing at the driver, he thought better of it. “I didn’t want that guy to notice,” he recalled recently. “From the day I was born, I had never seen so much money.”

Kirwa, now 26, put the windfall to good use, purchasing a car that enabled him to drive for Wasili, an Uber-style ride-hailing service in the nearby town of Eldoret. But he continued gambling, and over time, his losses mounted. In just a few years, he’s effectively erased his big win.

Kirwa’s experience is hardly unique. Since the middle of the last decade, elected officials, community leaders, and researchers from Kenya and across the African continent have been sounding the alarm over the rising prevalence of sports betting. The practice has produced tales of riches far greater than Kirwa’s, but it has
Bill Kirwa, 26, used winnings to purchase a car that enabled him to drive for Wasili, an Uber-style taxi service. But he continued gambling, and over time, his losses mounted.
That mobile money would become so ubiquitous in Africa—let alone fuel a betting epidemic—is in many ways an accident of history.

also broken families, consumed college tuitions, and even driven some to suicide.

Sports betting in Africa is not an entirely digital phenomenon: dingy betting parlors filled with underemployed youth have long been fixtures of the urban landscape. Increasingly, though, gambling has moved online, aided by the rapid spread of technologies like smartphones, high-speed internet, and mobile money platforms, which enable payments via phones without a bank account. Today, gambling happens almost anywhere: on college campuses, in far-flung villages, or even, as Kirwa admits with a hint of embarrassment, behind the wheel while driving. Experts say this ease of access is driving up participation and making betting more addictive across Africa—in economic powerhouses like Nigeria and South Africa; in poorer, more fragile states like the Democratic Republic of the Congo; and in soccer meccas such as Senegal, home to the 2021 Africa Cup of Nations champions, where online betting got a late start but is now growing by 50% each year.

Nowhere, though, is the craze as acute as it is in Kenya, the country that gave birth to the continent’s first mobile money service, M-Pesa, and is often called Africa’s “Silicon Savannah” for its status as a regional tech powerhouse. While the country’s mobile money revolution has played a well-documented role in encouraging savings and democratizing access to finance, M-Pesa’s role in betting presents something of a paradox. Today, it’s easier than ever for those in fragile economic circumstances to squander everything. Although estimates on the prevalence of gambling vary, a December 2021 survey by the US research firm GeoPoll found that 84% of Kenyan youth polled had tried betting, and one-third of those reported betting on at least a daily basis. The vast majority, like Kirwa, do so on their smartphones using mobile money.

“Most people who bet in Kenya are not doing it for recreation—they’re doing it because they want to make money,” says Fabio Ogachi, a professor of psychology at Nairobi’s Kenyatta University. Ogachi says a significant proportion of Kenyans who bet show signs of gambling addiction—behaviors that include betting to recover lost funds, staking increasing amounts, and lying about one’s habit. Technology, he adds, has been a major driver of the sports-betting phenomenon: “We’ve been using mobile money for so many years, it’s become part and parcel of how we conduct business. When online betting came along, it found this ideal system was in place.”

When financial inclusion isn’t enough

That mobile money would become so ubiquitous in Africa—let alone fuel a betting epidemic—is in many ways an accident of history. The technology has its roots in a 2006 experiment, conducted by the telecom firms Vodafone of the UK, and Safaricom of Kenya, that sought ways to increase access to finance among those who’d previously been excluded from traditional banking.

The original idea was to use phones to disburse and repay microfinance loans. But participants in a pilot scheme in Kenya began using it for something else: sending money home. In a country where young people continued to abandon family farms to seek out opportunities in towns and cities, mobile money filled an essential niche. Previously, supporting relatives often meant sending cash by bus or post, which was unreliable and expensive. Safaricom invested heavily in building a network of agents who acted like human ATMs so recipients could withdraw cash from their digital wallets. Over time the system, called M-Pesa (M for for “mobile” plus the Swahili word for money), expanded to include a range of other payment and loan services, and eventually it began to replace cash entirely. Today, Safaricom boasts 30 million active M-Pesa accounts in Kenya, roughly equivalent to the country’s adult population. In the 12-month period leading up to March 2021, the service processed transactions worth $193 billion, a figure nearly twice the size of Kenya’s GDP.

True to the experiment’s promise, M-Pesa’s growth produced tangible benefits. In 2006, according to the Central Bank of Kenya, only 27% of Kenyan adults had access to formal financial services, such as means for saving, borrowing, or making non-cash payments. Thanks to M-Pesa, 84% do now. Research published
in 2016 by the economists Tavneet Suri and William Jack found that access to M-Pesa helped pull 2% of Kenya’s households out of extreme poverty, in part by enabling women to move away from subsistence agriculture and into retail businesses. Studies from countries where mobile money has spread have found that its use improves resilience to financial shocks and facilitates higher rates of household saving. The technology’s global footprint continues to grow: as of 2020, according to the Global System for Mobile Communications Association, there were 310 mobile money services available in 96 countries, with 300 million active accounts—more than half of them in sub-Saharan Africa.

M-Pesa may have been a great success, but it was still no magic fix for Kenya’s wider economic challenges. Although the country’s GDP doubled in the 15 years before the pandemic, vaulting it to World Bank-designated “lower middle income” status, citizens have long complained that this new wealth hasn’t trickled down. Many lament a recent infrastructure binge that has included new highways, a major expansion of the power grid, and a $3.6 billion Chinese-built railway to the coast. Watchdogs say the budgets of these projects have been inflated by kickbacks. That has boosted government debt, weakened the Kenyan shilling, and created new taxes, causing living costs to spike in turn.

Finding employment hasn’t gotten easier, either. According to government statistics, Kenya, with a population of 54 million, had just 3.1 million official salaried jobs in 2019. Pandemic restrictions contributed to a net loss of nearly 200,000 of them in 2020.
With so many shut out of employment, young Kenyans are turning to entrepreneurship—or as many call it, perhaps more accurately, “hustling.”

2020. But even before the coronavirus, annual job growth was barely enough to put a dent in the onslaught of new high school and college graduates looking for work. Even graduates of Kenya’s elite universities often struggle for years to find suitable employment. The rise of social media has also offered up close confirmation that their counterparts elsewhere have it better. “People are comparing themselves not just with their neighbors but with everyone, even strangers from across the globe,” Ogachi says. “That breeds an even higher level of frustration.”

Betting becomes the hustle

With so many shut out of employment, young Kenyans are increasingly forgoing the job search entirely, turning instead to entrepreneurship—or as many call it, perhaps more accurately, “hustling.” Kirwa’s hustle began in 2017, after he abandoned plans to become a teacher. He’d struggled to pay his university tuition, so he dropped out, took the money he had left, and opened a kiosk where customers could access desktop computers and perform M-Pesa cash-outs. For extra cash, he started selling printouts with information about foreign soccer matches. Customers, he’d noticed, were increasingly tethered to their phones to bet on Kenya’s favorite pastime.

Kenya’s status as an early tech adopter helped fuel the trend. New undersea cables and an influx of Chinese-branded smartphones had drastically reduced the cost of getting online (today an estimated 85% of the population has access to a connection). In a country where most people still lacked bank accounts or credit cards, M-Pesa

Mobile money has widened financial opportunities in Kenya. It has also made sports betting, which still persists in brick-and-mortar locations (top right), even easier.
offered a fast and secure means of payment. And a barrage of loosely regulated third-party lending apps that can link to M-Pesa meant bettors could indulge even if their accounts were empty.

Kirwa, who saw his father placing bets as well, was soon taken by the craze himself. He tried out multiple sites, which came with ever-expanding options: dog racing, rugby, e-casinos, even darts and table tennis. Like most young Kenyans, though, he mainly stuck to soccer, betting in ever larger amounts. Sometimes he’d choose to bet rather than eat. Convinced he could outsmart the bookmakers, he began to analyze past results—“Googling the potential of teams,” as he puts it—and following self-styled experts on social media. Kirwa’s life-changing bet was based on advice from a Nigerian tipster he found on the messaging service Telegram. By that point, betting had become central to his hustle. “Nowadays in Kenya, we term betting as a job,” he says. “People believe that when you do genuine bets, when you take time to do good analysis, you can win.”

In the long run, of course, that belief is incorrect: sports betting is not a game of skill, and the odds always benefit the house. Yet with enough people buying into that narrative, or at least putting faith in their luck, the industry exploded. SportPesa, a firm founded in Nairobi by a group of Bulgarian and Kenyan investors, including a former mayor of the city, was the vanguard. Established in 2014, it offered a sleek online interface that allowed users to fund accounts via M-Pesa and place bets on matches from around the globe within seconds. By 2018, according to figures obtained by the British investigative outlet Finance Uncovered, Kenyans were spending $1.3 billion a year to place bets on the platform—more than the annual budget of the country’s Ministry of Health. At its height, SportPesa sponsored teams and athletes in rugby, boxing, Formula One, and soccer—including the English Premier League squad Everton. Wayne Rooney, one of the most prolific goal scorers of his generation, plied the pitch with “SportPesa” emblazoned on his chest.

Other companies followed SportPesa’s lead. Hempstone Ngare, a former radio reporter hired in 2017 to manage social media for one of the company’s competitors, recalls a period of especially aggressive marketing: billboards placed across the country, “good-looking ladies” offering T-shirts in exchange for sign-ups, unsolicited text messages, and Ngare’s own posts on Facebook, Instagram, and Twitter, designed to lure followers who could later be converted into customers. Opportunity was rife. One 2016 poll at Kenyatta University found that 78% of male and 57% of female students had tried betting, with nearly half gambling at least once per week (and 80% reporting net losses). Subsequent surveys by GeoPoll consistently found that more than three-quarters of youth in Kenya and more than half across Uganda, Tanzania, Ghana, Nigeria, and South Africa had indulged, most of them on their phones with the aid of mobile money.

By 2018, Kenyans were spending $1.3 billion a year to place bets on the SportPesa platform.

As sports betting became entrenched, addiction followed. A 2020 study of Kenyan student bettors by Ogachi diagnosed nearly seven out of 10 with gambling disorders.

Nelson Bwire, who led the Kenyatta University poll while an undergraduate, was so alarmed he founded a nonprofit, the Gaming Awareness Society of Kenya, that seeks to reduce gambling harm. Bwire has counseled students who’ve been forced to leave school after betting away their tuition, and workers who’ve been jailed for squandering their employers’ money.

A habit that’s not easy to kick

Some argue that Kenya should ban sports betting entirely. There is certainly precedent: the practice is highly restricted in many parts of the world, including most of Asia and the Middle East. Yet those who know the Kenyan sector well say that dramatic reforms aren’t likely. For one thing, taxes derived from betting have become an important source of revenue for Kenya’s cash-strapped government. Many of the country’s leading betting houses also have close financial links to politicians or their associates; some believe that could be part of the reason a 2019 bill calling for a new regulator with stronger teeth did not gain traction in the Kenyan parliament. And betting firms themselves have become important sources of employment: Ngare, who’s worked for several of them, says he’d prefer to return to journalism,
but he also has rent to pay and parents back home to support.

Still, there are signs that Kenyan authorities have had some success in reining in the industry’s excesses. New taxes on stakes and winnings appear to have incentivized some bettors to cut back. A law passed last December gives the Central Bank new powers to regulate digital lenders. And thanks to restrictions put in place by the country’s Betting Control and Licensing Board (BCLB), gambling firms can no longer advertise on radio and TV during daytime hours. But the industry is still pushing forward. In July 2019, the board refused to renew the licenses of 27 betting firms, including SportPesa, in a row over the payment of back taxes. Some returned, and new firms saw an opening. Today, the BCLB lists 99 licensed bookmakers, more than before the crackdown.

In an interview at its Nairobi headquarters, BCLB director Peter Mbugi told me the number of Kenyans betting and the total volumes staked are lower today than in 2019, though he declined to share any figures. Mbugi attributes the drop to tighter regulations and a growing awareness that sports betting is “not as rosy” as many had thought. But others say a reduction in numbers could be a temporary blip caused by the 2019 shake-up and the pandemic, which put a squeeze on household finances and disrupted global soccer leagues for months. Data from Safaricom, which controls more than 99% of Kenya’s mobile money market, shows that M-Pesa users’ transactions with betting sites were worth $737 million in the six months ending in September 2021, up from $436 million in the same period of 2020. Meanwhile, there are new African markets to explore. Karen Njerenga, who leads marketing in Kenya for Betway, a global firm with operations in seven African countries, says the company has its sights on several others. Chalkline Sports, which helps betting companies acquire and retain customers, has described the continent’s “untapped potential” in online gaming as “incredible.”

Some hope the same sorts of technologies that enabled this industry to thrive could also mitigate the damage it can cause. Last year, for example, Bwire and fellow activist Weldon Koros partnered with the British company Gamban to introduce an app that allows addicts to block access to all gambling sites on their devices. Uptake of the software, which cannot be uninstalled, has been modest so far, but Bwire says it has helped some people “reduce temptations.” Bwire and Koros have also had some success in lobbying universities to block betting sites on their networks: if students have to pay for data, the thinking goes, they might spend less time on their devices. And the men laud Safaricom’s 2021 launch of a “smart mobile payment system” for student loans, which prevents tuition fees from being diverted for betting. But Bwire would like to see the company do more, including placing tighter restrictions on text-based advertising and the overdraft facilities that many bettors use to place bets on credit, in addition to loans from outside apps. (A spokesperson for Safaricom, which earned $37 million from betting-related fees in the 2021 financial year, did not respond to multiple requests for comment.)

New digital products could sway some bettors toward alternative hustles. Kevin Kegera, a third-year student at Kenyatta University, says he tried sports betting after high school but gave up after realizing the odds were rigged against him. These days, he’s moved on to trading foreign currency: FXPesa, an app that lets him use mobile money to do so, launched in 2019, and others have followed. Many of his friends also use apps to trade in foreign currencies, cryptocurrency, or foreign stocks—options that weren’t unavailable even a few years ago. Kegera, who aspires to be “Kenya’s Warren Buffett,” suspects greater awareness of these products will continue to lure some educated Kenyans from betting, though probably not the masses. “It’s very hard to convince someone who hasn’t been to college about markets,” he says.

Kirwa, for his part, is unlikely to kick his habit. One evening in Eldoret, I joined him in his red Toyota Vitz, a hatchback he had outfitted with tinted windows and electric-blue interior lighting. The Afrobeats blaring from the stereo would have been less tinny if he still had his old sound system, he lamented, but he’d sold it to repay a loan used to place a bet. Despite Kirwa’s poor record in the years since his big win, he says he has no plans to quit. Betting has become so core to his identity, he says, it’s hard for him to fathom life without it.

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Plus, it’s so convenient. His smartphone and M-Pesa wallet will always be right there in his pocket—and there’s always a chance luck will be on his side again.
In July 2019, Kenya’s Betting Control and Licensing Board refused to renew the licenses of 27 betting firms, including SportPesa. But the company is back, and there are now more licensed bookmakers than before the crackdown.
Coin of the realm
A startup called Worldcoin is giving out small bits of its currency to new users—if they agree to hand over a slew of biometric data.
On a sunny morning last December in Gunungguruh, a village in the Indonesian province of West Java, a 35-year-old furniture maker named Iyus Ruswandi was woken up early by his mother. A technology company was holding a “social assistance giveaway” at the local Islamic elementary school, she said, and she urged him to go.

Ruswandi joined a long line of residents, some of whom had been waiting since 6 a.m. In the pandemic-battered economy, any kind of assistance was welcome.

At the front of the line, representatives of Worldcoin Indonesia were collecting emails and phone numbers, or aiming a futuristic metal orb at villagers’ faces to scan their irises and other biometric data. Village officials were also on site, passing out numbered tickets to the waiting residents to help keep order.

Ruswandi asked a Worldcoin representative what charity this was but learned nothing new: as his mother said, they were giving away money.

Gunungguruh was not alone in receiving a visit from Worldcoin. In villages across West Java—as well as college campuses, metro stops, markets, and urban centers in two dozen countries, most of them in the developing world—Worldcoin representatives were showing up for a day or two, making similar promises about free money, collecting biometric data, and providing minimal information on their real intentions.

This left many, including Ruswandi, perplexed: What was Worldcoin doing with all these iris scans?

Two months before Worldcoin appeared in Ruswandi’s village, the San Francisco–based company Tools for Humanity emerged from stealth mode. Worldcoin was its product.

The company’s website described Worldcoin as an Ethereum-based “new, collectively owned global currency that will be distributed fairly to as many people as possible.” Everyone in the world would get a free share, the company suggested—if they agreed to an iris scan with a specially designed device that resembles a decapitated robot head, which the company refers to as the “chrome orb.”

The orb was necessary, the website continued, because of Worldcoin’s commitment to fairness: each person should get his or her allotted share of the digital currency—and no more. To ensure there was no double-dipping, the chrome orb would scan participants’ irises and several other biometric data points and then, using a proprietary algorithm that the company was still developing, cryptographically confirm that they were human and unique in Worldcoin’s database.

“I’ve been very interested in things like universal basic income and what’s going to happen to global wealth redistribution,” Sam Altman, Worldcoin’s founder and the former president of Silicon Valley accelerator Y Combinator, told Bloomberg, which first reported on the company last summer. Worldcoin was intended, he explained, to answer the question “Is there a way we can use technology to do that at a global scale?” (In an emailed statement to MIT Technology Review, Altman reiterated his belief in UBI as “a powerful component of helping people reach their full potential” and said he was “excited for continued experiments and ideas in this space.”)

In the same article, Worldcoin’s then-27-year-old CEO, Alex Blania, added that “many people around the world don’t have access to financial systems yet. Crypto has the opportunity to get us there.” (Blania and others have used “Worldcoin” to refer to the company as well as the currency; we do the same here.)

But beyond these do-gooder intentions, Worldcoin would also solve key technical problems for Web3, the much-hyped, blockchain-powered third iteration of the internet, where data and content could be decentralized and controlled by individuals and groups rather than a handful of tech companies.

Giving “ownership in this new protocol to everyone” would be the “fastest” and “biggest onboarding into crypto and Web3” to date, Blania told MIT Technology Review in an interview, addressing one of Web3’s major challenges: a relative dearth of users.

By biometrically confirming that an individual is human, Worldcoin would also solve another “very fundamental problem” in decentralized technologies, according to Blania: the risk of so-called Sybil attacks, which occur when one entity in a network creates and controls multiple fake accounts. This is particularly dangerous in decentralized networks where pseudonyms are expected. Coming up with a truly Sybil-resistant proof of personhood has thus far been difficult, which is seen as another barrier to mass Web3 adoption.

With these two solutions, Worldcoin could become “an open platform that everyone can use [for] both the proof-of-person part and the distribution part,” Blania said. Therein lies its promise: it could become the universal authentication method for a whole new generation of the internet, which would make the currency itself more valuable. “Investors hope that the Worldcoin project brings value to the world and, as a result, that this equity and/or these tokens will appreciate in value,” the company said in an email.

This may be why some of Silicon Valley’s biggest names are pouring money into it; Andreessen Horowitz recently led a $100 million investment round that tripled the startup’s valuation, from an already heady $1 billion to $3 billion.

By the time Worldcoin came out of stealth mode, it had already been field-testing over 30 orbs in 12 countries, with somewhere in the neighborhood of 100,000 people submitting...
Worldcoin says that biometric information is deleted once uploaded—or it will be, once the company has finished training its AI neural network to recognize irises and detect fraud.

by then, Worldcoin had already scanned 450,000 faces, bodies, and pairs of eyes in 25 countries. Of those, 14 are developing nations, according to the World Bank. Eight are located in Africa.

Central to Worldcoin's distribution was the high-tech orb itself, armed with advanced cameras and sensors that not only scanned irises but took high-resolution images of “users’ body, face, and eyes, including users’ irises,” according to the company’s descriptions in a blog post. Until recently, its data consent form noted that the company also conducted “contactless doppler radar detection of your heartbeat, breathing, and other vital signs.”

In response to MIT Technology Review’s questions, Worldcoin said it never implemented detection of vital signs and has since removed this language from its consent form.

The biometric information is used to generate an “IrisHash,” a code that is stored locally on the orb. The code is never shared, according to Worldcoin, but rather is used to check whether the corresponding individual is already in Worldcoin’s database. To do this, the company says, it uses a novel, privacy-protecting cryptographic method known as a zero-knowledge proof. If the algorithm finds a match, this indicates that a person has already tried to sign up. If it does not, the individual has passed the uniqueness check and can continue registration with an email address, phone number, or QR code to access a Worldcoin wallet. All of this is meant to occur in seconds.

Worldcoin says that biometric information remains on the orb and is deleted once uploaded—or it will be, once the company has finished training its AI neural network to recognize irises and detect fraud. “During our field-testing phase, we are collecting and securely storing more data than we will upon its completion,” the blog post states. “We will delete all the biometric data we have

biometric scans. But the company was just getting started—it’s aim is to garner a billion sign-ups by 2023.

To better understand Worldcoin’s registration and distribution process, MIT Technology Review interviewed over 35 individuals in six countries—Indonesia, Kenya, Sudan, Ghana, Chile, and Norway—who either worked for or on behalf of Worldcoin, had been scanned, or were unsuccessfully recruited to participate. We observed scans at a registration event in Indonesia, read conversations on social media and in mobile chat groups, and consulted reviews of Worldcoin’s wallet in the Google Play and Apple stores. We interviewed Blania, corresponded with Tools for Humanity PR representative Anastasia Golovina, and submitted a detailed list of reporting findings and questions for comment.

Our investigation revealed wide gaps between Worldcoin’s public messaging, which focused on protecting privacy, and what users experienced. We found that the company’s representatives used deceptive marketing practices, collected more personal data than it acknowledged, and failed to obtain meaningful informed consent. These practices may violate the European Union’s General Data Protection Regulation (GDPR)—a likelihood that the company’s own data consent policy acknowledged and asked users to accept—as well as local laws.

In a video interview conducted in early March from Erlangen, Germany, where the orbs are manufactured, Blania acknowledged that there was some “friction,” which he attributed to the fact that the company was still in its startup phase.

“I’m not sure if you’re aware of this,” he said, “but you looked at the testing operation of a Series A company. It’s a few people trying to make something work. It’s not like an Uber, with—like—hundreds of people that did this many, many times.”
collected during field testing once our algorithms are fully-trained.” In response to our questions just before this article went to press, Worldcoin said the public version of its system would soon eliminate the need for new users to share any biometric data with the company—though it hasn’t explained how this will work.

**BUT WE DO KNOW HOW ONBOARDING WORKS. TO GET** Worldcoin into the smartphones of new users, the company contracts with local “orb operators” to manage sign-ups for their countries or regions.

Operators apply for the job and are interviewed and approved by the Worldcoin team, though Golovina, a company spokesperson, emphasized in an email that operators “are independent contractors, not Worldcoin employees.” As such, they work without contracts or guarantee of payment, instead receiving commission for each person’s biometric data that they collect. However, Golovina added, they must “comply with local laws and regulations, including local labor laws.”

These country-level operators receive their commission in the stablecoin Tether. Stablecoins are a type of cryptocurrency whose value is pegged to a traditional currency, often the US dollar. The most successful operators hire subcontractors to help scan and register new users. This boosts the rate at which new people can be signed up, which in turn leads to larger commissions.

On the other side, new users currently earn $15 worth of Worldcoin for submitting to the biometric scan, and $5 more when they log in to their Worldcoin wallet; while some receive the sum all at once, for others it vests at a rate of $2.50 per week. Blania says that differences are meant to test out the most effective incentives. Either way, Worldcoin isn’t a stablecoin, and since the currency has not yet launched, the company “doesn’t yet know how many WLD tokens would be equivalent to USD $20,” it noted in a written statement.

To understand user incentives, some people were given the option to receive $20 worth of Bitcoin instead, effectively allowing them to cash out. Worldcoin said it found that its “most engaged users elected to hold on to their WLD,” though most of our interviewees said the opposite.

But that ended last fall. For now, the promise of $20 worth of Worldcoin amounts to an IOU from the company, and any tokens people may have in their digital wallets are, for all intents and purposes, worthless.

**WORLDCOIN’S USERS JOINED FOR A MYRIAD OF REASONS.**

“The out of curiosity” was a common refrain. Because the orb operator “seemed nice”—or happened to be their brother, cousin, or classmate—was another. Some hoped to get in early on what could become the next Bitcoin. Others had lost jobs or income during the pandemic. Some became desperate as civil war threatened to reignite around them. Most just wanted free money. Many suspected it was a scam, though few could risk passing it up in case it was not.

Ruswandi fit into several of these categories. He had lost much of his work as a furniture maker during the pandemic and spent his free time trading stocks and cryptocurrencies and frequenting crypto-related message boards and exchanges.

“I was curious and thought it wouldn’t hurt to try,” he recalled, adding that the money was attractive given his reduced income. But he quickly had doubts. Neither the company representatives on site nor the village officials could answer even basic questions about Worldcoin. After doing more research online and coming up empty, he came to conclude it was a scam. He believed the mysterious giveaway was a mass data collection effort disguised as some kind of secret, offline airdrop—a tactic in which cryptocurrency projects release free tokens to encourage adoption.

After all, many of his neighbors’ understanding of the internet was limited to the Facebook app preinstalled on their smartphones, so before prospective users were even able to receive the new currency, Worldcoin representatives “first had to help many residents in setting up email accounts and logging into the web,” Ruswandi recalled. If it was about attracting users to a new cryptocurrency, he wondered, “why did Worldcoin target lower-income communities in the first place, instead of crypto enthusiasts or communities?”

**WHEN WORLDCOIN MADE ITS “WE’RE HERE!” ANNOUNCEMENT** last October, it encountered immediate backlash.

As National Security Agency whistleblower Edward Snowden put it in a tweet thread, “Don’t catalogue eyeballs. Don’t use biometrics for anti-fraud. In fact, don’t use biometrics for anything. The human body is not a ticket-punch.”

Many doubted Worldcoin’s privacy protocols, especially since the company had yet to issue a white paper or open its code for outside evaluation. “This looks like it produces a global [hash] database of people’s iris scans (for ‘fairness’), and waves away the implications by saying ‘we deleted the scans!’ Yeah, but you
save the "hashes" produced by the scans. Hashes that match "future" scans," Snowden tweeted.

Others took issue with the company’s purported focus on fairness given that 20% of the coins had already been allocated: 10% to Worldcoin’s full-time employees and another 10% to investors, like Andreessen Horowitz.

Many in the blockchain field even disagreed with the underlying premise of what Worldcoin was trying to build: creating one identity across Web3 was anathema to a movement that had turned to blockchain, decentralized finance, and DAOs (“decentralized autonomous organizations”) to transact anonymously.

For Blania and his team, the criticism misses the mark. “Big parts of our team have had backgrounds in crypto … so we care about this [privacy] a lot,” he told MIT Technology Review. “I fully understand the concern,” he said, but he thinks it’s more “emotional gut reaction” than “objective criticism.” What the critics were missing, he added, was just how good Worldcoin’s protocol would be at protecting privacy once complete.

Representatives of Worldcoin used a range of questionable tactics and enticements to bring in new users, according to many of the people MIT Technology Review spoke to.

When operations began in Sudan last March, for example, the operators, who were paid based on number of sign-ups, found it hard to “explain the concept of digital currencies to people who don’t even have emails,” according to Mohammad Ahmed Abdalbajege, one of Sudan’s four former orb operators. So to encourage registration, they ran a contest to win AirPods; it resulted in some 20,000 sign-ups.

Worldcoin, however, said that these were “independent and isolated efforts by local Orb Operators,” rather than standard practice, and that “we are wholly focused on incentivizing Operators to sign up engaged users who are excited about using Worldcoin.”

More recently, in roughly 20 villages in West Java that hosted recruitment events, many new users, like Iyus Ruswandi, were attracted by giveaways.

“It was held during the pandemic, where the government usually handed out social assistance packages,” explained Ece Mulyana, the principal of an elementary school madrassa who was informed, the night before, that his school was to be used as a Worldcoin registration site. Because the instructions came from a higher-level official—Ade Irma, the sub-district governance head, who was helping Worldcoin coordinate the village registration drives—“I couldn’t refuse the request,” Mulyana said.

Mulyana said that Irma paid him a fee of 2,000 IDR (around 14 US cents, at the time of writing) for each person successfully scanned. Mulyana estimates that 170 made the cut, for a total of 340,000 IDR (roughly $23.80).

Heni Mulyani, the sub-district leader who approved the events and Irma’s boss, said that some money was provided for “coffee and cigarettes,” a euphemism for gratuities given to government officials to facilitate desired actions. She said none of the money paid for site rental—but, she added, “we assure you it’s not coming from the village fund or budget.”

Instead, the money appears to have come from a company called PT Sandina Abadi Nusantara, cofounded by a man named Muhammad Reza Ichsan, who happens to be Worldcoin’s “best-performing operator” (according to Worldcoin’s launch blog post), and his mother. The company was the legal entity through which Worldcoin Indonesia conducted its activities; it was Ichsan’s mother’s job to reach out to local government officials to coordinate recruitment.

Ichsan has told MIT Technology Review that “we don’t pay the village, but we have an operational fund for people who helped us assemble the public in the field.”

Even if Mulyani had not misused village funds, these gratuities are—with rare exceptions—illegal under Indonesia’s anti-corruption and anti-bribery laws, with potential criminal penalties for both giver and receiver.

In response to questions about the incident, Worldcoin representatives said they weren’t aware of it, called it “isolated,” and said they have launched an investigation to learn more.

For their part, villagers were not told that at least some of their officials were being paid to promote Worldcoin; in fact, many thought the event was run by the government itself, as Mulyana, the school principal, recalled. “We have to explain to them that it was not a government program,” he said—that “Worldcoin is a foreign company who came and needed help from the village staff.”

Some villagers now doubt they will receive any money at all: late January, the time when they were told Worldcoin representatives would return to the village to hand out funds, has come and gone. Nor has the ability to trade Worldcoin from the wallet appeared, for those digitally savvy enough to navigate the app.
THE MIXED MESSAGES AND MISINFORMATION WEREN’T necessarily intentional. The orb operators we spoke to often mentioned how little information they received from the Worldcoin representatives who recruited them, even as they were made acutely aware that their payment was tied to the number of people they could sign up. (Worldcoin said that it provides its country-level orb operators with a code of conduct, which sub-operators must also abide by, and that it is moving away from commissions based on number of sign-ups)

Bryan Mtembei was one such operator. A civil engineer who recently graduated from college in Nakuru, Kenya’s fourth-largest city, Mtembei freelanced for Worldcoin after he was scanned on campus last September.

He wishes that he had received “a brief training or basics about Worldcoin.” Instead the only instruction he got was to “bring more people in to get yourself more money,” he said. “The rest was up to my social marketing skills.”

So he did his best to answer new users’ questions, with the most frequent being about privacy. Mtembei says that he signed up between 150 and 200 people, at 50 KS (44 US cents) per scan. He estimates that roughly 40% of the individuals he approached had concerns about sharing their biometric data. When he initially expressed similar concerns, he was assured by a representative that all his questions were addressed in the Worldcoin “white paper.” No such document exists. The company said this is by design, since people would be unlikely to read “a long, highly technical academic-style paper,” and that its shorter blog posts could be thought of as white papers. According to Golovina, the Worldcoin spokesperson, “All users who sign up during field testing are provided full disclosure about what is being collected and how that data is used and are required to provide their consent before they’re allowed to sign up. Any individual who does consent to our collection and use of their biometric data may revoke their consent at any time, and this data will be deleted.”

But of the people we interviewed, none were explicitly told—or, in the case of orb operators, told others—that they were “test users,” that photographs and videos of their faces, and 3D body maps, were being captured and used to train the orb’s “anti-fraud algorithm” to “differentiate between people.” They were not told that their data was treated differently from the way others’ would be handled later, or even that they could ask for their data to be deleted.

ALTHOUGH MUCH OF WORLDCOIN’S FIELD TESTING HAS BEEN happening in developing countries, the company stressed that it is active in developed countries as well, including several in Europe. “Worldcoin has always tried to conduct field tests in a sample of countries around the globe that would be representative of the world as a whole,” the company told us.

This presents its own challenges. In collecting, controlling, and processing the data of EU-defined “data subjects”—that is, any person within the European Union, including citizens, residents, and potentially visitors whose data is being collected—Worldcoin is subject to the GDPR.

Enacted in 2018, the GDPR requires that data subjects be fully informed about why their data is collected, how it will be used, who will be processing it, where it will be transferred, how they can erase it, and how they can stop its processing. Failing to sufficiently safeguard data can lead to fines of up to 5% of global revenue or €20 million, depending on the severity of the infraction. Furthermore, the GDPR was written to be extraterritorial in scope, meaning that a company registered in Delaware and headquartered in San Francisco, like Worldcoin, is not exempt.

That is, however, exactly what Worldcoin has claimed in its data consent policy, which asked users to accept the following statements:

- “we [Worldcoin] voluntarily comply with the GDPR as a matter of policy”
- “we have not adopted a board-approved data privacy and security policy describing the means and the methods by which we plan to protect your Data to meet the standards prevalent in the GDPR”
- “there is a possibility that our policies and procedures will not be sufficient to meet GDPR requirements”
- “it may be more difficult to assert your privacy rights in court in the United States if we do not comply”

This policy tries to create “carve-outs,” says Marietje Schaake, the international policy director at Stanford University’s Cyber Policy Center, who reviewed the document; exceptions, she adds, are not possible under the GDPR.

“As an EU citizen, you have the right to challenge it,” Schaake says, referring to any potential violation. Those challenges would be reviewed by European data protection authorities and

COURTESY OF WORLDCOIN

Worldcoin has done field testing in 24 countries; these promotional images were taken in (from top) Sudan, Indonesia, Chile, and Kenya.
eventually argued in European courts rather than American ones, as Worldcoin’s policy suggests.

Worldcoin said that it is fully compliant with the GDPR. It added that it employs a data protection officer and that it has conducted a data privacy impact assessment—though it has declined to make either the officer or the assessment available to us. The company told us that the statements in its consent policy “no longer appear in the latest version of our Data Consent Form.” As of press time, however, the language still remains.

MIT TECHNOLOGY REVIEW’S REPORTING PLAYED OUT OVER

many months, but it was not until our interview with Blania in early March that we began to understand Worldcoin.

“We will let privacy experts take our systems apart, over and over, before we actually deploy them on a large scale,” he said, responding to a question about the privacy-related backlash last fall.

Blania had just shared how his company had onboarded 450,000 individuals to Worldcoin—meaning that its orbs had scanned 450,000 faces, bodies, and sets of eyes, and stored all that data to train its neural network. The company recognized this as problematic and aimed to stop doing it. Yet he did not provide these early recruits with the same privacy protections he says future users deserve. What was the difference between them?

Speaking to Blania was clarifying: these legions of test users were not, for the most part, Worldcoin’s intended end users. Rather, their eyes, bodies, and very patterns of life were grist for Worldcoin’s neural networks. The lower-level orb operators, meanwhile, were paid pennies to feed the algorithm, often grappling privately with their own moral qualms. The massive effort to teach Worldcoin’s AI to recognize who or what was human was, ironically, dehumanizing to those involved.

All of this so that Worldcoin has an attractive user number to bolster its sales pitch as Web3’s preferred identity solution. And so that whenever the real, monetizable products—whether it’s the orbs, the Web3 passport, the currency itself, or all of the above—launch for its intended users, everything will be ready.

Eileen Guo is the senior reporter for features and investigations at MIT Technology Review. Adi Renaldi is a journalist based in Jakarta. Additional reporting was provided by Lujain Alsedeg and Antoaneta Roussi.
House prices in Las Vegas leaped 25% last year, and the market was awash with cheap mortgages and wolfish investors.
iBuyer

Instant buying accounts for tens of billions of dollars in home sales—but who’s really benefiting?

By Matthew Ponsford
For years, Michael Maxson spent more nights in hotels than his own bed, working on speaker systems for the titans of heavy rock on global tours. When Maxson decided to settle down with his wife and their two dogs, they chose the city where stadium rock spectacles took him more often than any other: Las Vegas.

After renting for several years, in 2021 he found a home he wanted to buy in Clark County—a place within easy reach of Vegas’s headline venues yet also quiet, an airy single-story stucco house on Dancing Avenue, which backs onto a 2,000-acre park. He dreamed of waking up each morning to look out across lakes and parkland. “It was a beautiful home,” says Maxson. “I mean, the fact you could see the mountains and the sun set and rise. Man.”

But Maxson’s house hunt was unexpectedly chaotic. House prices in Las Vegas leaped up 25% that year, and the market was awash with cheap mortgages and wolfish investors.

His dream home was not owned by a person but by a tech company. Zillow, the US’s largest real estate listings site, had begun buying up homes in 2018, predicting it could create a “one-click nirvana” for purchasing real estate. It estimated returns of $20 billion a year. Las Vegas was among the top 10 markets where startups concentrated their investments. In a feverish summer, Maxson had already been outmuscled on two bids by cash offers from Zillow and Opendoor. On Dancing Ave., Zillow now acted as seller, having listed the home on June 24 for $470,000, nearly $60,000 more than it had paid less than two weeks before. But Maxson wanted it and agreed to close at just under asking price.

When he went to take a look at the property, however, he discovered a 37,000-gallon water leak that had eroded garden walls and flooded the neighbors’ yard. Seattle-based Zillow, which owned the home, was oblivious, but the city authorities weren’t—Maxson found a notice stuck to the garage door, threatening a fine for allowing green water to pool, attracting mosquitoes carrying West Nile virus. This is one downside of having homes owned by “faceless” corporations, says Maxson: “The [owners] were disconnected from it, because it’s just a number on a spreadsheet.” Though he offered to handle the estimated $30,000 of repairs himself, and take it off Zillow’s books for $30,000 less than the list price, they said no. Maxson discovered soon after that the house had sold to another family, at the same price he had offered. He estimates that he lost about $2,000 on inspections and other costs—the closest he came to securing a home in 22 attempts that summer.

But at the very same time, the startup that had profited from his dream home was discovering cracks in its own foundation. As it turned out, Zillow Offers was based on flawed technology; it had lost more than $420 million in three months of erratic house buying and unprofitable sales. As Zillow Offers shut down, analysts questioned whether other iBuyers were at risk or whether the entire tech-driven model is even viable. For the rest of us—neighbors, renters, or prospective buyers—the bigger question remains: Does the arrival of Silicon Valley tech point to a better future for housing or an industry disruption to fear?

**Dogfight**

By summer 2021, the US housing market had almost run out of records to break. The Washington Post reported house prices at all-time highs (with a median of $386,000 in June) as the number of homes listed hit record lows (1.38 million nationwide). The average home sold in 15 days that summer—half the time taken a year earlier—as cash-rich investors and second-home buyers bought more than ever before. By November, a New York Times headline asked: “Will Real Estate Ever Be Normal Again?”

Despite making just under 2% of home purchases nationwide during this period, iBuyers began to play a larger, and more unpredictable, role than most, leading to calls from city leaders in Los Angeles to ban the platforms. iBuyers grow city by city; investment is tightly concentrated...
in a handful of locations across the Sun Belt, where the top five—Phoenix, Atlanta, Dallas, Charlotte, and Houston—accounted for more than half the total activity. Through 2021, iBuyers bought 70,400 houses nationwide. Nascent iBuyers are raising fundraising rounds in the United Kingdom, Europe, and Canada—but all are looking to the successes and failures of the state side front-runners.

These cities form a neat growth pattern, following a “strikingly similar” trend to one seen in the trailblazer, Phoenix, according to the National Bureau of Economic Research (NBER), which analyzed iBuying by Zillow, Opendoor, Knock, Redfin, and Offerpad between 2013 and 2018. iBuyers had roughly 1% market share in Phoenix in 2015, growing to 6% in 2018. In the frantic summer of 2021, iBuyers accounted for 10% of home buys in Phoenix. “In certain neighborhoods, 25 to 30% of current listings right now are owned by iBuyers,” says real estate tech strategist Mike DelPrete.

Today Opendoor, the market leader, is operating in 44 markets. iBuyers are intervening in super-hot housing markets by harnessing big data and artificial intelligence to create a one-sided advantage over regular folks. Where house buying was once a “dogfight” between individuals, “now we’re in the age of guided missiles,” says DelPrete, with data-driven buyers claiming a big edge.

There is, obviously, a lot of money tied up in real estate. Residential real estate remains the main asset that American families possess, accounting for about 70% of median household wealth. Over 2021, the value of US housing stock jumped by $7 trillion, hitting $43.4 trillion total.

Real estate transactions have long been considered ripe for disruption because buying or selling a house is time consuming, confusing, and laden with hidden expenses. Yet residential real estate has been slow to innovate—it’s the “largest, undisrupted market in the US,” according to Opendoor.

When it comes to buying and selling, real-estate tech—or “prop-tech”—is changing three things, says Zach Aarons, cofounder of venture capital firm MetaProp. “One, it can showcase listings,” says Aarons, calling back to Zillow’s initial success as a one-stop shop for seeing what’s on the market. Second, startups started digitizing time-consuming processes that have “fundamentally been pen-and-paper for centuries.”

“How do we deliver a title policy with more transparency, more accountability, quicker timing?” he asks. “How do we have e-closing, e-notarization? I think the pandemic accelerated a lot of that.”

The third matter, valuations, remains by far the thorniest. Automated valuation models (AVMs) are proprietary data systems that take in sales prices from the US’s 600 multiple listings services—the real estate agent’s bread-and-butter data—and combine them with information from mortgage lenders, public data sets, and map data like Yelp reviews of local bars, plus private data sold by real estate analysts.

First-party data is increasingly accumulated, too: Opendoor created an app for in-person inspectors, pre-covid, with a 100-point checklist, while today, sellers perform self-service virtual assessments.

Opendoor’s tech chief, Ian Wong, says the foundation of their work is data cleansing—taking partial, duplicated, and contradictory data and parsing it to produce reliable insights. But “human-in-the-loop” systems remain vital, he says. The company has real people annotate visual data, adding labels in a manner he likens to the processing done...
One goal of this data work is to eliminate the so-called “lemons problem.” So far, AVMs have been able to access only a portion of the information that a family selling its home knows, explains Amit Seru, a professor of finance at the Stanford Graduate School of Business—failing to appreciate architectural style, unruly neighbors, how light hits the porch on late summer evenings, and myriad qualities contributing to a house’s human appeal. Consequently, these AVMs can lead iBuyers to disaster when some sellers offer up “lemons” (dud homes, say, with stinking carpets) and others offer “peaches” (a charming home in a neighborhood full of amenities). By bidding an average price for both homes, the iBuyer ends up paying too much for lemons, while families with peaches—who feel harshly undervalued—refuse to sell.

Wong says that both deep learning and humans can help minimize such issues by, say, analyzing photos for defects like ugly power lines cutting across the yard. AVM advances have expanded Opendoor’s “buy box,” the subset of homes it can purchase, since its launch in Phoenix in 2014. iBuyers typically start buying cookie-cutter houses, priced between $100,000 and $250,000, that are relatively new and on modest-sized lots, according to research out of Stanford, Northwestern, and Columbia. In February, Opendoor explained that it had grown its buy box by 50%. “Today we are doing higher-price-point homes. We’re going to gated communities, age-restricted communities, things that are harder to price,” says Wong. “And we’ve been able to expand all the way to Atlanta … to the most recent market we announced, which is the San Francisco Bay Area, which has very heterogeneous housing types.”

But how effective has this valuation technology actually been? Zillow has revealed that it lost $881 million on Zillow Offers. In its Q3 letter to shareholders, CEO Rich Barton explained that the venture was “too risky, too volatile to our earnings and operations”; it “provides too little opportunity for return on equity, and serves too narrow a portion of our customers.” The pivot forced the company to lay off 25% of its staff and left it facing two class action lawsuits from shareholders. Other iBuyers have a better record of profiting from sales yet are losing money overall, with Opendoor reporting a net loss of $662 million for 2021, its shares falling as measures of profitability were cut. The company, though, is bullish on growth, predicting a 460% increase in revenue in the first quarter of 2022 compared to one year ago. “In short, Zillow is out of the game, but Opendoor is getting bigger and stronger,” says DelPrete.

**Database: America**

Zillow’s pricing failures wiped out more than $35 billion in market value by February 2022. For buyers like him, Maxson says, “It’s insane! They’re falsifying the market.” Despite concert tours torpedoed by covid, Maxson says, he’s lucky to have kept earning a living, but he fears his neighbors will struggle: “A blackjack dealer and the husband does maintenance at the MGM [casino] … How do they try to navigate this if they want to buy a house?”

Making sense of iBuyers’ erratic transactions means understanding not just how their technology works, but where they come from, explains DelPrete. Tech-led disruption of real estate is not the result of a couple of buddies in a garage, he explains: “There are no pure tech plays that are revolutionizing real estate.” The fuel is billions of dollars that investment firms are pouring into housing, with Opendoor backed by $400 million from SoftBank, among other giants. The upheaval Maxson witnessed is one “downside of having a for-profit Wall Street–funded corporate middleman involved in the real estate transaction,” says DelPrete. “The company’s winning. Somebody has to lose.” But the impact is also felt by consumers, neighborhoods, and cities.

iBuyers’ primary benefit is supplying liquidity to a market where transactions are onerous. For a busy family, selling to an iBuyer can cut the need for presale repairs and viewings. For someone offered a new job in a faraway city, it can mean saying yes to relocating right away. Thousands of sellers have been willing to take an average $9,000 discount for this speed and simplicity, according to the NBER working paper. iBuyers’ arrival in new cities gives consumers extra options, offering fair bids and often lower agency fees than conventional agents, says DelPrete.

Drew Meyers, founder of Geek Estate, a private and paid community of more than 500 proptech executives and a Zillow alum, says it’s crucial to see iBuyers in the context of other proptech innovation, which also includes “power buyer” startups that allow homeowners to “buy before they sell.” VC investment and cheap debt are key here, too: “Most of the innovation is finance-driven, frankly,” says Meyers. “A lot of these companies are disguised as real estate companies, but they’re really fintech plays.”

One clear example, investment marketplace Roofstock, provides a platform that has helped investors put $5 billion into buying single-family homes to flip into rentals, often without a buyer ever entering the home. Roofstock compares prices, rental yields, and risk, giving
Las Vegas was among the top 10 markets where startups concentrated their investments last year.
a one- to five-star “neighborhood rating” based on factors like school districts and rates of employment. “We built a database of all roughly 90 million homes in the US, where we started with tax and deed information and then augmented it with ownership information, rents (if it’s a rental), evaluation information, all that,” says Gary Beasley, Roofstock’s CEO. “So we have this living, breathing database of every single-family house in America. And we overlay our neighborhood scores and transactional data, and really have a view on what every home is worth as an investment, right?”

Today investors buy 27% of single-family homes in the US. Four in 10 are bought by small-scale investors owning fewer than 10 homes—who may buy in their home neighborhood or use tools like Roofstock. These buy-to-rent purchases are today a lightning rod for criticism, with investors outmuscling first-time buyers for scarce starter homes and reducing the number of affordable homes later sold. By “equity-mining” neighborhoods where families could once build wealth, investors instead capture the uplift themselves.

Dashboards like Roofstock’s are the mostly unseen war rooms in America’s housing chaos, helping faraway speculators make big returns while playing havoc with the lives of people on the ground. In interviews with startups as well as real estate agents and analysts, it emerges that when a family finds its dream home, it has often already been crawled by AVMs that have analyzed its value as an asset, its potential yield as a rental, its forecast price growth, and countless other metrics.

Wall Street elite
Some of the world’s biggest real estate investors are guided by in-house systems that remain black boxes—and whose insights are fiercely guarded in Wall Street towers.

Private equity giants like Blackstone and Starwood Capital bought foreclosed homes in the aftermath of the subprime crash in 2008, bundling them into single-family rental empires, including Invitation Homes and Starwood Waypoint. These merged in 2017 to create the US’s largest single-family landlord, with a portfolio of 82,000 homes. Again, as in the subprime crisis, homes were transformed into tradeable asset classes worth billions. Cloud-based property management technologies underpinned these landlords, explains Steve Weikal, real estate tech lead at the MIT Real Estate Innovation Lab. These allowed firms to manage everything—from rent collection to home maintenance—in geographically dispersed homes, as easily as corporations had managed apartment buildings. Bigger tools followed, like Blackstone’s Real Estate Data Direct, which since 2021 has pooled data from hundreds of companies it owns while amassing the world’s largest portfolio of commercial real estate, now valued at $514 billion.

Many Wall Street pioneers sold their rental businesses in the decade after the crash, making billions for investors and executives but leaving a trail of anger from tenants who endured poor maintenance and rent hikes. Yet coming into the pandemic, Wall Street had again assembled an unimaginable arsenal with which to strike deals—around $2.3 trillion. It was preparing, suggested the Wall Street Journal, “for what could be a once-in-a-generation opportunity to buy distressed real-estate assets at bargain prices.”

These firms are reinvesting in a big way. Blackstone bought Home Partners of America, with 17,000

76% of iBuyer purchases are concentrated in 10 metros

iBuyer purchases increased significantly in 2021

SOURCE: CORE LOGIC

SOURCE: CORE LOGIC
homes, for $6 billion in June 2021. Toronto-based Tricon launched a $5 billion joint venture in July to buy up 18,000 homes across the Sun Belt. Indeed, many proptech innovations were developed by these Wall Street giants, with Blackstone alumni leading disruption from VC firm Fifth Wall and European pioneer IMMO. Roofstock founder Beasley was co-CEO of Starwood Waypoint Residential Trust, one of the US’s largest single-family rental companies, and sees his startup as disseminating the same tech tools.

“The idea with Roofstock really was to take a lot of that knowledge of how we could package up and sell and manage single-family rentals, and offer that as a service both to institutional investors as well as individual investors,” says Beasley.

But links between Wall Street and proptech go further. A Bloomberg investigation found a “secret pipeline” of sales from iBuyers to big investors accounting for one in five homes they sold. The rate is double that, around 40%, in some Sun Belt metro areas, with many sold off-market. “That’s a big issue,” says DelPrete. “If that was 7,000 transactions, that’s 7,000 families that didn’t have a chance to buy a home just because a company decided not to list houses for sale.”

**Fighting back**

Last October, Los Angeles city council members Nithya Raman and Nury Martinez sounded the alarm that startups and Wall Street threat-ened to put an end to the American Dream. “It shouldn’t be impossi-bile for Angelenos to remain in the neighborhood they grew up in or for hardworking families to purchase their first home,” says Martinez. “Angelenos just can’t compete with the money and power of iBuyers.”

In a motion, they instructed the city’s legal departments to seek ways to limit such speculative prac-tices in order to rebalance the playing field. California had already restricted its SB9 law (which allows homeowners to develop another property on their lot) to those who commit to living on-site for three years, explained Meyers, to exclude corporate landlords. Maxson, who eventually found a home with the help of a regular, human agent, agrees with the move: “I think they need to be regulated. They’re taking a problem in the United States and making it worse.”

But some caution against clamp-ing down on disruption. In a market ingrained with a history of racist practices—and where the appraisal industry remains 84% white—AVMs can mean fairer deals for minorities, explains Lauren Rhue, an assis-tant professor at the University of Maryland.

A landmark study in September confirmed anecdotal evidence of an “appraisal gap,” showing that homes in Black and Latino neighborhoods are consistently undervalued. Freddie Mac analyzed more than 12 million mortgage records between 2015 and 2020 and found that in Latino neigh-borhoods appraisers were twice as likely to value homes below the eventual sale price, with similar outcomes in Black neighborhoods.

Rhue is concerned that “what you could see is just a perpetua-tion of the issues that we’ve had historically in this country with housing.” Indeed, machine learning can entrench problems when fed data influenced by decades of discrimination. Home values—which are 55% lower in majority Black census tracts, on average, than in white areas—are a prime example.

A viral TikTok video by Nevada-based real estate agent Sean Gotcher made headlines in September by demonstrating how iBuyers might attempt to manipulate prices. “Let’s say that that company buys 30 homes within a two-mile radius, and let’s say the price is $300,000,” Gotcher explained. “Then on the 31st home, they buy it for $340.” Although overpaying, this new “comp” means they have a benchmark to sell the rest at $340,000.

Most analysts agreed that iBuy-ers are not big enough to pull this off. That would mean owning a big share of the local market, and restricting supply to drive sale prices up. But there are already signs big investors are restricting supply, further exacerbating housing cri-ses and setting a template that any big iBuyer could follow. New York corporate landlords “warehoused” up to 50% of homes during the first covid-19 lockdown—keeping them empty to restrict free-falling rents. On a smaller scale, Opendoor continued buying homes in the winter of 2020, but curiously stopped list-ing them for sale.

For ordinary people, so long as Wall Street cash is flowing into housing, Zillow’s failure is not the end of tech-led disruption but a fumbled beginning. “iBuying, power buying, co-investments, down payment assistance, cash offers,” says Meyers. “They’re all going to end up doing it all.” Each company is now trying to capture and automate more of the value of the transaction chain that has traditionally been split between mortgage brokers, flippers, title agents, real estate agents, and more. The core mechan-ics—tech to value homes and manage deals, married with free-flowing finance—give entrepreneurs room to reinvent the offer. Some innovations may be boons for prospective home buyers. But just as surely, others will empower the most cut-throat investors in the world. ■

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AI’s inequality problem

The economy is being transformed by digital technologies, especially in artificial intelligence, that are rapidly changing how we live and work. But this transformation poses a troubling puzzle: these technologies haven’t done much to grow the economy, even as income inequality worsens.

Productivity growth, which economists consider essential to improving living standards, has largely been sluggish since at least the mid-2000s in many countries.

Why are these technologies failing to produce more economic growth? Why aren’t they fueling more widespread prosperity? To get at an answer, some leading economists and policy experts are looking more closely at how we invent and deploy AI and automation—and identifying ways we can make better choices.

In an essay called “The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence,” Erik Brynjolfsson, director of the Stanford Digital Economy Lab, writes of the way AI researchers and businesses have focused on building machines to replicate human intelligence. The title, of course, is a reference to Alan Turing and his famous 1950 test for whether a machine is intelligent: Can it imitate a person so well that you can’t tell it isn’t one? Ever since then, says Brynjolfsson, many researchers have been chasing this goal. But, he says, the obsession with mimicking human intelligence has led to AI and automation that too often simply replace workers, rather than extending human capabilities and allowing people to do new tasks.

For Brynjolfsson, an economist, simple automation, while producing value, can also be a path to greater inequality of income and wealth. The excessive focus on human-like AI, he writes, drives down wages for most people “even as it amplifies the market power of a few” who own and control the technologies. The emphasis on automation rather than augmentation is, he argues in the essay, the “single biggest explanation” for the rise of billionaires at a time when average real wages for many Americans have fallen.

Brynjolfsson is no Luddite. His 2014 book, coauthored with Andrew McAfee, is called The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. But he says the thinking of AI researchers has been too limited. “I talk to many researchers, and they say: ‘Our job is to make a machine that is like a human.’ It’s a clear vision,” he says. But, he adds, “it’s also kind of a lazy, low bar.”

In the long run, he argues, far more value is created by using AI to produce new goods and services, rather than simply trying to replace workers. But he says that for businesses, driven by a desire to cut costs, it’s often easier to just swap in a machine than to rethink processes and invest in technologies that take advantage of AI to expand the company’s products and improve the productivity of its workers.

Recent advances in AI have been impressive, leading to everything from driverless cars to human-like language models. Guiding the trajectory of the technology is critical, however. Because of the choices that researchers and businesses have made so far, new digital technologies have created vast wealth for those owning and inventing them, while too often destroying opportunities for those in jobs vulnerable to being replaced. These inventions have generated good tech jobs in a handful of cities, like San Francisco.
and Seattle, while much of the rest of the population has been left behind. But it doesn’t have to be that way.

Daron Acemoglu, an MIT economist, provides compelling evidence for the role automation, robots, and algorithms that replace tasks done by human workers have played in slowing wage growth and worsening inequality in the US. In fact, he says, 50 to 70% of the growth in US wage inequality between 1980 and 2016 was caused by automation.

That’s mostly before the surge in the use of AI technologies. And Acemoglu worries that AI-based automation will make matters even worse. Early in the 20th century and during previous periods, shifts in technology typically produced more good new jobs than they destroyed, but that no longer seems to be the case. One reason is that companies are often choosing to deploy what he and his collaborator Pascual Restrepo call “so-so technologies,” which replace workers but do little to improve productivity or create new business opportunities.

At the same time, businesses and researchers are largely ignoring the potential of AI technologies to expand the capabilities of workers while delivering better services. Acemoglu points to digital technologies that could allow nurses to diagnose illnesses more accurately or help teachers provide more personalized lessons to students.

Government, AI scientists, and Big Tech are all guilty of making decisions that favor excessive automation, says Acemoglu. Federal tax policies favor machines. While human labor is heavily taxed, there is no payroll tax on robots or automation. And, he says, AI researchers have “no compunction [about] working on technologies that automate work at the expense of lots of people losing their jobs.”

But he reserves his strongest ire for Big Tech, citing data indicating that US and Chinese tech giants fund roughly two-thirds of AI work. “I don’t think it’s an accident that we have so much emphasis on automation when the future of technology in this country is in the hands of a few companies like Google, Amazon, Facebook, Microsoft, and so on that have algorithmic automation as their business model,” he says.

**Backlash**

Anger over AI’s role in exacerbating inequality could endanger the technology’s future. In her new book *Cogs and Monsters: What Economics Is, and What It Should Be*, Diane Coyle, an economist at Cambridge University, argues that the digital economy requires new ways of thinking about progress. “Whatever we mean by the economy growing, by things getting better, the gains will have to be more evenly shared than in the recent past,” she writes. “An economy of tech millionaires or billionaires and gig workers, with middle-income jobs undercut by automation, will not be politically sustainable.”

Improving living standards and increasing prosperity for more people will require greater use of digital technologies to boost productivity in various sectors, including health care and construction, says Coyle. But people can’t be expected to embrace the changes if they’re not seeing the benefits—if they’re just seeing good jobs being destroyed.

In a recent interview with MIT Technology Review, Coyle said she fears that tech’s inequality problem could be a roadblock to deploying AI. “We’re talking about disruption,” she says. “These are transformative technologies that change the ways we spend our time every day, that change business models that succeed.” To make such “tremendous changes,” she adds, you need social buy-in.

Instead, says Coyle, resentment is simmering among many as the benefits are perceived to go to elites in a handful of prosperous cities.

In the US, for instance, during much of the 20th century the various regions of the country were—in the language of economists—“converging,” and financial disparities decreased. Then, in the 1980s, came the onslaught of digital technologies, and the trend reversed itself. Automation wiped out many manufacturing and retail jobs. New, well-paying tech jobs were clustered in a few cities.

According to the Brookings Institution, a short list of eight American cities that included San Francisco, San Jose, Boston, and Seattle had roughly 38% of all tech jobs by 2019. New AI technologies are particularly concentrated: Brookings’s Mark Muro and Sifan Liu estimate that just 15 cities account for two-thirds of the AI assets and capabilities in the United States (San Francisco and San Jose alone account for about one-quarter).

The dominance of a few cities in the invention and commercialization of AI means that geographical disparities in wealth will continue to soar. Not only will this foster political and social unrest, but it could, as Coyle suggests, hold back the sorts of AI technologies needed for regional economies to grow.

Part of the solution could lie in somehow loosening the stranglehold that Big Tech has on defining the AI agenda. That will likely take increased federal funding for research independent of the tech giants. Muro and others have suggested hefty federal funding to help create US regional innovation centers, for example.

A more immediate response is to broaden our digital imaginations to conceive of AI technologies that don’t simply replace jobs but expand opportunities in the sectors that different parts of the country care most about, like health care, education, and manufacturing.

**Changing minds**

The fondness that AI and robotics researchers have for replicating the capabilities of humans often means trying to get a machine to do a task that’s easy for people but daunting for the technology. Making a bed, for example, or an espresso. Or driving a car. Seeing an autonomous car navigate a city’s street or a robot act as a barista is amazing. But too often, the people who develop and deploy these technologies don’t give much thought to the potential impact on jobs and labor markets.

Anton Korinek, an economist at the University of Virginia and a Rubenstein Fellow at Brookings, says the tens of billions of dollars that have gone into building
autonomous cars will inevitably have a negative effect on labor markets once such vehicles are deployed, taking the jobs of countless drivers. What if, he asks, those billions had been invested in AI tools that would be more likely to expand labor opportunities?

When applying for funding at places like the US National Science Foundation and the National Institutes of Health, Korinek explains, “no one asks, ‘How will it affect labor markets?’”

Katya Klinova, a policy expert at the Partnership on AI in San Francisco, is working on ways to get AI scientists to rethink the ways they measure success. “When you look at AI research, and you look at the benchmarks that are used pretty much universally, they’re all tied to matching or comparing to human performance,” she says. That is, AI scientists grade their programs in, say, image recognition against how well a person can identify an object.

Such benchmarks have driven the direction of the research, Klinova says. “It’s no surprise that what has come out is automation and more powerful automation,” she adds. “Benchmarks are super important to AI developers—especially for young scientists, who are entering en masse into AI and asking, ‘What should I work on?’”

But benchmarks for the performance of human-machine collaborations are lacking, says Klinova, though she has begun working to help create some. Collaborating with Korinek, she and her team at Partnership for AI are also writing a user guide for AI developers who have no background in economics to help them understand how workers might be affected by the research they are doing.

“It’s about changing the narrative away from one where AI innovators are given a blank ticket to disrupt and then it’s up to the society and government to deal with it,” says Klinova. Every AI firm has some kind of answer about AI bias and ethics, she says, “but they’re still not there for labor impacts.”

The pandemic has accelerated the digital transition. Businesses have understandibly turned to automation to replace workers. But the pandemic has also pointed to the potential of digital technologies to expand our abilities. They’ve given us research tools to help create new vaccines and provided a viable way for many to work from home.

As AI inevitably expands its impact, it will be worth watching to see whether this leads to even greater damage to good jobs—and more inequality. “I’m optimistic we can steer the technology in the right way,” says Brynjolfsson. But, he adds, that will mean making deliberate choices about the technologies we create and invest in.
Last summer, a special subcommittee of the US Senate met remotely to weigh the benefits of launching a central-bank digital currency, or CBDC—something that could, if optimally designed, transform the US financial system, making it more accessible to more citizens. For senators staring intently at their laptops, this was basically the first day of digital-currency school.

And to introduce them to this highly technical world, the first witness that Senator Elizabeth Warren called was MIT Digital Currency Initiative director Neha Narula.

Narula had only five minutes to explain what could be gained by reimagining US currency—and what could go wrong. She’d never provided Senate testimony before. “I went into it a little bit blind,” she says.

But there was a reason Narula had been chosen to start the session. In the years since her 2016 TED talk on the future of money, which has reached 2.5 million viewers, she’s gained a reputation globally for remarkably clear communication about incredibly complex and politically charged ideas in digital currency. She’s emerged as a neutral, trusted source of knowledge about financial technologies that very few people genuinely understand.

Narula was able to help senators quickly learn not only how digital currency works today, but also how it could be redesigned to better address concerns around ethics, privacy, security, equity, and innovation. She knows that ultimately it will be policymakers who decide whether and how to build a CBDC, and her goal is to make sure they know the trade-offs that will come with every decision. For example, she told senators that “two-tier” CBDCs, which require a commercial bank account and function the same way electronic payments work today, could be less financially inclusive and harder to continually improve than another much-discussed design that the DCI likens to creating digital cash. While that approach would necessitate new technology, it doesn’t require that users have a
commercial bank account, making it potentially more accessible to the approximately 7 million people nationwide who do not.

Narula was introduced to the digital-currency world after finishing her PhD studies on databases and distributed systems at MIT in 2015. She had been taking a few months off to figure out where she wanted to go with her research, knowing she wanted to get involved in building technology to address problems affecting people's everyday lives. During this break, she spent a lot of time hanging out with friends who had gotten interested in Bitcoin. It was attracting plenty of attention on campus: in 2014 Jeremy Rubin, then an MIT student, helped raise half a million dollars to airdrop $100 in Bitcoin each to more than 3,000 undergrads.

Narula says Rubin hoped his experiment would get more people interested in researching Bitcoin, but she didn't pay much attention. Then her friends told her that Bitcoin was having trouble scaling—the system was struggling to process a growing number of transactions. Narula had spent a lot of time considering how to scale systems. Suddenly she was obsessively reading not just about Bitcoin but also about the technology of money in general and how it works in the world of central banks, fractional reserve banking, payment systems, and credit cards. She saw an opportunity to solve a real problem by helping reinvent how money changes hands.

“We had never really been able to make digital payments without an intermediary in the middle before,” Narula says. “This was the first time that that was happening, and it was happening with a really interesting technology.”

Narula got into Bitcoin right at the start of the “blocksize war,” a period from 2015 to 2017 when
people started fighting for control over Bitcoin protocols as the cryptocurrency’s user base grew and limitations were placed on transaction size.

Partly in response to that battle, Rubin cofounded DCI with former White House Office of Science and Technology Policy advisor Brian Forde. Forde became DCI’s first director and started building a team focused on Bitcoin security. Narula joined as director of research in 2016, and though she’d initially been ambivalent about Bitcoin, she quickly became one of the world’s most respected authorities on it. Within a year, Forde stepped back and Narula took control. She’s been DCI’s director ever since.

These days, once or twice weekly, Narula visits the DCI corner offices on the MIT Media Lab’s third floor, where there’s a giant light-up Bitcoin sign that marks the research DCI was founded to do. Bitcoin security—and the insights it can provide about other cryptocurrencies—remains a DCI priority. But Narula has extended the initiative’s scope, with pilot projects on a variety of new types of digital currencies. One of DCI’s biggest undertakings yet is Project Hamilton, a multiyear research collaboration between DCI and the Federal Reserve of Boston that is exploring the technical challenges of designing a CBDC.

This new line of research has introduced some conflict at DCI; after all, many researchers there are interested in cryptocurrency because it eliminates the need for banks or government monetary bodies. But Narula has found a way to bring crypto enthusiasts to the table with central bankers to talk about what lessons Bitcoin might hold for the design of a bank-backed digital currency.

Narula sees DCI as neutral territory. “These worlds are very different, the cryptocurrency world and the central-banking world,” she says. “We see ourselves in part like a bridge.”

It’s not always easy. “There’s a real tension,” says Shira Frank, a strategic advisor at DCI.

When Frank first started researching digital currency, in 2018, she felt cryptocurrency had become too toxic and worried that the technology might not be salvageable. “It’s going so far in the wrong direction,” she recalls thinking.

But Narula told Frank that cryptocurrency still had untapped potential, and that much of its toxicity sprang from a widespread failure to predict the most-negative outcomes amidst its hasty evolution. Narula says we are now dealing with what we’ve wrought through this inadequate planning but that we can use what we learn from crypto’s mistakes to design new digital currencies that can serve people better.

Narula says Bitcoin research helps her team answer fundamental questions about other kinds of cryptocurrencies as well as CBDCs. It should be possible to design a CBDC to work for “those who are often the most disadvantaged” by the current monetary system, she says. Properly implemented, it could help cut the red tape around social support programs or eliminate fees that people without bank accounts must often pay to access their cash.

Earlier this year, Project Hamilton debuted its design for a speedy payment processor that can handle 1.7 million transactions per second, seemingly paving the way for the US to launch a CBDC. Then, in March, President Joseph Biden issued an executive order to ramp up CBDC research, a bid to keep America ahead of other countries in the financial technology race.

Biden expects a technical evaluation of what will be needed to design a CBDC to come out by September, and Project Hamilton will inform that policy. The US isn’t the only country turning to DCI; Narula says the group recently began advising other countries on CBDCs as well. There are still unanswered questions when it comes to adopting them, she adds.

Narula’s top concern for any new digital currency—be it a CBDC or a cryptocurrency—is to ensure that it protects user privacy. She is watching what happens with China’s CBDC, which has already been used to conduct billions of dollars in transactions. Experts have noted that China could eventually link it up to the country’s social credit system (which uses citizens’ financial data to score their trustworthiness), cautioning that this could vastly increase social monitoring in that country and allow the government new levels of control. It might even be able to deny citizens access to their own money in response to their social media posts.

No one knows how it will all play out. But Narula plans to be there, by the glowing Bitcoin sign in the DCI office, to help navigate this new future. “We want to understand the implications of different technology designs,” she says, because ready or not, “money is really changing.”

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DeFi loans to avoid being hit with high interest rates once again.

How do DeFi loans work?
Decentralized finance is a catch-all term for blockchain applications used to create complex financial products. Since DeFi loans aren’t tied to the traditional banking system, they sometimes have lower interest rates, do not affect the borrower’s credit score, and could in theory be held indefinitely.

DeFi loans can be based on any digital currency. That includes stablecoins, which are cryptocurrencies whose value is tied to external sources like the US dollar. To take out a DeFi loan, borrowers must first deposit collateral in the form of crypto assets worth more than the amount they wish to borrow. How much more is based on a percentage set by the lender. It’s a bit like putting down $100 in one currency to borrow $75 in another.

The borrower receives the loan in, for example, stablecoins, which can then be exchanged for US dollars. That money is used to pay off a debt, and then the borrower eventually pays off the DeFi loan to reclaim the collateral.

With the benefits of DeFi, however, come risks. A borrower’s collateral can be liquidated if its value drops below the value of the loan. Bitcoin, despite having more market liquidity than any other cryptocurrency, is still highly volatile, fluctuating in value by an average of 3% per day. If prices dip too much, borrowers lose their collateral. (Though if the price of the collateral appreciates, that risk is lower.)

Stablecoins have also been the target of government scrutiny, given the risks of an unregulated stablecoin market to the global economy. Regulators have warned that potential fluctuations in value could lead to widespread losses for stablecoin holders and destabilize the entire financial market.

In November 2021, a US government working group recommended that Congress require stablecoin issuers to be subject to the same regulations as banks. In February, US Representative

Would you take a loan from a blockchain app?

Robin Kim graduated from New York University in 2015 with a degree in economics. He borrowed more than $100,000 from the US government and quickly became locked in to high interest rates. He has been trying to pay off his student loans ever since.

Eventually, Kim refinanced through a private lender to lower the interest rate, but he wondered if there was another way out. “I was paying $1,500 a month, every month, to pay off this loan,” he says. “That amount could have been better spent elsewhere.”

A former engineer at Coinbase and a cofounder of Gallery, an online platform people can use to curate and share their NFT collections, Kim had thought of selling cryptocurrency to pay off his loans. But if he did that, he’d have to pay taxes on any profit he made.

Instead, Kim took out a loan through a lending platform called Aave, built on the Ethereum blockchain. He used that money to pay his debt and is now working on paying off the new loan.

More than 43 million people in the US have student loans, with an average federal balance of over $37,000. During the pandemic, the Biden administration paused student loan repayments for millions of borrowers. Whenever repayments resume, some borrowers may turn to decentralized finance (or DeFi) loans to avoid being hit with high interest rates once again.
Josh Gottheimer, a New Jersey Democrat, announced the Stablecoin Innovation and Protection Act, which would issue government-backed insurance for stablecoins. These steps would reduce the risk of volatility, but a government-backed coin would no longer be decentralized.

Another major risk is that smart contracts, the automated agreements underwriting loans on the blockchain, are not infallible. Smart contracts are executed on the basis of predetermined conditions written into code. That code is written by humans, and mistakes, bugs, or hacks could ensnarl borrowers.

A matter of trust
Borrowers must therefore place a good amount of trust in the platform issuing their loan. More prominent platforms can take security measures to reduce the risk. For example, the platform Compound Treasury’s community has hired security firms to evaluate its loan protocol to make sure its code is secure.

“Even so, it’s really up to the end user, the developer, and the borrower or lender to really assess the stability and riskiness of the smart contract,” says Reid Cuming, Compound’s vice president and general manager. “I think we’re still in a state where there’s a lot of room for improvement here.”

DeFi platforms also provide little privacy to borrowers, meaning anyone who knows your wallet address can see how much you borrowed and when.

Crypto skeptic Molly White says this divides users into three camps: people who protect their privacy at the expense of being able to use the major crypto platforms, people who give up some privacy to use them, and people whose identities and crypto wallets are publicly linked.

As the choice of platforms comes down to liquidity versus privacy, many of the purported benefits of decentralization—privacy, anonymity, and independence from corporations—no longer apply. And managing these risks requires technical expertise that most borrowers simply don’t have.

On one hand, White says, some believe these platforms are making financial transactions, once the domain of experts, available to anyone—but on the other hand, people are getting sucked into making risky decisions that they don’t have the knowledge to be able to make responsibly.

Kim remains optimistic. He compares the situation to the early days of the internet and says that even with the risks, DeFi has the potential to go mainstream. “I think DeFi will meet parity with centralized finance ... just because of the transparency and openness of it,” he says. “The ecosystem does have to mature, but I think that’s the case with any emerging technology.”

Tisya Mavuzam is a tech writer based in New York City.
S

A young woman of color, then just 23, exposing the plans of a Big Tech firm with tools apart from her own ability to reverse-engineer code was (and is) pretty radical—and it’s changed the way tech companies work.

The tweet was the first of many that Wong would send out. By going into public source code for companies like Twitter, Facebook, and more, she has been able to find out what features and projects companies are secretly working on before they announce it. She takes the information she finds, tweets it out with a screenshot of the mocked-up feature, and watches the internet do its thing.

Wong, 27, has a preternatural ability to crack difficult code—along with a sizable Twitter following that includes some of the biggest names in tech and journalism. As she gets into the back end of websites’ code to see what software engineers are tinkering with, they await her discoveries with interest.

“Basically, there’s no such thing as a secret beta anymore for the world’s biggest apps,” says Casey Newton, the founder of the popular Substack tech publication Platformer. “If it’s in the code, Jane could find it. I do think that affects how companies think about testing new features and communicating about them.”

It isn’t Wong’s job to do this. In fact, she describes reverse-engineering code as her hobby. “I just like to dig deep into the apps and see how they are structured; she says from her home in Hong Kong, where she lives with her family. She isn’t a hacker; all the data from which she derives her information is public. She’s more like the computer science version of Gossip Girl.

Wong’s Twitter feed is a near-daily scoop factory, but she insists that nothing she posts is a leak. “Leaks mean that they are based on information coming from employees, that employees are the source,” she says. “But I use publicly available data and code. They’re not leaks.”

Wong has built a reputation for always being right. Journalists cite her work in articles, crediting her scoops. “Initially, people would question, ‘Who is she? How does she have this information?’” she says. “But I built trust over time. You have to prove your information is valid.”

It’s gotten to the point where companies create Easter eggs for her to find. Newton says many have given up on trying to hide their code and simply play along. “There have even been cases where developers will put a ‘Hi, Jane’-style message in their code,” he says. “They know she’s coming.”

Wong’s work brings attention to the oft-ignored research and development parts of companies, which can be a PR win. Coders at Meta love her so much that they’ve created an internal Jane Manchun Wong fan club, which counts among its members Andrew Bosworth, the company’s
CTO. “We value her contributions and feedback that help improve our products,” a Meta spokesperson says.

But even if they know she’s coming, that doesn’t mean they always welcome her. Showmanship and surprise are key elements of maintaining the aura that surrounds a tech launch or feature reveal—and Wong has blasted through these secrets, breaking tech companies’ carefully constructed walls. With one tweet, she effectively destroys any buildup or narrative they have about a feature.

This is precisely why, in fact, Wong says she tweets out features before they go public. To her, the secrecy and subsequent hype are problematic. Apps are used by people; shouldn’t those people know what updates and products are being worked on behind the scenes?

It’s not hard to imagine that companies might be disgruntled about a social media celebrity unceremoniously spilling their secrets on Twitter. And as a 20-something Asian woman posting a steady stream of bombshells about tech companies on Twitter, Wong is a prime target for the type of harassment and trolling that can break even the strongest of humans. “I wish more people realized I’m a person,” she says. “I’m more than a machine.”

It’s a contentious dynamic, and one that has affected her deeply. Several times over the years she hastweeted about being depressed and feeling that people hate her. She has been open about her mental health struggles and says she continues to deal with depression.

And though Wong describes what she does as a hobby, at times it has been more of an obsession: she used to spend nearly 18 hours a day combing code and checking out what companies were tinkering with. She sacrificed her sleep and health, sometimes locking herself at home for days when the harassment became too much. A few times, she’s gone so far as to threaten suicide after being taunted online. She left the University of Massachusetts, Dartmouth, a few months short of graduating because of medical issues, something she regrets.

Is it all worth it? Wong believes it is, saying she’s noticed that companies are more transparent about what they are working on these days. “And if they had been before, I wouldn’t have to do this,” she says.

Over the course of the pandemic, Wong has adjusted and reevaluated her schedule. She’s still a night owl, but she’s starting to find a balance. She’s taken up hiking the outskirts of the city, and she has found refuge at a local cafe nestled in a nearby church.

Quarantine has also made her realize that she doesn’t want to do this work full time. “I’ve been wanting to be a software engineer since I was six,” she says. “I want to create things.” But she’s not ready to get a job in tech, even though she’s gotten numerous offers. “I still haven’t gotten to the bottom of my curiosity for this,” she says. “When I satisfy that curiosity, I’ll stop. I’ll move on.”

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Money changes everything

Sometimes it’s been hard to tell if our shift toward transactions via machine has been a promise or a threat.

From “Computer-Based Services in Personal Transactions”: The challenge thrown down by the computer for the future is to transmit information without the paper. This challenge leads to speculation about a “checkless society,” a phrase that has captured the imagination of journalists to the point of popularizing a concept long before economic, social, and legal aspects have been resolved. Thomas J. Watson, Jr., of IBM has written, “In banking alone, for example, the advances of yesterday are merely a faint prologue to the marvels of tomorrow. In our lifetimes we may see electronic transactions virtually eliminate the need for cash. To draw down or add to his balance, the customer in a store will insert an identification into the terminal located there, and punch out the transaction figures on the terminal’s keyboard. Instantaneously, the amount he punches out will move out of his account and enter another.”

From “The Bottom Line on Checkless Banking”: Anyone who has ever deposited money in a soda machine, only to find that it does not deliver the product, knows that we humans have difficulty dealing with nonworking machines. Upon receiving his bank statement, a friend noted a mysterious $50 charge. He drove to the bank where he confronted the manager with his problem. The manager told him that it was a “computer transaction.” The friend knew he had not used the computer terminal for a transaction that particular day. Unfortunately, feeling intimidated, the fellow let it drop and later explained, “You can’t argue with a computer.” The consumer is still skeptical of ATM terminals. Experience has shown that human nature does not take quickly to change. The benefits to banks and retailers are overshadowed by enormous costs. Therefore, growth in this area will continue to be slow.

From “The Neverhood of Internet Commerce”: New technologies sometimes offer an illusion of benefit that holds true only within a narrow economic frame. While we eagerly chase the savings in money and effort that a new tool seems to offer, we may disregard the wider social costs that may eventually mock our sense of prosperity. Before we shift our purchases to Internet vendors, we need to recognize a hidden price we may end up paying: the demise of traditional shops. A bookstore is first and foremost a gathering spot for those who care about books and reading. In these places the purchase of a product is only part of the experience. Yes, we should use every Internet resource to explore the market and make intelligent comparisons. But when it comes to casting “dollar votes,” we can better spend the money closer to home, in a neighborhood where people actually live rather than the neverhood of digital bits.
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