MIT MANAGEMENT SLOAN SCHOOL | IDEAS MADE TO MATTER

CONFRONTING CORONAVIRUS

Managing during a pandemic requires knowledge and foresight. These five articles examine what's next for the economy, remote work, and an innovative vaccine.

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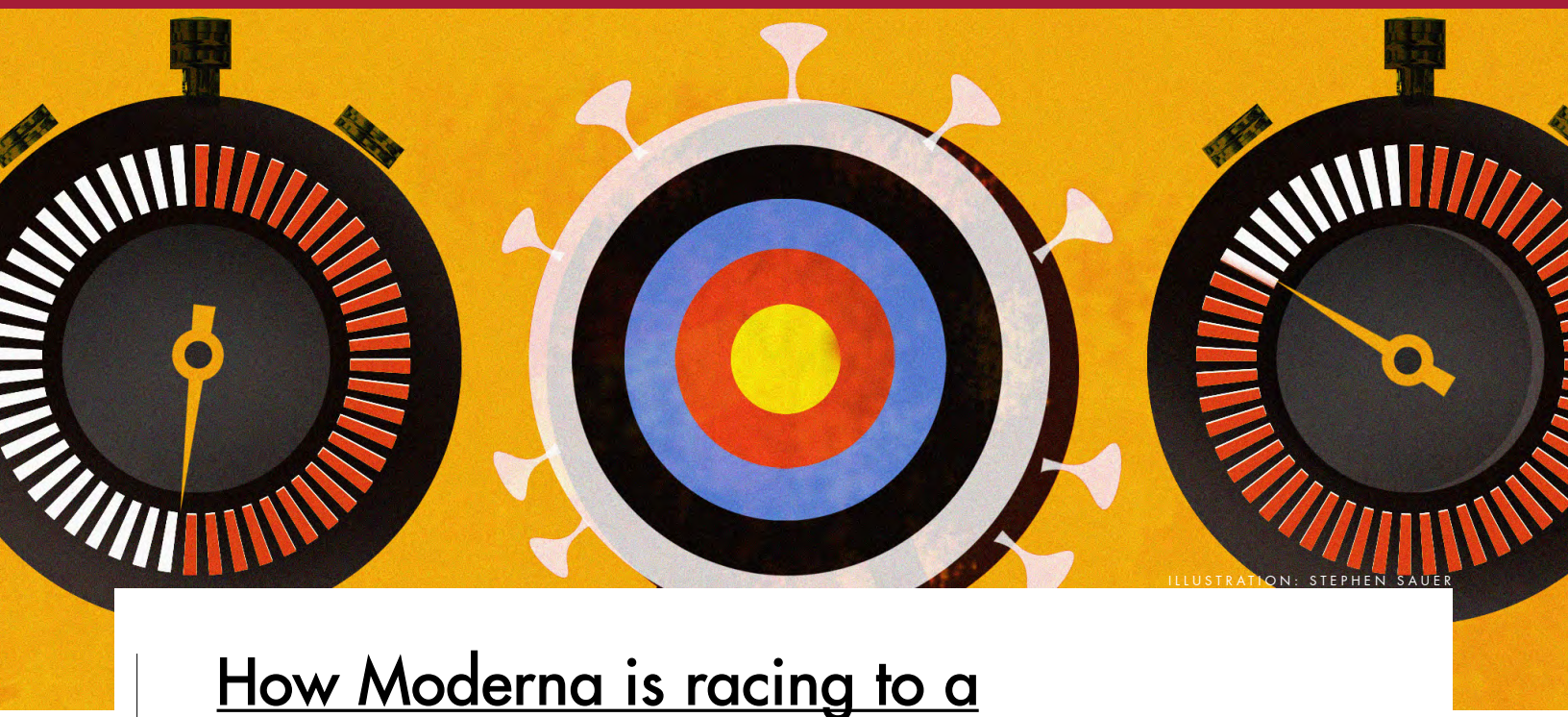


ILLUSTRATION: STEPHEN SAUER

How Moderna is racing to a coronavirus vaccine

by **Tam Harbert**

Why It Matters

With messenger RNA, Moderna wants to develop and manufacture a vaccine in record time. With a public-private partnership, it could be even faster.

A Cambridge biotech company is developing a coronavirus vaccine that could be ready in limited volume as soon as this fall. The speedy timeline is bolstered by its unique technology using messenger RNA — a sort of platform for vaccine development.

That's according to Stéphane Bancel, CEO of the company, Moderna. Bancel was interviewed by MIT Sloan finance professor Andrew Lo in an April 1 webcast co-hosted by the MIT Laboratory for Financial Engineering and the MIT Golub Center for Finance and Policy. "Finance and biomedicine are inextricably linked because you need money to develop drugs and devices," Lo said. "Part of the challenge of financing biomedical innovation is the underlying risks that are involved with these efforts."

And developing vaccines is especially risky. "The economic model for vaccines is broken," Lo said.

The financial engineering lab runs Project ALPHA, for Analytics for Life-Sciences Professionals and Healthcare Advocates. The project's mission is to use data analytics to assess the risks and rewards of drug development. It has analyzed data on hundreds of thousands of clinical trials for diseases and drugs, estimating the likelihood of success for each. Researchers there were shocked to find that, although vaccines have by far the highest success rates — 40%, fewer and fewer companies are developing them, Lo said.

"In fact, right now there are only four big pharma companies that are focused on it," he said. "A number of them have left the space, and smaller companies have gone bankrupt or are not developing vaccines anymore."

To find out why, ALPHA researchers conducted a business simulation, looking at rates of return for investments in vaccine development. The results: very low, just a few million dollars. In fact, the internal rate of return on a portfolio of vaccines using today's typical pricing models is negative 60%, the lab estimated.

Messenger RNA and a platform for vaccines

The COVID-19 pandemic has put a spotlight on this troubling problem, and Moderna's technology may point the way to a solution. The company is one of several firms now developing a vaccine to stem the pandemic.

Founded in 2010, Moderna uses messenger RNA, which carries genetic information from DNA to ribosomes to produce proteins. Moderna hijacks mRNA and uses it to carry a copy of the genetic sequence of the virus, which prompts the production of the antibodies to that virus.

Messenger RNA is similar to computer technology in several ways that offer promise for lowering costs, Bancel said. For one thing, it's an easily replicable process. "We call mRNA the software of life," he said. "You can copy and paste the information into a lot of drugs by using the same technology." That means "the way we make mRNA for one vaccine is exactly the same way we make mRNA for another vaccine," he added. It just carries a different genetic sequence depending on the disease.

That means the same manufacturing process and facilities can be used for many different vaccines. Plus Moderna's process uses less expensive raw mate-

rials (water and enzymes) which lowers the overall costs. Bancel talked about building a platform. "We think if we digitalize and robotize [things], like in any platform, we could scale very quickly," he said.

The mRNA platform is promising, but new. A Q&A on the Moderna website notes that "we are still early in the story," with the company's most advanced vaccine in phase 2 clinical testing and "no approved drugs to date."

In the case of COVID-19, the disease caused by the new coronavirus, Moderna had already spent two years developing a vaccine for MERS (Middle East Respiratory Syndrome). When it saw the genetic sequence of the new coronavirus (technically SARS-CoV-2) that China published Jan. 11, Moderna scientists realized it was extremely similar to the MERS sequence and quickly shifted focus. By mid-March, the firm had a vaccine and had begun its first human trial in Seattle.

If all goes smoothly, the company could be producing millions of doses per month later this year, ramping up to "dozens of millions of doses per month toward next year," Bancel said. The initial production would likely go to inoculate health care professionals, especially because experts expect the virus to resurge in the fall, he said.

Moderna is also working with diagnostics companies to develop more effective tests to determine who has been infected with the new coronavirus. European economist Mathias Dewatripont of the Free University of Brussels and his colleagues have "pointed out that having a method for identifying people who are immune to COVID-19 would actually be part of the economic recovery, because if we can tell who's immune and can get back to work, we can actually begin restarting the economy with those individuals," Lo said. Bancel said he thinks the industry is a few months away from having such serology tests.

63

Using messenger RNA, Moderna took a coronavirus vaccine from sequencing to human trials in 63 days.

Scaling up with a public-private partnership

Moderna's technology could improve the economics of commercial vaccine development. The company and its investors have been spending big on the technology for a decade, Bancel said, and yet the company is not yet profitable.

"The reason we were able to do the vaccine in 63 days from sequence to injecting the first human is because we have invested more than $2 billion of capital over the last 10 years," he said.

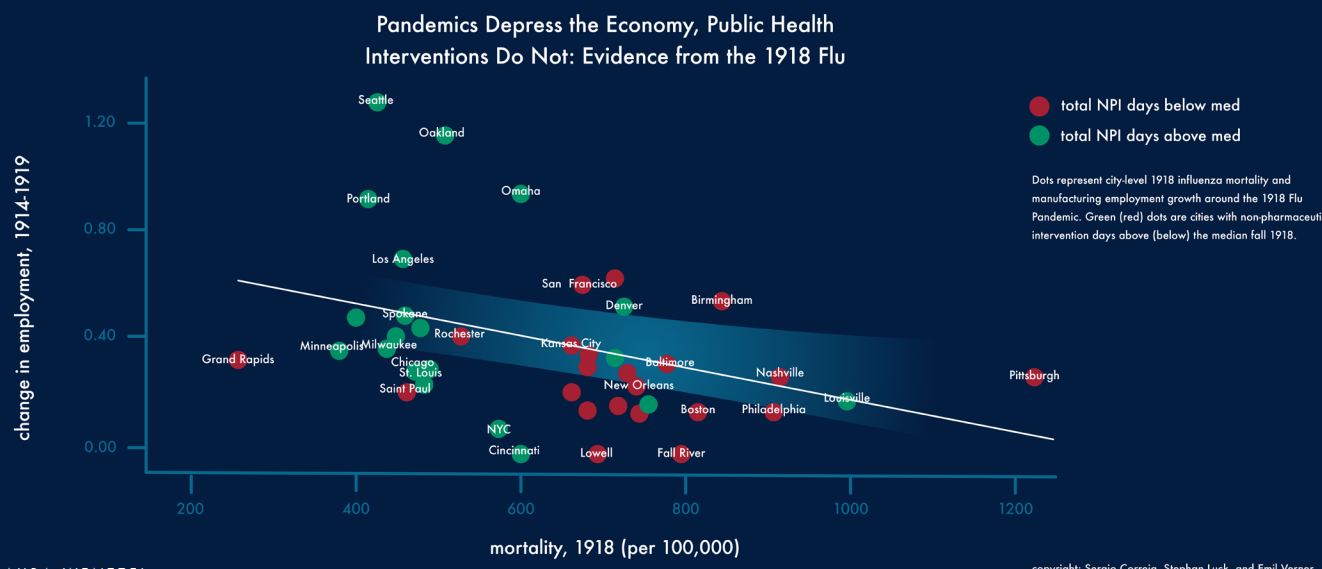
To help speed a COVID-19 vaccine to market, the government is providing funds to companies. The U.S. Department of Health and Human Services, for example, announced March 30 it was providing funding to Johnson & Johnson's Janssen Research & Development as well as Moderna.

Long and big picture, Bancel said industry and government should consider a permanent public-private partnership to help companies take the sort of financial risks that lead to vaccine breakthroughs.

Such a partnership could build a large facility that companies could use for producing commercial vaccines for commercial use but would switch 100% of capacity to the public good during a pandemic to manufacture whatever vaccine was required. A process technology like Moderna's could make such a quick switch possible, he said.

"Governments spend billions of dollars every year on nuclear weapons they hope never to use," he said. "How about spending a couple of billion dollars to build plants, teams and scientific projects to equip ourselves [to more effectively fight pandemics] ?"

"We can do it," he said. "We just have to work together."



CREDIT: LAURA WENTZEL

Cities with strong social distancing see stronger economic recoveries

by **Betsy Vereckey**

Why It Matters

Critics fear social distancing edicts hurt the economy, but research on the 1918 flu pandemic reveals an aggressive response can help spur economic recovery.

Curbing the spread of COVID-19 with quarantines, school closings, and social distancing doesn't just lower mortality rates — it can also help strengthen an economic recovery, according to a preliminary paper co-authored by an MIT Sloan researcher.

By comparing economic outcomes in U.S. cities that acted swiftly and aggressively to combat the 1918 flu pandemic to cities that lagged in their response, researchers found that strongly limiting social and civic interactions helped cities record stronger economic growth once the restrictions were lifted.

The study focused on the effectiveness of non-pharmaceutical interventions, which are actions such as social distancing that people and communities can take to help slow the spread of illnesses, as well as hygiene

recommendations and mask-wearing ordinances.

"Somewhat surprisingly perhaps, we find that areas that acted early and aggressively with non-pharmaceutical interventions do not perform worse economically, at least in the medium term — if anything, they actually come out of the pandemic stronger," said Emil Verner, an MIT Sloan assistant professor and co-author of the paper, alongside Sergio Correia, an economist with the U.S. Federal Reserve, and Stephan Luck, an economist with the Federal Reserve Bank of New York.

The 1918 influenza pandemic

The researchers based their study on the 1918 flu pandemic — which infected about 500 million people, or one-third of the world's population — and had a severe economic impact, rattling supply and demand dynamics in the U.S. The researchers found that the pandemic lowered manufacturing output by 18% between 1914 and 1919 in states at the mean level of exposure to the pandemic.

The authors created a data set for the years surrounding the 1918 pandemic spanning U.S. cities and states to compare information on: influenza mortality statistics from the U.S. Centers for Disease Control; historical economic data from the U.S. Census Bureau; and bank balance sheets. In addition, to measure the effect of social distancing, the researchers considered information from an earlier study on how fast and how long cities implemented non-pharmaceutical public health interventions, such as theater and church closings and bans on public gatherings.

Early social distancing, quicker rebound

Results of the study showed that cities acting more aggressively to limit social and civic interactions during the 1918 flu pandemic recorded a higher level of economic growth once restrictions were lifted.

The researchers found that cities that implemented social distancing and other similar measures 10 days earlier than other cities recorded an approximate 5% gain in manufacturing employment after the pandemic. In addition, implementing social distancing more intensively increased manufacturing employment by about 6.5%.

"What might explain this result? In short, it's because pandemic economics are

different from normal economics," Verner said in a recent MIT Sloan web briefing. "In a pandemic, the pandemic itself is so destructive for the economy that any policy you can use that directly targets the root of the problem may potentially end up being good for the economy, at least in the medium-term."

> *Pandemic economics are different from normal economics*
>
> **Emil Verner** | MIT Sloan

Why western cities fared better in 1918

Western cities such as Oakland, Calif., Omaha, Neb., Portland, Ore., Los Angeles, and Seattle — which required their residents to social distance for longer in 1918 — recorded higher manufacturing growth between 1914 and 1919 and lower mortality rates in 1918, compared to eastern cities Lowell, Mass., Philadelphia, Baltimore, and Nashville, which all social distanced for a shorter amount of time. Philadelphia even allowed a parade to take place during the pandemic.

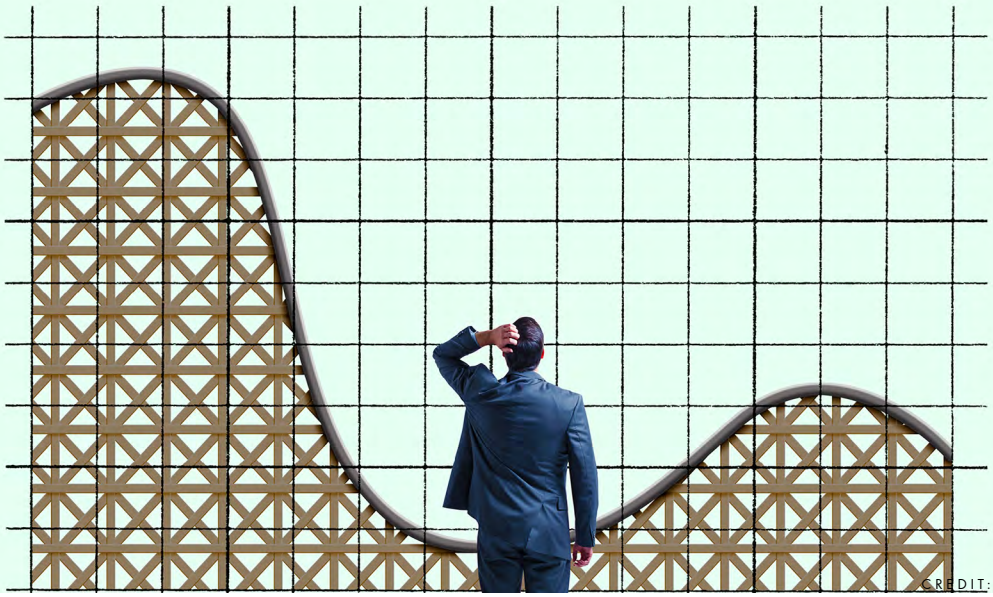
The authors speculated that, as the flu traveled from east to west after arriving in the U.S. from Europe, cities further west saw the suffering taking place in cities like Philadelphia and implemented stronger social distancing measures.

The economic dangers of easing up too soon

Responding aggressively to a pandemic with measures like social distancing had a positive impact during the 1918 flu, and it is helping curb illness today in the COVID-19 pandemic.

By practicing social distancing and limiting large gatherings, cities can keep their citizens safe and improve their chances of an economic turnaround — but only if social distancing guidelines remain in effect to give them time to work.

"Lifting restrictions too early could make the economy worse by leading to a resurgence of the virus in an even more destructive pandemic," Verner said. "We have to defeat the disease before the economy can go back to normal."



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To navigate the current markets, look back to 2008 — and 1918

by **Betsy Vereckey**

Why It Matters

What can the 1918 influenza pandemic and the 2008 financial crisis teach us about how the market is responding to coronavirus fears? An MIT finance professor shares his perspective.

While the impact of the coronavirus has already roiled the financial markets, the worst is still yet to come, according to Andrew Lo, professor of finance at MIT's Sloan School of Management.

"Things will probably get worse before they get better, both from the perspective of this particular outbreak but also financially," Lo said in a March 16 MIT webinar that unpacked the impact of COVID-19 on financial markets.

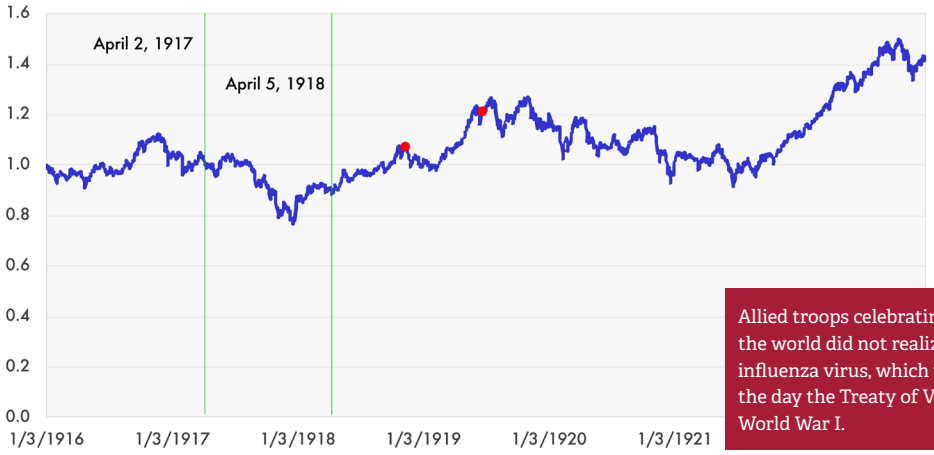
"Part of the reason that markets are reacting the way they are is because the [government] response so far has not provided a credible set of measures that will deal with this crisis in a way that will deal with it once and for all."

Lo acknowledged that the following few months would present a challenging set of market conditions

for investors to navigate but said that looking to past scenarios — while not perfect — can provide valuable insights. "It's been said that history doesn't repeat itself, but it often rhymes," Lo said. "Thinking about the past doesn't always tell us exactly what's going to happen, but it can give us ways of at least providing guidance in how we react."

1918 Influenza Pandemic

Dow Jones Composite Index Cumulative Return, 3 Jan 1916 to 30 Dec 1922



SOURCE
G. William Schwert

Allied troops celebrating Armistice Day around the world did not realize they were spreading the influenza virus, which was still raging in Paris on the day the Treaty of Versailles was signed, ending World War I.

The market returned after the 1918 flu pandemic

Many have compared the current coronavirus to the so-called Spanish flu, in which millions of people died. Lo noted, however, that the economic effects of the 1918 influenza pandemic were relatively short term, with industries reporting mixed results. For example, health care businesses fared better than those in services and entertainment.

"As long as you were well-diversified over that period of time, even though there were short-term losses, eventually [the market] recovered," Lo said. "As close as we can tell, it is clear that even in something as devastating as the 1918 influenza pandemic, the economy recovered and went on to do really well after that."

Effective intervention in the 2008 financial crisis

During the 2008 financial crisis, the government was able to restore order in the financial markets with a $700 billion Treasury fund that was used to purchase

failing bank assets. This was an "unprecedented" intervention, Lo said, one that helped avoid the same kind of depression seen after the 1929 stock market crash.

In contrast, a March 6 $8.3 billion coronavirus spending bill isn't enough to assuage investors' fears, Lo said, especially combined with the fact that dealing with a public health crisis isn't like a financial crisis. The former requires scientific and medical expertise, plus sustained resources to prepare for outbreaks.

"While the $8.3 billion is a good start, we need many more billions of dollars," Lo said, speaking two days before U.S. Treasury Secretary Steven Mnuchin proposed a $1.3 trillion stimulus package. "As we've seen from the financial crisis, once you start dealing with a situation in a way that gives investors confidence, once you are able to restore trust and confidence, at that point you can start turning things around."

So, what to do? Diversify, and don't panic

Lo said that there are "tremendous" opportunities available right now for active managers who can spot winners and losers. Diversification can also help spread bets across different assets.

"In the short run, if you need cash, and you need to be able to put money to work, you will need to preserve your capital," Lo said. "But in the medium and longer run, there is going to be a recovery, so you need to examine your goals, your particular constraints and resources, and do not panic."

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How to manage the hidden risks in remote work

by **Dylan Walsh**

Why It Matters

Remote work can work. But without careful attention, productivity and sound decision-making will suffer.

For many people, COVID-19 began as a distant story. Now it's a threat filling every corner of life. Markets have plunged, settled uneasily, and plunged again. Sports seasons are suspended. Schools are closing, along with restaurants and bars. People are huddled at home. And companies, amid it all, are struggling to balance employee and public health with the maintenance of basic operations.

"The obvious answer that comes to everyone is, 'oh, let's go virtual,'" said professor Alex "Sandy" Pentland, director of MIT Connection Science, in a March 16 webinar.

In sectors where this is feasible, employees just work from home. "But that is not as simple as it looks," he said.

The fact is, companies derive subtle but profound value from social interaction. Pentland noted that productivity

and sound decision-making rely heavily on informal communication, like hallway run-ins or coffee breaks. Companies suffer when this gets stripped away. Likewise, employee trust, solidarity, and mental health rely on the hundreds of minute affirmations and gestures of support that we offer those around us every day: expressions of understanding or empathy, nods of courtesy, morning greetings, and so on.

That's problematic news, given COVID-19 shows no signs of abating. Recent research out of Imperial College London projects that preventing a massive overload of the U.S. health care system and as many as 2.2 million deaths will require drastic restrictions on social gatherings, including work and school, for up to 18 months. The world we occupy now may persist for a long time. Pentland highlighted strategies for preserving, as much as possible within virtual work environments, the social fabric essential to success.

Monitor, and improve, communication

It's important to monitor the quality of conversations that take place online, which inherently lack much of the interpersonal richness present in in-person discussions. As co-creator of the MIT Media Lab, Pentland has worked with MIT startups developing software tools responsive to this need.

RIFF Analytics, for example, uses artificial intelligence to analyze online conversation dynamics and provide real-time personalized feedback to each participant: Is anybody dominating the conversation? Is discussion as inclusive as it should be? Cogito, which is widely used in call centers, provides similar analysis of individual voices, helping people understand when their tone is too aggressive, or if they are interrupting.

These kinds of metrics can provide behavioral crutches in the absence of the clues we rely on during in-person communication, said Pentland, who is a co-founder of both RIFF Analytics and Cogito. If we can't readily observe shifts in posture or tapping feet or subtle hand motions, then a computer should be our fallback interpreter.

Maintain inclusivity

Physical distance between an employer and employee can quickly develop into psychological distance, which means companies need to take extra care to involve

people in decision-making when they work remotely.

One method Pentland suggested is secret voting on new ideas and initiatives. This reduces the cost of stating an opinion but lets everybody take part.

It also prevents "the loud guy from taking the day, which is particularly problematic online," he said.

Idea markets, in which colleagues can vote new ideas up or down, are another way to keep people engaged.

Implementing processes like these can also help mitigate the blow to decision quality suffered in the absence of informal communication channels; providing everybody with a voice in a digital forum can help fill this hole.

Reward cohesion

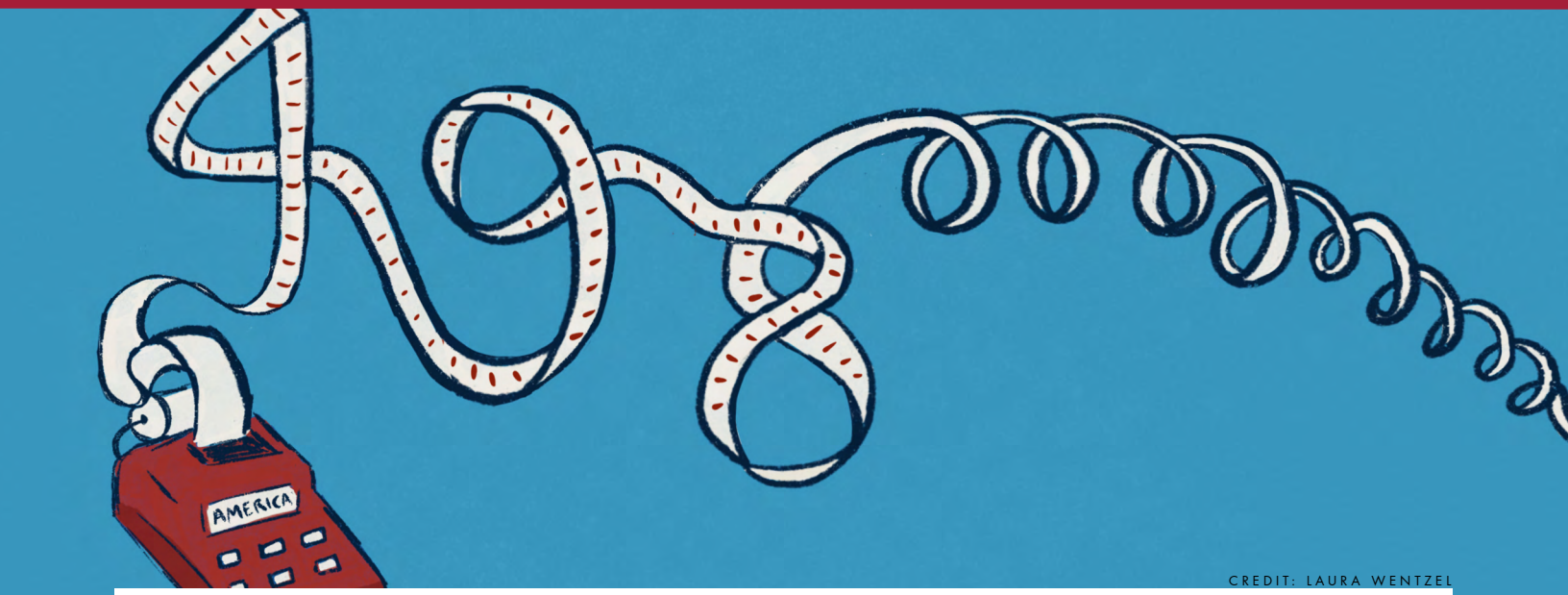
Finally, though most companies are navigating financial straits, they should reward groups with social incentives. One idea is peer reward, where people working in a group vote for colleagues who have been helpful; those who receive the most votes get a bonus. (This needs to be designed so it doesn't become a popularity contest that further alienates individuals.)

There should also be time for reinforcing social ties. Consider a remote movie viewing among coworkers, for example. With online chat open, "it could be something like Mystery Science Theater 3000," Pentland suggested. "They can talk while watching, make snarky comments."

Personally, he has scheduled tea over Zoom with his colleagues. People can also be partnered up for weekly discussions about challenges outside of work, like childcare coverage. And for small groups of employees who live in the same town, perhaps they can meet for coffee, assuming the appropriate social distancing and hygiene measures for the time and location are put in place.

In the end, Pentland explained that thinking through these dimensions of building an effective online workplace is not simply a matter of emergency preparedness. It could be central to competitive strategy and long-term success moving forward.

"This COVID thing — it's not clear how it's going away, and we may need to manage it, or the next thing like it, continuously," he said. "We need to be able to think about how we build structures that are not only resistant and resilient to economic and political shock, but also this sort of shock. We've been very lucky in the last long period of time."



CREDIT: LAURA WENTZEL

Here's how much the 2008 bailouts really cost

by **Tam Harbert**

Why It Matters

Accurately assessing the costs and benefits of government bailouts will enable future policymakers to make better choices.

Originally published Feb. 21, 2019.

Ask three people their opinion of the U.S. government's bailouts during the 2008 financial crisis, and you'll likely get three different answers.

Policymakers from that time argue that bailing out critical financial institutions was necessary to stave off an even greater meltdown. Others maintain the government should have taken even more aggressive actions — to save Lehman Brothers, for instance, or rescue homeowners with underwater mortgages. Still others say that the government shouldn't have used taxpayers' money to save wealthy bankers.

Each of those groups can find numbers to support their conflicting views of the bailouts' price tag.

In 2012, then-President Barack Obama claimed the

government got back "every dime used to rescue the banks." Meanwhile, ProPublica's ongoing "Bailout Tracker" reported a total net government profit of $96.6 billion as of February 2019, a figure that includes money paid back by bailed-out companies as well as revenue from dividends, loan interest, warrants, and other proceeds. In contrast, a 2015 Forbes article claimed the U.S. had by then paid out $4.6 trillion of $16.8 trillion in committed funds.

> *You can't know if a policy is worthwhile if you don't know how much it costs.*
>
> **Debora J. Lucas** | MIT Sloan

Redoing the math

None of those numbers are accurate, according to Deborah J. Lucas, MIT Sloan distinguished professor of finance and director of the MIT Golub Center for Finance and Policy.

Popular accounts of bailout costs tend to severely overstate or understate their economically relevant value, Lucas writes in a [paper published in late 2019] in the Annual Review of Financial Economics.

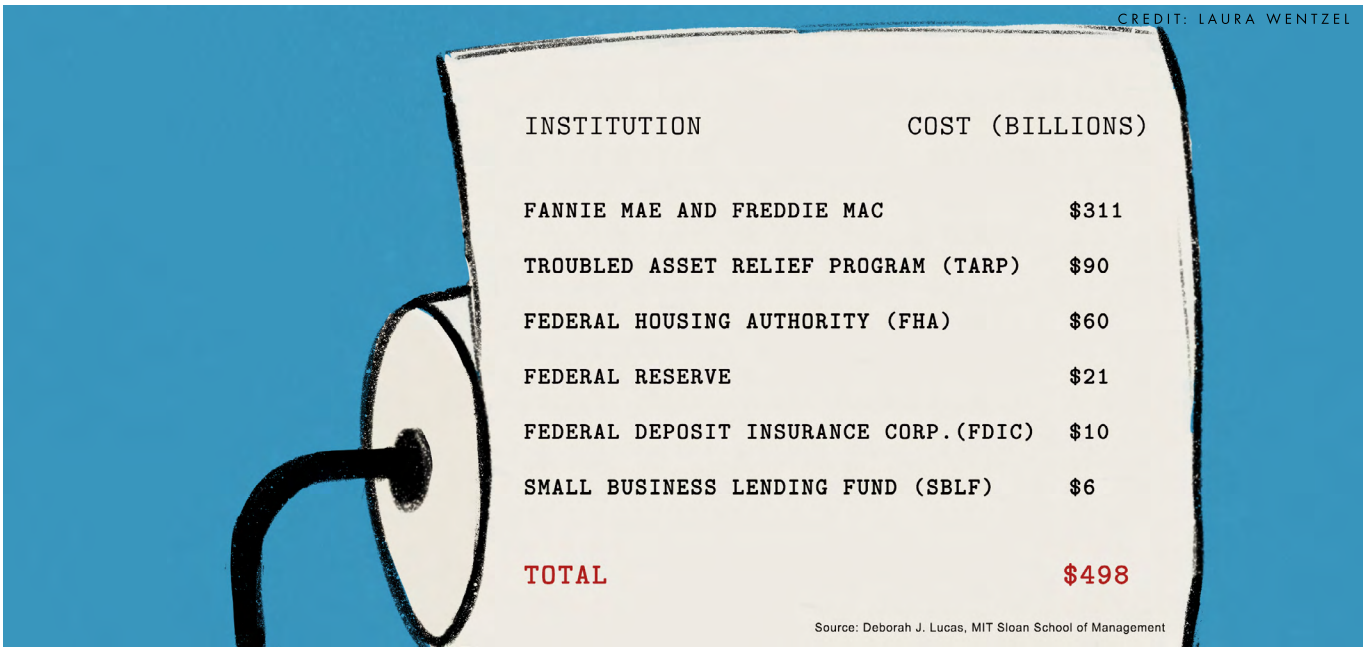
According to Lucas, an accurate measure of cost requires taking a fair value approach — one that considers the full range of future gains and losses, and that recognizes the cost of that risk. Lucas draws selectively from existing costs estimates, such as those from the U.S. Congressional Budget Office, which use that method, and she augments those numbers with calculations based on various data sources from that period.

By those calculations, the total direct cost of crisis-related bailouts on a fair value basis was about $498 billion, which amounted to 3.5% of gross domestic product in 2009.

As for who directly benefitted, Lucas found that the main winners were the large, unsecured creditors of large financial institutions. While their exact identities have not been made public, most are likely to have been large institutional investors such as banks, pension and mutual funds, insurance companies, and sovereigns.

More bailouts to come?

Why is it important to get the number right? Meaningful measurement of the



direct costs of bailouts will arm policymakers with critical information on which to base decisions in future crises, said Lucas.

And credible cost assessment may help reduce political and policy discord around fairness. "Unless we can agree on what things cost, we're not going to be able to agree on the right policy response," she said.

Public aversion notwithstanding, "most economists don't believe that we can prevent all financial crises," she said. "And that means we're likely to bail out some financial institutions in the future."

When crisis hits, policymakers have to act fast — which is why it makes sense now to study the cost and benefits of the various tools available to them.

The many new regulations put in place to prevent the need for future bailouts also require further study. "Policymakers have to weigh the costs of future bailouts against the costs of the regulatory burden imposed by trying to prevent the need for them," Lucas said.

498

Professor Deborah J. Lucas pegs the cost of the 2008-09 bailouts at $498 billion.

"We haven't had an explicit conversation about what regulations are cost-effective or what government policies could be most cost-effective in the future," Lucas said. "And you can't know if a policy is worthwhile if you don't know how much it costs."

Inventory of 2008 bailouts

Lucas's analysis of the direct costs and direct beneficiaries of the major U.S. government bailouts includes:

- **The Troubled Asset Relief Program, in which the government purchased equity and warrants in distressed banks as well as in General Motors and AIG.**
- **Government capital infusions into Fannie Mae and Freddie Mac (to this day still under government conservatorship).**
- **Government losses arising from ongoing and expanded federal loan and loan guarantee programs, including on mortgage guarantees of the Federal Housing Administration, and on federal student loans.**
- **Increased FDIC coverage (which temporarily increased the cap on insured deposits to $250,000 and created a program that gave unlimited coverage of transaction accounts to banks).**
- **Federal Reserve emergency actions designed to provide more liquidity to the market.**

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