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A Conversation about COVID-19 with Economists, Sociologists, Statisticians, and Operations Researchers

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ABSTRACT

The COVID-19 pandemic is causing economic and social change. Moderated by David Banks, the Director of the Statistical and Applied Mathematical Sciences Institute (SAMSI), six eminent scientists who study different aspects of social change and public policy came together to discuss the impacts of the COVID-19 pandemic on the U.S. and the world. The discussion took a range of quantitative perspectives on how to respond to the crisis and to forecast what challenges lie ahead. Specific topics include the role of data science, strategies for beginning to reopen the economy, the international impact of the disease, and its effect upon universities.

Keywords: cost-benefit, COVID-19, economic recovery, re-engineering work, social inequity

Media Summary

The participants in this discussion are leaders in areas of economics, sociology, statistics, and operations management that are relevant to the COVID-19 pandemic. They felt that the economic toll of the pandemic would be large, adversely affecting the U.S. and the world for years to come. Even if an effective vaccine is found quickly, some changes (e.g., telemedicine, increased working from home) are likely to be permanent. Some portions of commerce can be safely restarted now, with appropriate social distancing protocols, but other portions (concerts, theaters) cannot. Social distancing is an effective tool for reducing the reproduction number of the disease, and small changes in that figure have nonlinear impacts on the scale of the problem. It is important to get better estimates for epidemiological modeling, and for this we need disease and antibody testing on representative samples of the population. We also need to re-engineer work and other activities in ways that allow the economy to begin to slide back towards normal operation without increasing the reproduction number. As restrictions loosen, there will be patchwork outbreaks throughout 2020. Universities will face challenges to their traditional ways of doing things, but will also have opportunities to improve what they do.

This conversation took place on April 17, 2020. The initial conversation took place among everyone except Sylvia Frühwirth-Schnatter and Duncan Thomas, who added their comments afterwards.

David Banks (Department of Statistical Science, Duke University, and the Statistical and Applied Mathematical Sciences Institute) hosted the following participants:

Laura Albert, Professor in the Department of Industrial & Systems Engineering, the University of Wisconsin--Madison

Jonathan Caulkins, H. Guyford Stever University Professor of Operations Research and Public Policy, Carnegie Mellon University's Heinz College

Sylvia Frühwirth-Schnatter, Professor in the Institute for Statistics and Mathematics, Wirtschaftsuniversität Wien, Vienna, Austria

Fiona Greig, Director of Consumer Research, JPMorgan Chase Institute

Adrian Raftery, Boeing International Professor of Statistics and Sociology, University of Washington, Seattle

Duncan Thomas, Norb F. Schaefer Distinguished Professor of International Studies, Professor of Economics, Global Health and Public Policy, Department of Economics, Duke University

David Banks (DB): What do you see as the economic impact on the U.S.? How bad might it get and how long might it last? What do you see as prudent staging for rebuilding the economy?

Laura Albert (LA): This is a big question. Let's look at the aviation industry as a starting point. We expect some industries, such as the airline industry, to be severely impacted by this pandemic. Airline travel is down more than 95% from this same time last year. There are about 100,000 passengers going through security checkpoints today, versus about 2.5 million per day this time last year in 2019 (US TSA 2020). This is a tremendous change in one year.

We can see how the airlines are reacting. Most have extended their elite status programs for an extra year, signaling that they don't think much air travel will happen for the next several months, potentially longer.

When I look at the past, I have some reason to be optimistic. In the past 20 years, airline travel has always rebounded. There was true after September 11, 2001, the 2003 SARS epidemic, the 2009-2010 H1N1 epidemic, the 2002 shoe bomber, and the 2009 Brussels airport attack. The airline industry sprang back pretty quickly in terms of passenger travel. In 2018 and 2019, more than a billion passengers flew each year (US DOT 2020). Those were the two busiest years in airline travel history, and before this, the number of passengers had increased steadily since 2009 after falling temporarily during the recession.

There is an enormous thirst for travel. So many have canceled work trips, conferences, and vacations. Many are already talking with friends and family about their plans to reschedule family reunions and weddings. Conferences have already being rescheduled in the future. Airline travel will return at some

point. Once the economy bounces back, travel will more fully return. The question is how quickly the economy can return.

Fiona Greig (FG): We are already seeing so much change in retail spending. Data we've been seeing at JPMorgan Chase as of March 2020, based on credit and debit card swipes and merchant processing volumes, shows travel and entertainment spending are down, by almost 100% relative to last year; restaurant spending is down by more than 50%; and retail is down by 20% to 30% (JPMorgan Chase & Co., 2020). It's really just activity at supermarkets, wholesale clubs, and discount stores that remains roughly level relative to last year after an initial surge. When you break it out by brick-and-mortar versus e-commerce, the supermarket brick-and-mortar shops are okay, but purchases at other brick and mortar stores are down by roughly 50% relative to last year. By contrast, e-commerce has dipped a little, but by less than 10%.

These are very predictable consequences of the response to the pandemic, but it is difficult to say how things will change over time. I think we are all waiting to see whether this will be a V-shaped or a U-shaped recovery. We know from Institute data that the typical small business had about 15 days' worth of cash (Farrell et al., 2019). As the days roll on, we could see more and more business exits. Business exits don't bode well for rehires once we are back out of the house. Preventing business exits and closures is something I'm thinking about quite hard as a source of resilience. Are we going to be able to skid through this incredible pandemic, or will there be massive collateral damage?

The business loans subsidized by Congress are going out are important, but I'm not sure they are going to hit the right segments of the population, where the need is the greatest. We've already seen the first round of loans be completely spent. I worry quite a bit about the distributional equity and impacts that we are observing, in terms of communities that are doing fine and communities that are being devastated.

Sylvia Frühwirth-Schnatter (SF): I wonder what will be the impact on the social security system in the U.S.? In Europe, countries with a tight social security net, such as Denmark or Austria, managed the COVID-19 crisis so far pretty well.

DB: Jon, I think you have some ideas on how the economy can be restarted.

Jonathan Caulkins (JC): I'm in the camp that thinks the economic hits are going to be big and bad. I admit that I have a lot of uncertainty in my forecast. I don't think anybody knows what will happen, even the professional macroeconomists, because this is really different from crises that we've seen before.

My main point is that we are suffering under two false binaries that are very harmful. The first is that we are dividing the economy into components that are essential and those that are not. There are

clearly components of the economy that are critical infrastructure, such as food distribution and medical treatment, and there are components that are decidedly non-essential, such as concerts and professional sports. But the great bulk of the economy is in between.

The second binary that I think is destructive is the idea that things are either shut down, or that they are going to restart normally. I think we are going to be in the COVID-19 era for more than a year, so I don't think the language should be staging, or restarting. I think we should be talking about re-engineering our operations to be safe and sustainable in the new COVID-19 world. I think the task facing most of society is not on/off, but how do we rethink things so that we can do as much of what we were doing before as possible, while maintaining social distancing.

If you ask me what I would like to see data scientists doing, I'd like to see them focusing upon operations re-engineering. Absolutely, we should study the transmission of the virus, but there are already many people doing that. Absolutely, study the progression of the disease, but there are many people doing that. What we are not doing enough of is going into facilities and looking at how to redesign them or restructure operational protocols to make them safe.

Adrian Raftery (AR): I have just a few thoughts about staging to rebuild the economy. I agree with Jon that it's unlikely that we will avoid subsequent waves, so we shall probably be in this situation until there is a vaccine or a treatment that brings the pandemic to a halt. I think the important question, then, is to understand what would be the consequences of various kinds of relaxations of restrictions upon our economy and our lives.

There's an impressive paper that just came out from the Imperial College group (Flaxman et al., 2020). They took a transmission model, but they also looked at the various non-pharmaceutical interventions (NPIs), such as social distancing orders, lockdowns, and school closures in eleven European countries. They looked at the timing of the introduction of the NPIs and combined this with a Bayesian hierarchical model of the susceptible-exposed-infected-removed (SEIR) kind. They used this combination of Bayesian and epidemiological modeling to estimate the impact of the various NPIs in the different countries. The main finding was that social distancing was quite effective. When the famous Reproduction Number, R_0 , is less than 1, then the epidemic diminishes. They found that in most of these countries, after social distancing, the posterior distribution of R_0 includes 1, so it is not proven that it is below 1, but it is definitely reduced.

They didn't yet take the next step, which is to forecast what would happen under various kinds of relaxation. For example, what would be the like range of R_0 if we open schools, or if we open bars, and so forth. We could use this approach to study the impact of opening the economy up in various ways. I think that kind of analysis could be applied to the United States, although there are some clear differences.

To say something about the data needs, I hear from media that we need to test a lot of people. They say we need tens of thousands, or even millions, of tests. I don't think we need to test that many people to estimate the quantities needed for this kind of analysis. Instead, for that we need tests from nationally representative samples, so we can get a good estimate of prevalence by location. If we have lots of testing and invite anyone who wishes to be tested or is referred by their doctor, then we could get self-selection and big biases in the estimates. I don't think that would be very useful, and possibly even worse than useless, if it yields results that are misleading and causes wrong decisions.

We are set up to do that kind of nationally representative sample in the U.S. The American Community Survey (ACS) interviews over 150,000 people every month, and they are essentially a random sample of the population, and are required by law to respond. So all you would have to do is put a COVID-19 test on one month of the ACS and then we have an accurate picture at that time, and it could be repeated in subsequent months to track spread. That project might cost only \$10 million, which, compared to the trillions of dollars we are spending now, is not large. I think smart, representative samples are vital for epidemiologists and data scientists to assess the public health needs. New York state has just done a statewide survey, getting reasonable estimates of prevalence with only 3,000 tests. It's imperfect, but better than what we had before, which was nothing. This kind of work should be built on and extended to the nation as a whole.

DB: Social distancing is clearly important, but different regions of the U.S. are practicing it to different degrees. Urban areas tend to be much more aggressive, but there is a lot of variation (Canipe, 2020).

SF: Adrian points out the importance of testing. Several countries already performed COVID-19 prevalence studies, a pioneering example being [a study in Austria](#) on April 10.

There, it turned out that five out of 1,544 randomly selected people were infected, so we are dealing with a very small risk, meaning that standard errors are going to be small even if we consider only rather small samples. Hence, I agree with Adrian that such prevalence testing can be relatively inexpensive and can be performed for different regions on a regular basis to monitor the situation.

JC: I think we all know about the value of information from decision trees (cf. Caulkins and MacCoun, 2003). Any calculation will show that investing \$10 million in pinning down these parameters through testing is hugely justified in terms of the value of information.

DB: **There has been discussion that, at some point, the damage to the economy is worse than the damage from the loss of life. And there are related concerns: job loss often entails loss of health insurance, which could boost non-COVID-19 disease and mortality. How does one decide when the cost-benefit balance tips in favor of opening back up for business?**

JC: I think, on a chalkboard, it makes perfect sense to frame the question that way. And I would urge us and society not to. It will fail badly with the real people out there.

People are scared. They do not want to hear wonks talk about benefits-costs analysis trading off their lives. This is the first time in our lives that people have been able to go from perfectly healthy to dead in two weeks, other than from car accidents and murder. So, they are too scared to use that language.

Instead, I would urge us to think about things in terms of value created per amount of social interaction. So it's still a ratio, but you think about things in terms of how many jobs are created, how much economic activity occurs, how many goods are produced, per some measure of social interaction. Then we can assess things. If I walk into a restaurant that is now allowed to be open to make take-out, I usually see staff jammed together, far more tightly, than I see in the typical manufacturing plant. If I walk around an automobile manufacturing plant, or almost any modern manufacturing facility that is capital intensive, it is easier to maintain social distancing than it is in a restaurant.

That's an example of what I think we need to get much better at. We must think about value per unit of social interaction, allow the things that have high ratios, and re-engineer the processes to make the ratios higher. If we frame things as dollars per life, I think it will simply perpetuate the bitter and divisive political fight.

AR: Certainly economists, and to some extent statisticians, think about the cost-benefit analysis, but to do that it is necessary to have the comparison expressed on the same scale. My experience is that usually doesn't work except in a few highly stylized situations, such as when it's all measured in money and you are a stock trader. Most decisions are not like that. Generally, it is hard to put things on the same scale. Lives lost and dollars are not commensurate—certainly most people are not prepared ahead of time to try to make them commensurate. Acting as if they are commensurate sometimes enables one to reverse engineer what their utilities are, as with the method of revealed preference used to find the value of a statistical life (Viscusi & Aldy, 2003).

But I agree with Jon. A better way to proceed is to assess, for a given policy, what the likely economic benefits are, and what the likely costs are. Do those separately, and then discuss the differences. Sometimes the answer will be clear, sometimes not.

I know that there are some federal agencies, such as the Environmental Protection Agency (EPA), that do use the value of a statistical life to apply cost-benefit methods in the regulation of pollutants. Currently it is about \$9.5 million. Andrew Cuomo says that he's not prepared to reopen the economy at the cost of his mother's life, and few would argue with him. If one can evaluate the economic benefits and the health costs, then people can discuss those and often converge on some sort of balance.

FG: I'd like to add something. First, some of the public policy proposals that have been put forward try to change the math for individual workers, to make it better for them to stay home with extra unemployment income, rather than to stay at work and risk their lives. And that's appropriate. But as I think about the cost-benefit perspective, I worry that the costs are incurred by some segments of society, and the benefits accrue to others. So this is not a situation in which an individual person weighs her costs against her benefits. If this is going to be the sick, the vulnerable, and the elderly who are dying, there is no benefit that outweighs that cost for them.

SF: As Fiona points out, in a discussion about trading off economy against lives, we are talking about the lives of people who are unprotected and exposed in many ways, such as older people in institutions or low-skill workers in logistics. Hence, we are dealing with an ethical decision rather than with an economic one. Interestingly, in Europe, in most countries the discussion has been about protecting the most vulnerable part of the population, whatever it takes, and not about trading off the economy against lives.

LA: I concur with Jon and the other comments. It's not appropriate to do a strict cost-benefit analysis, and instead we can think about social values associated with various policy decisions. For example, many public parks and state parks are being closed to discourage crowds and interpersonal contact. I would argue that public parks add a lot of value in terms of exercise and enjoyment, especially to those who live in apartment buildings or neighborhoods that are not pedestrian friendly. Closing the parks means more people are cramming into smaller public spaces or to having more (now-) illegal group gatherings indoors, leading to elevated risks of COVID-19 transmission. The risks of keeping public parks open may greatly outweigh the costs of closing them.

JC: *[Laugh]* We should convert all the golf courses into public parks.

LA: The policy decision is not a single, binary decision. Instead, we will see a series of policy decisions, with different decisions being made at different times in various states and cities. We have the potential to learn from these decisions as well as their timing to inform what we know about benefits and risks. It's a natural experiment and we should learn from it to make better decisions.

Understanding COVID-19 risks as they evolve will be critical to inform decisions for loosening social distancing restrictions and opening up businesses. As a nation, we need much more testing to find the right balance as we relax social distancing requirements. We need to be able to quickly identify new outbreaks and respond appropriately. This should be achieved by expanding COVID-19 testing capacity, implementing contact tracing and testing those who have been in contact with an infected individual, regularly screening medical workers and first responders for COVID-19 with, say, at drive-through testing facilities that can quickly process COVID-19 tests, and implementing antibody tests to understand who has been exposed to the virus and has immunity. Germany, where I was with my

family on sabbatical when the pandemic began, is close to achieving this level of testing and monitoring. The United States is not. Currently, COVID-19 testing has been severely rationed in Wisconsin, where I live, with only health care providers and those with serious symptoms being tested.

SF: Laura brought up contact tracing. An important aspect that I would like to add is that people in a democracy might not be willing to accept this kind of big-brother control, which is taken to its extremes in China. Would we accept that our health status is checked via our cell phones and that we need a ‘green card’ on your cell phone to be allowed to move around?

DB: Excellent points. Some people may have privacy concerns about contact tracing. But public health officers have broad power in times of emergency to require quarantine, prevent assembly, and close restaurants (cf. Galva et al., 2005). Contact tracing is routinely used in many countries.

AR: I think the quantitative analysis from the transmission modeling and the impacts of social distancing are important because they are counterintuitive. We put in huge effort, closing down the economy, and in Europe they got the transmission rate down to an R_0 of about 1. Before that, it was about 3, which means it was exploding—every week or so, it was multiplying by three. Which means that we don’t have to relax the restrictions very much and it could easily go back up to 2. That would put us back on track towards the million or so deaths in the U.S. that were initially forecast. It’s highly nonlinear dynamics—a small change in isolation protocols could lead to hugely consequential outcomes.

JC: I predict that in every single week of 2020, there will be some U.S. county in which the R_0 is above 1.5 and the problem is getting substantially worse. So that alone can’t stop the rest of the country from getting on with life. We are going to have to start thinking about this at a smaller level of geographical granularity, and that’s a place where data analytics can really contribute. This is a big country, and it is extraordinarily diverse. New York City has half of the whole country’s cases. The rest of the country is in about the same shape as Canada. Throughout 2020, there will always be places where COVID-19 is out of control, and there will always be places where it is under control. We have to figure out how to make a fine-grained response, rather than having the entire nation or large regions of it either locked down or open for business.

FG: If you are allowing people to travel to places where it is out of control, it will be much harder to isolate the hot spots at, say, the county level. We may need a dynamic and granular approach to travel restrictions that specify no-go zones at a very local level.

JC: It is almost impossible to keep people completely contained. I worry that our fears of population movement are predicated on the image that if your county is virus-free and one case enters, you’ve got

a disaster. So, closing the borders in the first weeks when there are almost no cases might make sense, but travel between two places that both already have active community transmission may make less difference, and it substantially disrupts the kind of economy and life that we have led. It also complicates international supply chains that provide essential components for ventilators and other equipment. People will surely disagree with me about this, and I can't say that I'm 100% sure, but I worry that if a disease is already entrenched and spreading, then closing the border to valuable travel has modest positive impact and closes off important economic pipelines.

Duncan Thomas (DT): I did not understand this argument when Tony Fauci and the WHO made it in late January 2020, and I don't understand it now. I hope no one is arguing that goods should not travel across borders—they are not the key vectors. The argument is that people should not cross borders unless there is a really good reason for that person to do so. I think it is extremely important to distinguish closing international borders—and all the baggage that carries—from restricting travel across community boundaries. Isn't 'stay at home' defining the community as your home and restricting movement across that border? Local containment through travel restrictions of people outside of neighborhoods has been effective in China and Hong Kong and is being used in many parts of Southeast Asia today, but those countries are being more stringent than the U.S. The issue is not that you keep infected people out of your community but that you limit transmission by stopping infected people from travelling into a community where infection is contained. Consider, for example, if participants in the Biogen conference in Boston in late February had not been allowed to travel after the conference. At the very least, one might make inter-community travel a little costlier by testing people who travel across a community border or placing those people under quarantine (the policy in Hawaii).

LA: I'd like to return to the point about small changes in R_0 having big effects. Communicating exponential growth to the public has been and will be an ongoing challenge. If the infection rate goes from 0.9 to 1.1 to 1.3, those are huge changes that impact our healthcare system. Small changes in R_0 that result from behavior changes and compliance with social distancing policies have the potential to flatten the curve and keep the surge within our healthcare system's capacity or to accelerate the rate of infection until hospitals are at or over capacity.

We are a big country composed of many small communities. A uniform risk management policy for the entire United States does not make sense. Different communities may have to adopt different risk management strategies. It is important that all the communities understand the actions they can take to reduce the spread of the disease. Governors, healthcare experts, and public safety leaders must continue to communicate risks in the light of exponential growth and to encourage the adoption of low-risk behavior that will be effective in their communities. That will be a challenge.

DT: There has been a lot of insightful discussion about being smart about testing and re-engineering our economy and society. I am struck by the fact that this pandemic is a pandemic of disinformation or, at best, very limited data. Consider children, who make up about a quarter of the U.S. population. In mid-February 2020, the Chinese CDC reported that among those who presented with COVID-19 like symptoms, there were no deaths among those age 0-9y and a 0.2% death rate among those age 10-30y. (The death rate among those age >70y was >10%.) New York City Health reports that, as of April 14, 2020, of 6,839 deaths attributed to COVID-19, three were among those age 0-17y and all of those patients presented with underlying conditions. Assuming that children and young adults are as likely to be infected as any other demographic group, the evidence points to their presenting with serious health problems at very low rates. This is consistent with data from China which suggests that COVID-19 symptoms are less severe among children (<18y) and also in the U.S. where few children have been hospitalized. (CDC COVID-19 Response Team, April 10, 2020). If this is correct, it would seem that the primary goal of public health for this age group would be to reduce the rate of transmission from these people to those who are the most vulnerable. It is not obvious that the present discounted *social* value of the benefits to society of closing schools—or at this point, continuing to close schools—exceed the *social* costs. How effective are face masks among children of different age groups at not transmitting the virus? Are there ways to organize schools to minimize transmission? Are there ways for children and young adults to be isolated from the most vulnerable without closing down the entire school system? I am not aware of any scientific studies that are designed to provide generalizable answers to these types of questions. Yet, these answers would seem to be of first-order importance, as it is difficult to imagine parents returning to work if children are not in school (or similar organized activities), and it is hard to imagine parents sending their children to school if that results in the children and parents getting infected.

More broadly, are there ways to organize the workplace to minimize transmission of the virus that minimize loss of productivity? For some, ‘stay at home’ means productivity is reduced to zero, at least in that activity. For others, ‘stay at home’ has only a modest impact on productivity. Would it make sense to try to develop and rigorously test protocols for workplace organization that would achieve these goals for specific contexts exploiting what is known about transmission? In the course of testing these protocols, I would advocate for rigorous testing for infection and, if workers are infected, contact tracing. The evidence garnered from these experimental studies would provide valuable information as economic activity is increased. I have proposed such a set of experiments at my university, since a university is in many ways a microcosm of an economy and well-suited for controlled scientific experiments that advance knowledge. Multiple such studies that place their data in the public domain would yield an extremely rich resource that would also provide the evidence necessary to validate model-based approaches to design workplace environments and model-based transmission models as the economy ramps up. Without that data, I feel we are flying blind. Moreover, as the economy is

opened, there would be enormous value-added if survey data were collected—and made publicly available—on workplace environments (and maybe even measures of productivity) that is linked to infection rates and health of the population.

DB: What are the short-term, intermediate, and long-term social consequences for the U.S.? With the expectation that partially-effective treatments are at least six months away and a vaccine is at least 18 months away, should we anticipate significant changes in our lives?

JC: I am troubled by the language of ‘reopening.’ It implies we get to go back to normal, and I don’t think things will be normal anywhere this year. I think our political leaders should have the courage to say, “You will not be going to a concert in 2020. There should not be crowds at spectator sports in 2020.” We have to stop doing certain things until a sufficiently-effective vaccine is here. But not every non-essential activity packs people together as tightly as a rock concert. Parks to me are a great example. I want parks to be open, and I don’t think it should depend upon a public health calculation that finds that the reduction in heart attack deaths from additional exercise exceeds the increase in deaths from increased coronavirus exposure. There are lots activities that provide life-value and enjoyment without undue exposure risk. But not everything. Typical bars and nightclubs are different category. Crowded dance floors with intoxicated young people will be a thorny issue. They are highly valued by an age group that has relatively low death risk, but create a transmission risk that affects the general public health.

FG: Actually, there was a report of a Swedish nightclub that had figured out how to implement dancing with social distancing (NPR, 2020). It mostly involves song choice. When people get too close, you turn the music down or you play a boring song.

JC: Fantastic! I love the idea of re-engineering nightclubs to make them safer. I thought I had picked the one example that could not be changed.

But I think we have to get used to the idea that there are some things that are not going to come back for a year or two. If our leaders say, in effect, that we should just hold our breath for three weeks, or five weeks, and then we can safely go back to normal, that is a lie, and it will come back to haunt them because it will undermine their credibility.

SF: As we can currently see in several European countries, we will be ‘back to normal’ soon in many aspects of our life, such as working, shopping, meeting family and friends, and going to restaurants, but the effect on our cultural life will be devastating with operas, theaters, and cinemas closed for many months to come. What is even worse is that the crisis has put a sudden end to the career of so

many talented actors, artists, musicians, and many other entertainers and it will take many years to recover from this enormous loss of talent.

I also think we should be worried in general about the effect of the COVID-19 Crisis on young people. As they have been in the labor market for only for a few years, typically they are the first to be fired. Second, young people who just lost their own business might face a mental health risk when they see their hopes and dreams destroyed.

DB: How do you think things will play out for dating, or for religious services?

JC: I won't touch the dating topic, but I think one of the things we are tone-deaf to is religious experience that is deeply meaningful to so many people. Arguments that you can't gather more than 10 or 15 people together are problematic. You could have 10 or 15 people together in a cathedral and they could all be more than six feet apart. Shutting down religion, given the cultural divides, given the association of public health with the liberal side of American politics, will invite a nasty cultural backlash that will interfere with our ability to do necessary things. You've gotta say to folks that they should re-engineer their services so as to maintain social distance, but to have the state shut down religion, given the First Amendment, would invite cultural division. We have to be careful not to pick fights that take away our cohesiveness.

FG: One word that you said there that feels important is "re-engineering." Over time here, we are learning new ways to do things. As an example, I just did my first telemedicine appointment for my son, who had fallen down the stairs because both mom and dad were on phone calls. Classic—it was week one of staying home. We triaged the situation with a telemedicine visit, and everyone on the line agreed that he seemed to be fine. Nobody had to come for an in-person visit. That's the kind of thing that is a huge time-saver. I'd like that to become a permanent part of our healthcare system.

There is an enormous amount of productivity gains that could be generated out of this time. The longer it goes on, the more businesses will have to pivot, or re-engineer, to use your word., so I'm kind of excited about the opportunities. I want to see which of these new practices will stay with us as we ramp back up.

One small instance of this is that at the JPMorgan Chase Institute we have done a lot of work quantifying the Online Platform Economy ([Farrell, 2018](#)). That is things like rideshare services or homesharing. And one of the areas where there has been a lot of platform growth has been in non-transport work—the 'Uber for massage,' the 'Uber for legal services,' the 'Uber for dog-walking.' What we were seeing was enormous growth in the number of these platforms, but actually, none of these had really taken off yet. None of these had replicated the sort of adoption that we saw with rideshare.

I expect—and we shall look at this after a couple of months of data come through—that the pandemic will have been the break that they were looking for. Lawyers who might have lost their jobs are discovering they can practice remotely. Doctors, nurses, and therapists who might have been laid off or are unable to see their patients in person are discovering that they can continue providing care through telemedicine, potentially as an independent provider. There's a big supply shock going on in the [healthcare sector](#) right now—there was an 8.7% decline in healthcare workers between March and April (DOL, 2020). In the midst of all this destruction we are experiencing, there is also innovation and re-engineering that is productive for the economy, and we shall see those stay with us.

LA: Innovation and re-engineering will be necessary in the short-, medium-, and longer-term timeframes. We will slowly reintroduce activities, business openings, and social gatherings. I have been thinking about what I would prioritize to open first and last and the degree to which these businesses will have to be re-engineered. As a parent of three children who attend three different schools, I am very concerned about school cafeterias and high school football games. I agree that crowded bars may be one of the last businesses to open. I can live without bars, but I really *do* want to go to the symphony sometime in the next 18 months, even if that means we have to sit in every other row. That may be worth a small risk for me. We must fundamentally alter our spaces so we can safely have certain experiences again. I am slightly more optimistic in that I think life will eventually return to normal, but I acknowledge that it may take a long time.

In the short-term, I see many challenges. An example of a short-term challenge is ensuring that healthcare providers and first responders have personal protection equipment (PPE). The PPE supply chains have been decimated. There is a PPE shortage, and healthcare workers are reusing PPE and developing protocols to try to sanitize their PPE. The Strategic National Stockpile has only partially replenished PPE stocks and was never intended to deliver PPE for an entire nation. The Strategic National Stockpile PPE supply has been shipped to U.S. states in three waves, and the third and final wave was shipped earlier this week. States will receive supplies in the next week and then distribute them to hospitals, healthcare facilities, and first responders. After the PPE is distributed, it may be a long time before healthcare facilities have another major PPE replenishment. There are some businesses that are still manufacturing PPE components and chemicals such as polypropylene, but due to a globalized supply chains, there are still shortages of some PPE ingredients that will leave healthcare workers vulnerable for months to come.

DB: How will social changes differ by class, race, gender, and geography?

FG: We've done some historical work tracking how financial outcomes differ by race, gender, and age. We released a report that looks at how Black, White and Hispanic families differ in how their spending

changes after job loss ([Farrell et al., 2020](#)). If someone loses their job involuntarily and then receives unemployment insurance, we see that spending drops among everybody, but it drops by 50% to 60% more for Black and Hispanic families. However, if you control for how much of a liquid asset buffer they had before they lost their job, those differences mostly go away, so it has a lot to do with a person's financial footing before they experience this disruption.

I think the financial disparities that exist in people's lives also exist in their health status, co-morbidities, and access to healthcare. This is not to set aside Jon's point that there are perfectly healthy 40-year-olds who are winding up in the Intensive Care Unit, but there is something especially insidious about the economic impact of this pandemic that I think is compounding all of these inequities, in terms of who is losing their jobs. The job losses have mostly been accruing to the service sector, the low-wage sectors. These are precisely the people who can't telework and who don't have paid leave. The income losses are going to be concentrated among the Black and Hispanic and low-to-lower-middle income families. Many of these families have few reserves and will experience the largest relative spending and income drops. And this is on top of the staggering differences among races that we are seeing in terms of health outcomes. The most recent [Associated Press analysis](#) of data from select state and local governments that released victims' race showed that 42% of the deaths were among Black individuals, even though they accounted for just 21% of the population.

We know that in recessions the impact of the business cycle on individuals with little money are exaggerated, and the racial inequities were exacerbated by the last crisis (e.g. [Thompson and Suarez, 2019](#)). I think the same will be true today, even though the root causes of the two recessions are dramatically different.

DB: Adrian, how do you think a quantitative sociologist would address these concerns?

AR: The reality of sociology is that it tends to focus more on the present and the past and on existing data, than on future developments, but there are several people in my sociology department who are looking at the pandemic and trying to address these kinds of questions.

One outcome of the pandemic is that a lot of things that used to be unthinkable are now being thought. For example, recently in conversation about climate change with some generally liberal social science colleagues from around the country, I said that we university researchers are some of the worst culprits because we fly all over the place to conferences. I said we should reduce conference travel, for example by having all the conferences in a discipline in the same place and consecutive, so we only travel once a year. Several of those in the conversation, who had been inveighing against Trump leaving the Paris Accord, were skeptical about this idea, saying it would conflict with their teaching and family life. I was surprised that they were unresponsive to the suggestion, but now that the

pandemic has come, all the conferences are being done remotely, which is far more radical. We are all signing on to that as a way of doing meetings.

I think that kind of change is happening in lots of areas. Telemedicine is one example. Another is voting by mail. Here in the state of Washington, we have voted by mail for four or five years, and it's great. We have one of the highest voter participation rates in the nation. I originally didn't like the idea very much because I liked the symbolism of going to the polling station, but after voting by mail was brought in, I realized that it's the way to go. I think the rest of the nation is coming to realize that, and there are lots of fields where new ideas are taking hold.

Not all the new developments are in a good direction. Public transit is going to take a big hit, which I think is unfortunate. Another thing is international mobility. Trump said he would build a wall on the southern border, but managed to get less than 100 miles of it built. Then suddenly the pandemic came and both our borders are completely closed down with little pushback. I fear there will be a lot of receptivity in the future to limiting borders. My wife is from the Czech Republic, where for 40 years their borders were closed. Then, after the Velvet Revolution in 1989, they could travel anywhere. The Czech Republic later joined the European Union, and then they had no borders, which is amazing, but some weeks ago they closed all their borders, to keep the virus out, so they went back to 1988. The European Union has scrapped the Schengen Agreement, so its countries are now free to seal their borders and have done so.

So, a lot of things, good and bad, depending on your perspective, that used to be unthinkable have suddenly happened. I think there will be a lot of disruption of industries and of ways of doing business.

SF: An important aspect mentioned by Fiona is the heterogeneity in the reaction of people to an unexpected crisis such as job loss. While such a disruption will not have a permanent effect for some people, a recent study using model-based clustering techniques showed for the Austrian labor market that others never recover and experience a permanent career break (Frühwirth-Schnatter et al, 2019).

JC: Fiona is exactly right—there are a bunch of disparities along the lines we've talked about, such as race and class, but I think there are three disparities that are very important now, that we are not as used to talking about. One is age. Young people are losing their jobs because old people are dying. There is a stark difference in who suffers the economic hit, and who suffers the health hit. The gradient on death per infection as a function of age is really sharp.

The second is urban versus rural. We talked earlier about how an R_0 of 0.9 versus 1.2 makes all the difference. Go with common sense. If you live in New York City, or any other dense population center

with public transit, think about how many times you come in contact with someone. Then think about the suburbs, and the rural communities.

Relatedly, there are also public transportation cities versus cities with little public transportation. In Houston or Phoenix, everybody commutes in their own car, compared with Washington D.C. or New York City, where people ride the Metro or the subway. Those differences, which depend on how people live, are big compared to R_0 being 0.9 or 1.2.

The third distinction is blue-collar workers versus knowledge workers. I think it should be a little more refined than that, we should be talking about manufacturing and construction workers, who are now out of work in many places, but I think can work safely with reasonable protections and protocols. Retail and restaurant and entertainment workers are out of jobs, and it will be tough to get them back, and logistical workers, who are often poor and who face considerable exposure. We need to think about these six categories of workers differently.

I love Fiona's optimism, and how we are going to find new ways to do things, but this is going to be brutal for people with high school and lower educations, including Whites. The dynamic that led Trump to beat Clinton was that the elites are out of touch with the suffering of the blue-collar workers in the manufacturing sector. We're going to have another version of that, with the knowledge workers being out of touch with the suffering of the people who used to work in malls. We have not thought enough about that kind of political backlash, which will threaten the sustainability of whatever measures we want to put in place.

SF: I am strongly worried about the effect of COVID-19 on women. With kindergartens and schools closed, parents have to supervise their younger children and support them with their homework, often coping with working from home offices at the same time. While fathers appear more engaged than before the crisis, women still carry most of this additional workload. If this situation persists for a longer time, this might cause a major setback in women's liberation and a time-travel back to the 1950s.

In addition, I wonder what the effect of social distancing is on children. Children learn through social contacts, so what does it mean to keep distance from friends and peers in school or kindergarten? Besides, the role of children in transmitting the virus is still pretty unclear.

DB: What do you think will be the economic impact of COVID-19 on the world? What will happen to developing nations in different regions? What do you see for more developed nations? What will happen to supply chains and food production?

FG: When you compound the pandemic with the upsurge in xenophobia that allows us to close our border without anybody protesting, and which creates a very self-interested set of motives regarding supply chains, and reveals the economic vulnerabilities of a globally integrated system, I wonder if it will be a long time before the world is once again flat. This will accelerate some of the very nationalistic tendencies that have been surging. I don't see that taking any kind of a U-turn, even with a potential change in the administration.

JC: I entirely agree. It is important to note that we were far from the only country to have a populist, nationalist leader before COVID-19. Poland, Hungary, the Philippines, it's a long list. And we are far from the only country to respond to the pandemic with that kind of political shift. This isn't just a matter of Donald Trump—this attitude was already in the air in a lot of countries, and COVID-19 is amplifying that.

LA: There have been some really big shocks to food supply chains both on the demand and supply side. People are eating all of their meals at home now. Normally about half of all food production goes to people eating outside the home. That's not something we can fix overnight, since there are essentially two food supply chains for personal and commercial consumption that operate separately. Here in Wisconsin, farmers have been disposing of the milk that they cannot sell to commercial customers. It isn't that consumers are not buying milk, it is just that the milk was intended to go to commercial restaurants that are now closed.

There will be enough food to feed everyone despite the stockpiling and so-called panic shopping. As far as I can tell, most people shopped in a very orderly manner, buying toilet paper and canned goods in an orderly manner. The public is not prone to panic in emergencies and disasters. Consumers were building a stockpile of non-perishable food and perhaps buying much more than usual because they are eating all their meals at home. As a result, there are some temporary shortages.

There will continue to be shortages as supply shocks occur. Not a lot of our farming is mechanized; we rely upon people to pick many of the fruit and vegetables we eat and to work in meat production plants. These workers are at risk of COVID-19 production. Some meat production plants have been hit hard by COVID-19 and have been shut down, since plants are typically enormous, employing thousands of workers. Recently, Tyson, Smithfield and JBS shut down pork and beef plants that together process about 10% of the nation's pork. We can anticipate shortages of choice, but not shortages of food.

The toilet paper supply chain is similar in that it is split into two largely separate supply chains for consumer and commercial use. Commercial toilet paper is manufactured differently than consumer toilet paper, made with thin, recycled fibers and rolled into huge rolls that are incompatible with home dispensers. These will not be sold for home use. Americans are using approximately 40% more toilet paper at home while under quarantine and stay at home orders than before the pandemic. Again, we

will have enough toilet paper but we may not have many choices about what kind of toilet paper to purchase for the foreseeable future.

JC: Regarding the impact on the world, I don't know. Probably a lot. But I want to raise two particular issues. Will COVID-19 kill the European Union? We've already talked about Schengen. I think the chance of an Italian debt crisis is not small. I'm not sure that northern Europe is willing to bail out the south when the economy in trouble is the size of Italy's. Anyone who cares about the world economy should be thinking about whether the European Union will be around in five years.

The second thing I want to say is that, almost certainly, there will be a country that achieves herd immunity in 2020. We shall not. If you take our number of hospital beds, multiply by 365 and divide by 14, then divide by the probability that you need a bed, we cannot achieve herd immunity in a year without exceeding hospital capacity. Rich countries are not going to play the herd immunity game in the short-run, but there are poor, densely populated countries that will have no choice. And so, we shall have an international gap between some poor countries that do COVID-19 all in 2020, with 1% to 2% of their population dying, but then they're done, and rich countries which will not achieve herd immunity for some time. I think that will play out in an interesting way.

SF: I agree that what happens in the European Union is of global economic interest. Adrian mentioned that "the European Union has scrapped the Schengen Agreement, so its countries are now free to seal their borders and have done so." What indeed happened was that some European countries, such as Italy and Austria, sealed their borders *despite* the Schengen Agreement early in March, without even contacting the European Commission. Ursula van der Leyen could do not nothing but follow suit by stalling the Schengen Agreement. Another incredible violation of one of the core values of the European Union occurred when France and Germany tried to stop the export of masks and protective clothing to other Europeans countries where this equipment was in urgent need in the hospitals.

Nevertheless, I am optimistic that COVID-19 will not kill the European Union. As the crisis progressed and hit more or less all European countries, the members started to coordinate and influential leaders such as Angela Merkel made a strong commitment to the European Union.

DT: I think much can be learned from other natural and man-made disasters - including, for example, HIV in Africa. There have been many large-scale financial crises across the globe in the last two decades including the 2008 Great Recession in the U.S. All of these disasters have taken a toll on the health and well-being of the population. But it is important to also recognize that, by and large, individuals, households, and communities have displayed extraordinary resilience. For example, in the 1998 financial crisis in Indonesia, real GDP declined by 15% in 1 year. People rallied around to shore up their income, older adults literally tightened their belts to protect the nutritional status of their grandchildren and within three or four years, there were relatively few fingerprints of the crisis on

the overall health and economic status of the population. We have documented similar patterns after the devastating 2004 Indian Ocean tsunami in Aceh Indonesia, which killed 5% of the population in a matter of minutes. That said, it is important to underscore that there are long-lasting deleterious effects on the physical, psychosocial, social, and economic well-being of some survivors: identifying and providing assistance to those people should be a high priority. In addition, the deleterious impacts of these shocks do not necessarily manifest immediately but accumulate over time and present years later. I think it is difficult to overstate the importance of understanding the heterogeneity of effects within a population.

We know this because we have been following a population-representative cohort of 30,000 survivors of the tsunami since before the disaster and have collected extensive information on the health, economic and social well-being of the respondents. I find it shocking that there are no parallel longitudinal studies of, for example, Katrina or any of the other natural disasters in the United States since then. In addition to a series of cross-section surveillance studies that measure COVID-19 prevalence, it seems that following people through the aftermath of COVID-19 would be extremely valuable for science and policy. I would argue that this sort of broad-purpose, population-representative, large-scale, longitudinal data collection is long overdue in the United States. It seems to me extremely important to integrate high-quality data with thoughtful modelling to better understand the mechanisms underlying outcomes for specific sub-groups of the population and design cost-effective policies that mitigate the deleterious consequences. I imagine the CARES Act will provide plenty of case studies of what is not cost-effective.

DB: What changes do you expect at our universities?

AR: For years there's been this idea around, in kind of fringe thinking, that universities were ripe for disruption (Fischetti, 2019; Renn, 2018), but others have argued that this isn't going to happen, and that seems to be the default assumption, at least in the R1 universities (Freedman, 2019). I think the pandemic may change that. Suddenly it is being revealed that we actually can do higher education in a more efficient way. I'm at the University of Washington, which is a large and beautiful campus, but there's almost nobody there now. We are still teaching (on Zoom), the students are still coming to class, we're having faculty meetings, and our research projects are continuing.

So I think there is a vulnerability in our traditional way of doing things which is suddenly being revealed. I think it is important that we start thinking about that, in ways that are more out of the box than we have previously done. We may go back to a very different environment and need to be proactive in planning for that rather than waiting for things to change under our feet. Education is a big industry and it brings in a lot of money. If companies start to come in and find a way to sell elite higher education in non-traditional ways, it could change things quickly. So universities should be thinking about how they can reposition themselves.

On a smaller scale I think there are good things that can happen at the universities. Usually when I have office hours, especially at the beginning of the quarter, students don't come very much. Now I do office hours by Zoom and the students are coming much more. They say it's so much better—they can just jump online, they don't have to go to my office. Why haven't I been doing this for the past 40 years? Even after things return to normal, I plan to continue doing Zoom office hours as well as in-person ones—the technology works well, and students like it. There are lots of students who can't get to campus during my office hours—they have jobs or other activities.

That's a small change for the better, but universities need to be thinking about new models for the future. They're a big ball of money and they could be moved in upon by innovators who don't share our values. More positively, the new situation can give many opportunities to improve what we do and how we do it.

LA: I agree. It will not be business as usual at universities in the coming months or even years. Many university functions are inextricably linked with university facilities, which are by and large closed at the present.

In the past month, universities have made an enormous effort to move all instruction online and to adopt more inclusive online instructional practices. It has been an incredible effort. However, the role of the university goes well beyond classroom instruction. Universities also have research and service to society missions. The research mission of universities is aimed at generating new knowledge and fostering disciplinary leadership. The service to society mission takes many forms, including outreach and extension at land grant universities. It is worth pointing out that universities are still pursuing all facets of their missions during this pandemic.

Universities will have to untangle all their activities from their facilities in a way that that support their missions and values. This will take the form of online instruction, new research collaborations in virtual environments, the exchange of ideas in online conferences, and outreach to society online. It will not be simple. Universities will have to grapple with what it means to maintain excellence and standards in its educational programs; to generate new knowledge in research, scholarly, and creative endeavors; to achieve disciplinary leadership; to pioneer new fields of learning; and to foster new research collaborations. How can we achieve these goals online and remotely without face-to-face interactions and the full support of university facilities? Universities and scholars will have to make many important choices in the coming year given that the facilities are not available for supporting teaching, research, and service endeavors. The choices made will have consequences, not just for students in the classroom or professors doing research, but also for lifelong learning.

It is my hope that universities rise to the challenge and take advantage of opportunities to enhance the teaching, research, and service to society missions. Growth is always painful, but I am excited about

what universities can achieve.

FG: I was going to say I think there's another vantage point on this university question, which is the economic one. I study household finance, and student loan debt has been the fastest-growing debt category. We've been overdue for an economic reckoning for the universities on whether the cost-benefit for students makes sense. We've seen that 1 in 4 families making student loan payments is spending 11% or more of their take-home pay servicing student loans, which is a lot of money (Farrell et al, 2019). When you compound that with the economic challenges universities will be facing this fall, it will be a problem. Parents may not be willing to pay and students may not be willing to take on debt to attend college from their parents' house via Zoom.

So, you will have some people who decide to take a gap year, and some people who will decide to get their degree in some other way. Endowments are going to be way down. There will be a lot of pressure on universities to figure out how to change the math. There have already been many pressures on that math, from the growth in student loan debt, but this pandemic challenge underlines the need to revisit the math behind higher education.

LA: It gets worse. Many international students who pay out-of-state tuition are not going to be able to come in the fall due to visa processing delays. That will really impact the economic math for the state schools.

JC: I agree completely. A lot more will go on online. Prices are going to go down. Big disruption.

But I'd like to frame the problem a little more broadly, beyond universities. What are the parts of our world that will never go back to the status quo ex ante? Where will there be hysteresis? I've got a list of five. Universities for sure. Telemedicine will remain—I think we'll be doing more telemedicine than before, even three years after COVID-19 has been solved. Laura disagrees, but I think business travel may not bounce back—we are discovering that we can do business by Zoom, and I'm not sure our old strategy of losing productive days to travel will return. The fourth is malls. I think malls are deeply threatened. They were already endangered. I think a lot of them will soon be vacant. The fifth—which is probably not too important to anyone but me—is minor league sports. I think that professional sports that don't have television contracts are going to be deeply challenged by this disease. If we brainstormed, we could probably come up with five more, and I'd love to get back together and do it.

I think much of the world will return to normal after a vaccine is available, but there are chunks of the world that will change forever. Universities are at the top of that list.

DB: I'd add libraries. I think libraries were endangered before, and city budgets will be so strapped that their support will fail. Now we get books online and use e-readers.

JC: Let's return to the role of data science. I have a hope or a plea that data scientists will be open to working within modeling frameworks that include things that are not known, parameters and processes that we don't yet understand. In order for data science to be useful, it has to avoid the trap of only analyzing data that already exist. For example, data science can tell us a great deal about social interactions, how often people come within a certain distance of each other, but we still don't know how the risk of transmission depends on the nature of the interaction. We sometimes talk as if there is a deadly risk from being five feet apart, but we could lounge indefinitely at a distance of seven feet, or if one person wears a mask. It's not that simple, and transmission risks per interaction of a certain type will remain imperfectly understood until after most of the key decisions have been made. So data science needs to be contextualized within multidisciplinary frameworks that encompass things we don't know, such as spatial variation in the epidemic's reproductive number, the proportion of infected people who go to a hospital, the ratio of total infected to known infected, and so forth.

SF: An important additional aspect is how the crisis does effect younger researchers and their chance to create an international network, if the traditional way of travelling to conferences and interacting with as many participants as possible in person does not work anymore. Here the scientific community is challenged to develop formats for younger researchers such as virtual seminars. Such seminars very likely will persist after the COVID-19 crisis and will provide a new way of interacting and obtaining recognition in particular for younger researchers.

DB: We are at the end of our time. Thank you all for your insights.

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