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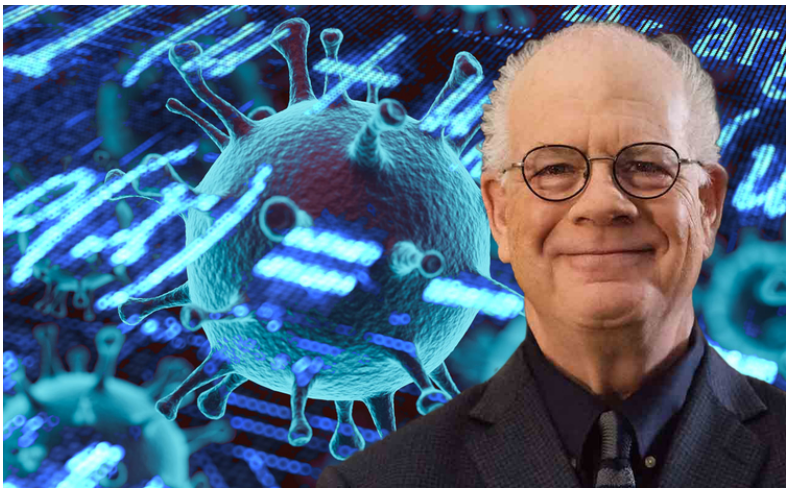
NYU's Epstein on fear and complacency in the age of Covid

Pioneer of agent-based models warns of virus resurgence akin to 1918 Spanish flu



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Joshua Epstein has spent decades creating mathematical models that make sense of human behaviour – from how juries convict, to what triggers mob violence. He does this using agent-based models: synthetic societies populated by avatars that try to replicate the conduct of everyday people.

Epstein, a professor of epidemiology at New York University, is now deploying his army of automatons in the fight against Covid-19. His models, he hopes, will help authorities make targeted interventions, such as determining who might be Covid super-spreaders and who best to vaccinate first.

The work may also give investors a clue to the future behaviour of financial markets.

An important part of Epstein's agent-based models, which he and fellow academic Robert Axtell began developing in the 1990s at the Brookings Institution, is fear. It's a base emotion that has a particular relevance in the age of Covid.

During an epidemic, "fear is your friend," Epstein says. "It's the evaporation of fear that's the problem."

Epstein's avatars, which he calls Agent Zeros, rely partly on deliberative thought when they make decisions. But he's programmed them also to experience and respond to fright. Agent Zeros also "catch" fear from one another – a contagion that in an epidemic intertwines with the actual spread of disease.

The simulations Epstein runs don't prove that fear is always the dominant force at play in the scenarios he is investigating. But they do a convincing job of matching patterns in human behaviour that otherwise are hard to explain: why a jury of individuals that alone would find someone not guilty collectively reaches the opposite view; why a crowd starts a riot when its members wouldn't act alone; why Spanish Flu came back in 1918 in multiple waves; perhaps, why financial markets crash.

Epstein calls his simulations "computational parables". One of his aims in running them, he says, is to make economists and other social scientists take 'animal spirits' seriously.

Epstein is one of a group of scientists and researchers seeking to supplant the traditional view of rational actors with more **true-to-life representations**. Their enquiries are of special interest to finance quants as they too **strive for more realistic** models of the real world.

New model army

Epstein's day job is at the NYU School of Global Public Health, where he founded and now runs the University's Agent-Based Modeling Laboratory. His previous work has ranged from modelling epidemics in the fight against Ebola, flu and Zika, to studying the collapse of ancient civilisations using tree ring data and archaeological deposits.

Epstein first encountered agent-based models through work by colleagues at the Santa Fe Institute to synthesise the growth of coral reefs. Epstein and Axtell wanted to see if they could build an artificial civilisation in a computer in a similar way. The idea was formulated "on the back of napkins", Epstein recalls. Today the method they helped develop is seen as a mature scientific instrument.

Models of all sorts, and most notably those in economics, have broadly assumed that individuals act in their own best interests at all times. Moreover, conventional models – of epidemics, markets, economies – ignore how people adapt, Epstein explains.

In doing so, the models make an implicit assumption: in the context of an epidemic, for example, they assume people will continue mixing despite the prevalence of the disease; in a financial market, they assume people will stop selling when an asset looks cheap.

But humans aren’t wired that way. And fear is one of the more obvious ways in which that’s true. “If I throw a snake in your lap, you don’t deliberate, you just freeze,” Epstein says. He tries, he says, “to offer a formal alternative to the rational actor”. His models “take fear seriously”.

> **“If there’s a huge speculative bubble, where expectations are high, that makes the shock even more surprising**
>
> **Joshua Epstein, NYU**

Agent Zero, then, is motivated by a fear module, a deliberative module and a social module. To help program the fear component, Epstein uses the Rescorla-Wagner model, which says individuals learn to be afraid depending on how surprised they are by negative events. The deliberative part is Agent Zero’s rational decision-making component. The social module aims to capture how individuals build networks of contacts – a feature missing from conventional models and critical in understanding such things as super-spreader events in an epidemic.

“It’s a departure from the canonical rational actor that dominates mainstream economics,” Epstein says. “It’s not entirely rational. It’s not optimising.”

The models are stochastic – random in layman’s terms – so Epstein must run them many times to identify patterns in the outcomes. In epidemics he observes “cascades of fear and complacency”, he says,

leading first to a suppression of the infection as people shutter themselves away from each other, then a resurgence as they mix again.

“For a long time, people wondered why there were multiple waves” in epidemics such as the 1918 Spanish Flu, Epstein says. The models provide an answer.

After the first wave of Spanish Flu policymakers thought they were “out of the woods”, he says. They relaxed measures and it “poured fuel” on the “embers” of still infected cases, he says, and “the whole thing blew up again”.

Epstein is nervous about the likely path of the current pandemic. He sees a second wave of infections in the US as likely, as fear wanes and people become complacent about social distancing. The return of children to school is another possible trigger for infections. So Epstein advocates mandatory mask wearing and social distancing.

Soldiers suffering from Spanish flu at Camp Funston in Kansas in 1918

Another concern for Epstein is vaccine refusal. During the Swine Flu outbreak in 2009 and 2010, only about a quarter of Americans were vaccinated despite a programme aimed at reaching far greater numbers. The influence of the anti-vaxxing movement in the US and further afield threatens to undermine government efforts to encourage vaccination, should an effective treatment become available.

Right now, Epstein is using his models to try and identify possible signatures of impending Covid flare-ups. He’s working also to incorporate Twitter and geolocation data into the models to track changing levels of fear and see how much social distancing is happening.

“We want to be poised to say something about vaccine refusal and disease resurgence,” he says. “If we can calibrate the models, and then run experiments on different levels of vaccine refusal, we’ll have a credible basis for insisting that minimum levels [of vaccination] be met – or at least for arguing that we’ll face serious risks of resurgence if not.”

When it comes to such programmes, the models could help identify the characteristics that make someone a super-spreader, say, so they could be targeted for immunisation, Epstein thinks.

Financial contagion

Epstein hasn’t yet applied the models directly to financial markets and says the drivers at play – in addition to fear – warrant investigation. “But there’s a strong case for introducing this type of behavioural epidemiology into the study of financial dynamics,” he says.

In March he spoke at an OECD conference on the twin contagion of coronavirus and fear-driven selling in financial markets. He argues that the analogue to financial panics is direct.

“There’s a real fall in actual fundamentals, like a recession,” he says. “But there’s also contagious fear of a further collapse. And that stimulates sell-offs.”

The more surprising an event, the scarier. So the further markets move from fundamentals – in August the S&P 500 price-earnings ratio reached its highest level since December 2009 – the greater the fear when the market turns.

“If there’s a huge speculative bubble, where expectations are high, that makes the shock even more surprising” and that generates a bigger spike in fear, he says.

Epstein has other ideas on how the models can be used. He’s working on an addiction module, for a new agent that he refers to as “Addict Zero”. The module is constructed to reflect the neurobiology of addiction, Epstein says. Exposure to addictive substances causes changes at the neuronal level in the brain. And with repeated exposure the social and deliberative components of the model increasingly are eclipsed by the biological need.

Elsewhere, Epstein continues to contribute to the OECD’s New Approaches to Economic Challenges initiative on modelling complex economic and financial systems. That group was formed after the financial crisis to explore how to protect economies and markets from the kinds of risks it’s hard to foresee – whether a Lehman-style banking crisis or a global outbreak of disease. Agent-based models and an understanding of fear and other human emotions will likely play a big part.

Editing by Alex Krohn
