Economic Effects of Pandemic Influenza
Dr. Lester Lave and Dr. Elizabeth Casman, Carnegie Mellon University

The purpose of this work is to estimate the effects of a pandemic influenza epidemic on the U.S. economy. Previous models, such as the Congressional Budget Office report, assume that revenue will be lost in various sectors due to people deciding to curtail activities such as theaters, restaurants, and travel. Compared to the 1918-19 economy, the US economy has become “just in time” with modest inventories; it is completely dependent on gasoline and diesel fuel for travel, and has many high skilled jobs that can be performed only by a small group of workers, e.g., nuclear power plant operators. This means that the 2007 economy is more “brittle”, less resilient, than the economy of a century ago. Quantifying this brittleness requires identifying the significant losses associated with the interruption of supply chains that would result from large scale worker absenteeism.

We have completed a model of pandemic flu. In our model we assume that up to 10% of the population would be ill at the peak of the pandemic, that schools would be closed, and that many workers would be unable or unwilling to report to work because they were quarantined, performing child care, treating a sick family member, or were unwilling to risk infecting their family by reporting to work. We have developed an analytical framework for combining the information we are gathering.

We are in the process of studying the implications of pandemic absenteeism on critical segments of the economy: (1) infrastructure such as provision of electricity, drinking water, sewage disposal, and trash collection, (2) critical products and services such as food and telecommunications, (3) access to health care, including hospitals and emergency rooms, clinics and physician offices, and pharmacies, and (4) fuel, such as natural gas, fuel oil, gasoline, and diesel.

We also need to quantify the interdependencies of the sectors in supplying essential goods and services explicitly. Many products and services have long supply chains, e.g., buying a carton of milk requires a dairy farmer, feed for the cows, electricity to milk the cows and refrigerate the milk, raw milk pickup, milk processing and packaging, finished milk delivery to stores, and operating retail stores. If any part of the supply chain is disrupted, the product will not be available. If there is a lengthy delay in any part of the supply chain, the product may spoil. If there is no electricity, the cows cannot be milked, and the milk cannot be processed or kept refrigerated. If there is no diesel fuel, the cattle feed cannot be delivered and the milk cannot be transported. The supply chain for pharmaceuticals and other medical supplies is even longer.

While the likelihood may be small that any part of the supply chain will be disrupted by worker absence, the likelihood is high that some part of the supply chain will be disrupted. If having any one part fail means that the product or service will be unavailable, it is highly likely that some critical parts of the economy will be disrupted.

Good planning, an inventory of worker skills, various stockpiles, cross-training, and other actions could ensure that the essential parts of the economy continue functioning. For example, with 10% of people ill, schools closed, etc., half or more of the workers could fail to show up to work. If this is a random selection of workers, it seems all but certain that essential services would be disrupted with high costs to the economy; still more important, the economic disruptions would cause significant increases in the mortality rate.
Quantifying the effects of shortages of personnel and materials in the health sector is complicated, disease-specific, and a function of the length of the disruption. A flu pandemic would not stop all the usual health problems, from heart attacks to broken bones. People with chronic diseases who are dependent on medication, from insulin to oxygen, would need continued access to these supplies. At the care-provider level, if the hospitals lose electricity or run out of pharmaceuticals or if standards of care have to be degraded, additional morbidity and mortality would be inevitable.

In order to understand pandemic influenza business continuity plans in the electrical generation sector, we have interviewed the Duke Energy emergency preparedness officer and the Head of the flu pandemic task force at the Edison Electric Institute. Both are reluctant to give us any numbers without DHS approval, and such approval is being sought.

To learn about the relationship between patient demand and degradation of service in the hospital center, we have met with Kathleen Criss, UPMC Director Disaster Management Center, Charles Mackett MD, Assoc. Prof, Exec. Vice Chair Dept. Family Medicine UPMC, and Eric Toner, MD Senior Associate with the Center for Biosecurity of the University of Pittsburgh Medical Center (UPMC). We learned that UPMC is leading in planning for a pandemic. In Pennsylvania a Governor’s task force has run statewide pandemic response exercises. UPMC is being helpful and cooperative.

Contacts have also been made (or initiated) in the Department of Homeland Security.

We continue to work with Donald Burke, MD and Bruce Lee, MD (University of Pittsburgh School of Public Health). They are preparing to run Ferguson’s pandemic simulation model (Nature, 2006.442:448-52) specifically to answer our questions concerning the timing of workforce absenteeism and demand for medical care.

We have found serious disagreements about the effects of a pandemic on the degradation of hospital services between Dr. Toner and Dr. Lee. These cannot be completely resolved, but we will capture the differences in the simulations.

The range of assumptions that the physicians regard as plausible could lead to a large scale shuttering of the economy for at least three weeks. We have identified critical weak points in the system, such as the fact that some well-prepared hospitals have only 2-3 days of fuel for backup generators. If the electricity is off for a longer period and if they are unable to obtain diesel fuel, there will be large problems. We are investigating inventories of critical medical supplies and there appear to be major difficulties, as well as bottlenecks in getting additional deliveries.

We have also made good progress assembling and evaluating the literature on the effects of drug discontinuation for the medical conditions responsible for the greatest mortality in the United States.