The Economy and Self-Organized Criticality

by Matt Wilson

Many different complex systems experience self-organized criticality with collapses that follow the power law distribution. These include forests, sandpiles, financial markets, wars, earthquakes and more. Looking at how some of these systems actually collapse can give us insight into the economic collapse of 2008. They suggest that society has two choices: small and intermediate collapses, or big collapses. The suppression or mitigation of small and intermediate collapses means that much bigger collapses will occur instead.

In the summer of 1988 Yellowstone National Park experienced a fire unlike anything ever seen before in that park. Initially, there was no indication that this fire was going to be exceptional. It started off like any other fire, but by the time the fire was ultimately put out over 1.5 million acres of land was burned. Prior to that fire the biggest fire ever recorded in Yellowstone was in 1886 where 25 thousand acres burned. Between 1886 and 1988 the policy of the forestry department was to put out or mitigate every fire (stabilize the forest). Paradoxically, this policy pushed the park into complete collapse.

In 2010 economists are trying to figure out how they can prevent the next collapse. When the U.S. financial system was prevented from collapsing in 1997 (the Long Term Capital Management collapse), we got the tech market collapse of 2000-02. When the Fed did everything to mitigate the collapse of the tech market, we got the housing bust of 2007-09. When the housing bust turned into the global financial crisis, the government did everything it could to mitigate the collapse. Now many are wondering if we will experience a double-dip recession in 2011-12.

The process by which some complex systems automatically go from a stable state to a critical state is called self-organized criticality (SOC). The overall system provides a feedback loop over time that drives the system to collapse. The distribution of collapses by size follows the power law distribution (Pareto's distribution). A graph of the power law looks similar to a bell curve, but it has fat tails.

Understanding System Feedback

Systems that exhibit SOC include properties of system feedback. System feedback occurs when the current system environment, including history, at least partially influences future events. Buying a stock after checking a chart of past prices, or moving to a city based on its size are examples of system feedback.

An example of a system that does not include SOC would be a marble pile. The marble system is not able to transmit historical information to new marbles being added. The newly dropped marbles just roll off most existing marbles. Sandpile systems do exhibit SOC.

In 1998 several geologists decided to develop a computer model of how forests work. They built a computer model with squares, and randomly placed trees on the squares. Each tree sprouted new seedlings in the surrounding squares from time to time. System feedback occurs because new trees can only grow in blank squares. The computer randomly dropped matches on squares from time to time.

When a match hit a square with a tree in it, the surrounding trees were burned up as well. If a tree was relatively isolated then the fire wasn't able to spread. However, as surrounding trees proliferated, the probability of large fires grew. Eventually, the board would reach a critical state where one match could literally wipe out everything on the board.

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Then the geologists started playing around with the rate that matches were dropped. For example, what would happen if you slowed down the rate at which matches were dropped – effectively the same as putting out fires? They found the small fires decreased, but very large, critical state (supercritical) fires increased.

Scientists also looked at computer sandpile models. The modeling of sandpile collapses also follows the power law just like forest fires. System feedback occurs because new grains of sand must land on top of prior grains with minimal rolling. If you color code areas of steepness, then you can see fingers of instability develop over time which connect one area with another. This ensures that a collapse in one area will be transmitted around the entire sandpile. The exact cause of a collapse is unimportant. It is the state of the sandpile system before the collapse that is most important.

In a July 22, 2010, article titled, "Agents of Change", *The Economist* magazine discussed how economists have been looking at agent-based models to better explain how our economy works. An agents' behavior is partially influenced by interactions with other agents. The effect of herding, commonly found with investors, is automatically modeled in an agent-based model. Effectively, agent-based models seek to model how the interaction between people—system feedback—affects future behavior. It is this type of feedback that drives markets to collapse over time.

Understanding Collapses

A system will reach a pre-collapse state before a collapse actually occurs. However, once it reaches a pre-collapse state the damage has already been done even though no collapse has actually occurred. Trying to suppress a collapse from a pre-collapse state will make the system unstable and prone to larger collapses in the future.

Current U.S. government policy is to place a put option under the economy in order to create economic stability. The U.S is not alone in seeking economic stability. European countries, Japan and China all seek to maintain economic stability through the suppression of collapses.

Japan's lost decade(s) is an example of an economic crash that has been heavily mitigated. China may be in an even worse situation. It needs to consistently produce a yearly economic growth rate of 8 percent or more in order to maintain a stable society. This requirement pretty much puts China on the expressway to a supercritical crash. We may see this sooner rather than later because China's real estate markets are overheated and may come crashing down in the next year or two.

What is the solution to economic collapses? Embrace small collapses in order to avoid large collapses. Consider forcing a collapse if a natural collapse has not occurred within the last five to seven years.

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