Catastrophic Risks: The need for new tools, financial instruments and institutions

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The tipping point: Katrina exposes a new trend

We live in a world that is increasingly uncertain. For the first time in history humans dominate the planet and yet, paradoxically, the success of globalization has increased the risks we face.

Nature has raised the stakes. In 2004 a record number of hurricanes and typhoons struck Florida and Japan. This month hurricanes Katrina and Rita delivered a one-two punch to New Orleans and Texas, tragically destroying thousands of lives and causing up to $400 billion in property losses.

While people watch TV screens in shock and disbelief, scientists forecast a new global trend. Hurricanes that could impact the US are increasing in strength and frequency. Many believe that we are entering a new geological cycle and that the increased storm volatility is caused by the warming of the seas, part of an overall pattern of global warming. We may need to brace ourselves for several decades of more frequent and intense floods, hurricanes and typhoons. We need to prepare for an increasingly dangerous physical environment, and we need to do that fast.

Katrina suggested the need for new thinking about catastrophic risk. The magnitude of the hurricane made it one of the largest economic disasters the country has ever faced, with up to $200 billion in losses. Those most affected were black families and lower-income groups, the most vulnerable segments of our society. This comes at a time of increasing economic risks faced by families all over the nation, and year-to-year family incomes that have suffered increasing fluctuations since 1972.

Many agree that catastrophic risks such as Katrina require a united front and organization, calling for new forms of public action and new roles for governance. Yet two decades after the Reagan revolution there is deep mistrust for public action and a fragmented decision-making process. This leaves matters increasingly in the hands of local governments who may not be equipped to deal with large-scale problems. The prevailing logic says that private action is best and that going alone is always better. National unity has reached a record low. George Bush's presidency has undermined multilateralism, and international cooperation is also at its lowest point in the nation's history. There is an enormous gulf between what is needed and the current social perception of how to find a resolution.

I will argue that the magnitude of the new risks we face calls for new forms of social organization and tools for decision making in periods of uncertainty. It requires new types of financial instruments and institutions, and leads us to rethink public action and the role of governments.

The new catastrophic risks

Hurricane Katrina suggests the need for new thinking about catastrophic risks. After Katrina everyone recognized that strength comes from unity and that we need each other in the face of tragedy. The message was clear in President Bush's speeches that called for national and international unity, and in the responses of people across the nation. In practical terms, a catastrophe of that size and scope requires a commensurate response.

But there was no organized national effort, no unified response to deal with the tragedy. The various authorities involved were not prepared to work with each other, leading to conflicting signals between local and federal agencies and paralyzing their efforts. In the end, the inadequate response to Hurricane Katrina was almost as shocking as the event itself. Lack of coordination and unexplained slow response time may have taken many lives unnecessarily. To the physical catastrophe was added a human-induced catastrophe. As President Bush said, the response was inadequate. We need better forms of social organization to face catastrophic risks.

Human factors have magnified Nature's shock in other ways as well. We had clear warning signals about the danger posed by New Orleans' levees, and discovered that a $200 billion hurricane loss could have been averted with an $18 billion investment beforehand. Yet our tools for decision-making in conditions of uncertainty failed us. We clearly underestimated the risks and the costs of doing nothing. We were not prepared.

New tools are needed to properly evaluate the risks that we face in many parts of the US and globally. New financial instruments and institutions may be needed to compensate the victims as appropriate, and to provide incentives to prevent catastrophic losses whenever possible.

We need to rethink our ways to hedge the economic risks we face by focusing on the family, the first and the most basic of all risk-sharing institutions.

Today the American family is under stress, a victim of the social uncertainty that we all feel. Although many advocate family-oriented values, the overall economic pattern has undermined rather than reinforced the family as a safe haven. Recently Jacob Hacker (2004, 2005) has shown that year-to-year family incomes have suffered increasing fluctuations since 1972.

The law of large numbers and opportunities for action

The twin hurricanes and the forecast of increased frequency and intensity of hurricanes could cause a tipping point for the nation that will enable us to rethink the role of public action and governments. Adversity can bring people together. After Katrina there was a strong show of national unity in the face of tragedy. If it helps to bring us together, the tragedy could become a blessing in disguise. Human evolution shows that a response to adversity is the creation of human bonds. The family emerged because people are better off as part of a team than alone when facing a hostile physical environment. Countries exist because they protect their citizens, who are better off together than apart. There is a solid scientific and business basis for unity under uncertainty, and it is called the *law of large numbers*. It says, roughly speaking, that there is safety in numbers.

All of us might worry about the risk of being in a car accident, but the total number of annual accidents across the nation is known because of the law of large numbers. This allows us to insure appropriately against car accidents so the risk is covered. It also provides an incentive to create seat belts and equipment safety laws that help preclude the risk in the first place. None of us know when we will die, but in large populations there is statistical certainty about life expectancy. We create actuarial

tables that are the basis for life insurance in all its forms. This allows us to insure our lives, and to cover the risk for our loved ones. It also concentrates our attention in preventing health risks that could be fatal.

Larger is better because, generally speaking, size removes uncertainty. The larger the group, the better the law of large numbers operates. (I am leaving aside for the moment the risks that arise from greater connectedness, which increase with the size of the group and will be discussed at the end of this essay.)

Large size can also increase profits. By reducing uncertainty, size can decrease costs. Indeed supply chains work better when we can anticipate what is needed and when. This is the basis for the 'just in time' inventory process that reaped enormous profits and reshaped the car industry around the world. It is one reason for the success of Wal-Mart. A car dealership cannot predict the number of cars that will sell in each location, but a chain of car dealers using the law of large numbers can predict demand better, buy inventory and supplies in bulk and increase profits. This is also a reason why large drugstore chains outperform independent corner drug stores everywhere, and why the corner store is almost defunct.

It can be said that the law of large numbers is behind the success of *mass production* that led to the consumer economy in the 20th century, and of *mass consumption* that led to the information economy in the 21st century. The bottom line is that there are *profits* in numbers. Social unity can be a profitable proposition. This is one of the reasons governments are needed and can be effective, because they can work like giant insurers that use the law of large numbers to hold society together for everyone's gain. The use of federal resources to provide relief to disaster areas across the nation – the role of the federal agency FEMA – follows this logic.

The law of large numbers is a powerful rationale for public action. By decreasing uncertainty it improves welfare. It helps us rethink the value of unity under adversity, and provides an undisputed role for governments and for public action all over the world.

In addition the law of large numbers creates a basis for profitable cooperation between the *public* and the *private* sectors. Financial institutions such as Fannie Mae and Freddie Mac have partly private and partly public objectives. As the second largest and most profitable financial institutions in the US, they offer liquidity for the mortgage market, even though they do not offer mortgages themselves, using the private sector for this purpose. They maximize profits by bundling large numbers of mortgages across the nation, thus reducing risk. The government's role is to direct the use of the profits to make mortgages available to lower-income families. By decreasing social uncertainty, the law of large numbers behaves as a 'public good' that benefits us all.

The benefits of large numbers cannot always be reaped by the private sector on its own. The government must ensure the transparency of such large financial institutions, which bundle the assets of about 40% of the nation's housing market. Any institution that achieves the size and nationwide scope of Fannie Mae and Freddie Mac runs the risk of creating a national monopoly, with the potential corruption and loss of welfare that such monopolies create. Therefore public intervention

of one type or another is needed. Here is a natural opportunity for public action. Consider, for example, the worldwide infrastructure projects that serve huge numbers of people such as the Internet. This was a public investment by the US military that provided a magnificent public infrastructure leading to innovation, private initiative and entrepreneurial profits around the world.

The law of large numbers can also help avert human-created risks, which are an important source of uncertainty. In the last twenty years the average family has faced sharply increased economic uncertainty. Some of the social institutions created through the New Deal to insure against extreme economic volatility are at a low point, some of them by design; and rather than modernize it, we have in many cases eliminated the social net and have gone against the benefits of the law of large numbers by attempting to privatize social risks such as social security (Hacker 2004, 2005). Privatization often decreases the size of the pool, and therefore undermines the benefits gained by pooling resources.

Barriers to perception and action – and how to overcome them

An increasingly threatening physical world and heightened social risks call for unity and cooperative public policies. They highlight the importance of public action in putting to work the law of large numbers, which is the foundation of risk-sharing in all its forms. Yet as mentioned above, there is a profound disconnect between the problems we face and the solutions we need. The nation is currently experiencing a period of deep mistrust of public action of any sort. This conflicts with the need to achieve social unity and cooperation in the face of increasing risks at the social and physical levels. The result of this conflict is that rational discourse cannot proceed and many people seek religious approaches instead.

An additional barrier to dealing with risks is their unequal distribution across lines of income and gender. It has been shown that women bear the brunt of their family's economic risk. Female-led families account for most bankruptcies in the US today, as shown by Elizabeth Warren in her essay. Hacker (2005) has also shown that the volatility of women's year-to-year income is larger than men's. In addition, and to the extent that some of the most important family risks are related to illnesses and divorce, women bear these risks disproportionately more than men across the nation as a whole.

To achieve unity, we must all pitch in and share the burden for the risk. Yet the Katrina tragedy revealed a dividing line through income, and race, as the statistics on poverty, literacy, bankruptcies, and the bearing of income volatility demonstrate. There is also a major division with respect to gender: it seems fair to say that women bear the brunt of social risks today, and women bear and raise the children who are our future and the ultimate public good.

In addition, the transformation of the economy itself in the last ten years has created new forms of instability. Recent years have seen a palpable increase in business disruption caused by terrorism and geopolitical events, as well as globalization of supplies. We now know (Chichilnisky and Gorbachev, 2004) that knowledge driven

sectors like telecommunications, finance and electronics create most new jobs, but tend to magnify the business cycle, expanding faster than the rest in an upswing, but also contracting faster in a down market, which leads to widespread bankruptcies and layoffs. As the most productive sectors in the economy today, they can be expected to expand while others shrivel, causing economic volatility to become a regular trend.

The challenge ahead of us is to harness the deep need for unity in practical values and consensus for appropriate public policy. We need to create new institutions to avert the new types of risks we face, and make the ones we already have work for us as they should.

This task should start from the logical foundations of the current disconnect, and build a more practical base. We need a solution that takes the real risks of catastrophe into account. Appropriate responses must be devised in the forms of precautionary investment, financial instruments and institutions that can hedge the risks. Yet current practices in economics are known to ignore rare events no matter how real and catastrophic they could be. Economics thinking must provide new tools to measure, anticipate and invest in catastrophic risks of all sorts. The received wisdom is part of the problem, and new thinking must be part of the solution.

Traditionally economists use 'expected utility' to decide when and how to take action in the face of uncertainty. This idea originated about sixty years ago from axioms that describe how humans choose in conditions of uncertainty, drawing on the work of such leading thinkers as Arrow, Von Neumann, Morgenstern, and Milnor. These ideas had an enormous impact the world over; related cost-benefit tools are routinely used in Congress to evaluate projects and appropriate funds. But in retrospect these tools underestimate and disregard rare events that could have catastrophic consequences. This has led to the inability to evaluate catastrophes appropriately, and to make profitable investments ahead of time before the catastrophe strikes. It may prevent us now from a realistic evaluation of these risks and therefore preclude investment to shore the US east coast, now facing the same risks as those that devastated New Orleans. The neglect of rare events by existing methods has led to increasingly paradoxical predictions and to the creation over time of a new agnostic field of 'behavioral finance' that questions the very hypotheses of 'rational' agents.

Human rationality is not, however, the issue. The issue is that traditional thinking neglects rare events. New foundations are needed to correct this neglect.

Before proposing solutions, and in the spirit of full disclosure, I must acknowledge that this has been the focus of much of my thinking and work for a number of years, and therefore there may be a bias in my thinking and in offering solutions. Robert Shiller's excellent work (2003) has been oriented to offer new financial mechanisms and institutions that can insure against social risks of various sorts.

New axioms explaining how people choose in conditions of uncertainty have been introduced that give a more realistic weight to rare events (Chichilnisky 2000). These axioms are intuitively appealing. They seem to agree in simple terms with the way people think, and at the same time resolve many outstanding paradoxical results in economics, such as the discrepancy between the returns on equity and bonds that are predicted by theory and what has been historically observed.

The new axioms imply decision criteria that account for catastrophic events. They show that we do not make decisions based on expected utility alone, by averaging risks. Now extreme risks are singled out, and they are given a proper weight in our forecasts and decisions. This provides a strong and simple basis for applying the law of large numbers to deal in practical terms with our widespread uncertainty at physical and social levels today. It suggest new tools and social organization, financial instruments and institutions to hedge against catastrophic risks, to compensate the victims, and even to create incentives to minimize the impact of the risks in the first place.

Correlated risks and new management approaches

We saw how the venerable law of large numbers, with its longstanding role in scientific and business thinking, can be used to create new tools and financial instruments and institutions, particularly when dealing with catastrophic risks.

Yet there are cases where the law of large numbers has limited use: when the risks are interconnected and correlated, as is the case in large catastrophes like the tsunami and Katrina. The outcome of the law of large numbers depends on the relative size of the pool of people affected over the total population, and therefore may require sharing the risks across nations. How should a single nation respond?

Another version of the same problem arises with those global risks – such as global warming – that simultaneously impact everyone on the planet. Biodiversity and global access to clean water are similarly interconnected problems. In these cases the law of large numbers may not be adequate in and of itself because the risks are correlated, impacting everyone at the same time (Chichilnisky and Heal, 1993). We need to complement it with other financial instruments that allow us to hedge the risk at the same time as they create incentives to prevent the risk itself. This is a somewhat ambitious goal, but it was nevertheless achieved by capping CO emissions on OECD nations and creating a global market for emissions trading, the author's proposal (Chichilnisky 1994, 1995, 1996, 2000), that became an important part of the Kyoto Protocol. Similar markets exist at a local level in the Chicago Climate Exchange, part of the Chicago Board of Trade. This market-based solution has the characteristics required, and its trading was sanctioned by international law in January 2005 when the United Nations Kyoto Protocol was ratified, leading to a traded market value of over $150 billion at last count.

There are other proposals for new financial instruments that can complement standard insurance policies when the risks are not global but are still strongly correlated. For example, 'catastrophe bundles' were instruments created by the author for this purpose in 1997. Related instruments, called catastrophe bonds, have been traded in the Chicago Board of Trade for some time. In these types of risks the correlated part of the risk is hedged through securities, while the independent risk is hedged through insurance in a carefully balanced fashion.

How does this work? Correlated risks are hedged through securities by taking advantage of *negative* correlations. For example, most earthquakes in California are followed by a boom in the construction industry. Therefore appropriate securities can be created that hedge the correlated risk by investing in the construction industry. This has clear implications for hedging catastrophic hurricane risks. The rebuilding efforts in New Orleans following Katrina will involve hundreds of billions of dollars in local and federal funds and in private donations throughout the nation. By carefully structuring insurance and security contracts, the Katrina victims could therefore be compensated for their financial losses through the negative correlation between the catastrophe and the value created by rebuilding efforts. Without the appropriate institutions and financial instruments, however, the benefits of reconstruction are likely to go to others, exacerbating rather than sharing the risks. This is why we have to put new financial instruments and institutions in place before the catastrophe strikes.

With respect to the economic risks from unemployment and market volatility that increasingly affect the American family (Hacker 2004, 2005), a recent proposal (Chichilnisky, 2004) was the creation of a 50% private - 50% public institution that would bundle corporate bonds the way that Fannie Mae and Freddie Mac bundle mortgages. This would allocate the profits that derive from the law of large numbers to provide liquidity for risk capital accessible to small companies. Small companies are the largest source of newly created employment in the US, the OECD nations and the world as a whole. The institution provided would therefore help to smooth the increased risk that arises from the volatility in the knowledge sectors of the economy (Chichilnisky and Gorbachev, 2004).

Conclusions

Independently from the specific management tools proposed, the ultimate goal is to build on the principle of unity and on the law of large numbers as well as on the various other financial instruments and institutions that encode this principle.

Private enterprise must join forces with public policy in appropriate ways to strengthen current institutions. The goal is to conquer the increasing risk that families and societies are exposed to, to shore up our existing risk-sharing institutions and to design the institutions of the future for everyone's gain.

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