Centralization versus Decentralization in the Regulation of Terrorism, Natural Hazards and other Large-Scale Risks

by Jason Scott Johnston
University of Pennsylvania Law School

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I. Introduction

To even the most highly erudite and perceptive contemporary commentators, the early twenty-first century has seemed a time of unprecedented impending doom. Normally the most clear-eyed and dispassionate of observers, Judge Richard Posner has recently cried the alarm over our – meaning the human species – failure to adequately take precautions against a lengthy list of doomsday risks. Posner worries about an entire range of risks, both those arising from natural causes – such as asteroid strikes – and those arising due to either intentional or accidental human agency – such as terrorist attacks, human-induced climate change, and various sorts of space-time disturbances caused by out-of-control particle accelerator experiments. In typical legal fashion, in arguing for the seriousness of the risks he discusses – which include even such things as a potential world takeover by cyborgs – Posner relies upon authority, in this instance no less a scientific authority than Sir Martin Rees, England’s Astronomer Royal. Sir Martin has recently published a book that does indeed describe and take very seriously many of the risks that concern Judge Posner. The kinds of risks that concern Posner and Rees share two characteristics: they involve very low probabilities of very large, generalized (often irreversible) harm, and (for most) are not recognized let alone being well understood by the general public. Like many other scholars, perhaps most notably Cass Sunstein, Posner argues that democratic regulatory processes have a very difficult if not impossible time in coming to grips with such complex, low probability but potentially catastrophic risks. He argues not only for more precautions, but for institutional reforms that would facilitate recognition and increased levels of precautions against doomsday risks. For the most part, Posner’s reforms call for greater centralized regulation of the development and use of risky technologies. In this, he is hardly alone, for whether the problem is global warming, species extinction, terrorism, or hurricanes, the default position of the vast majority of commentators of all professional stripes is that the possibility of generalized, widespread harm not only justifies but requires increased regulatory centralization.

The purpose of the present article is to rigorously question the view that the proper incentives for precautions to lessen the probability of large scale, doomsday risks can only be realized in a centralized regulatory system. Using the tools of elementary game theory, I argue to the contrary that in many situations – including plausible scenarios involving terrorism and other instances of joint security as well as natural hazards – there are strong local incentives for ex ante precautions to lower the probability and/or magnitude of large-scale risks. This same analysis reveals cases in which local incentives for precautions against such risks fall short of the globally optimal level. In such cases – such as that which arises when a small jurisdiction with relatively less to lose from hazard realization free-rides upon the hazard reduction efforts of larger, higher stakes jurisdictions – some form of inter-jurisdictional bargaining involving cross-subsidization is necessary to harmonize local and global incentives. While there are obstacles to the efficiency of such bargaining, many of the standard problems with private bargaining -- such as incomplete information -- are, I argue,

2 Martin J. Rees, Our Final Hour: A Scientist’s Warning: How Terror, Error, and Environmental Disaster Threaten Humankind’s Future in this Century – on Earth and Beyond (2003).
3 Throughout the paper, I use the terms “global” or “national” interchangeably, to refer to the set of all jurisdictions.
less likely to plague inter-jurisdictional bargaining over natural hazard precautions. Even harm diversion – a fundamental problem with decentralized efforts to ward off various kinds of both human and natural threats – is, on balance, susceptible to solution via inter-jurisdictional bargaining. An argument for centralization exists in some cases, but the role of the central government on this model is primarily to provide a forum (in the central legislature) for inter-jurisdictional bargaining, and to facilitate decentralized coordination.

The more formal game theoretic analysis in the first part of the article does not incorporate an important driver behind many large scale risks: central government programs that either actively subsidize economic development – thereby creating a potential risk of harm where one might not otherwise arise due to market forces alone – or insure localities against the loss from large scale risks. The second part of the article analyzes the impact of such centralized large-scale risk creation and insurance. It begins with a succinct but somewhat detailed description of the evolution of the federal disaster relief and flood insurance programs in the United States. This circa April, 2006 version then ends with a counter-intuitive suggestion (to be demonstrated at the workshop): that the best way to reduce incentives for the federal development subsidies that in a very real sense create the problem of large scale risk may be to retain federal responsibility to compensate for such risks.

II. Local Incentives and Large Scale Risks

In this part of the article I put aside, for the time being, the various things that people seem to believe make a large-scale risk “catastrophic” (such as irreversibilities), and begin with the more modest task of considering large-scale risks. My goal is to unpack what is “local” versus what is global or “general” about large-scale risks. My reason for so doing is purely analytic: to identify the structural features of such risk that are most relevant to the determination of local versus global incentives in controlling and managing them.

As observed earlier, there are all kinds of large-scale risks. While some, such as asteroid strikes and alien invasions, have extraterrestrial origins, most large-scale risks originate somewhere on the planet earth. Of risks with terrestrial origins, most have sources that at least in the short run are fixed or known. At any given time, there are only a certain number of places where particle accelerator experiments are being run, or various lethal viruses or bacteria stored. More prosaically, perhaps the most important source of carbon dioxide and other greenhouse gas emissions – coal-fired electric power plants – have fixed locations. Now not all sources of large-scale risks are fixed. Automobiles, a major source of greenhouse gas emissions and contributor to global warming, move about from place to place. More notoriously, nuclear and biological terror threats are as mobile as the terrorists who carry them out.

The temptation to categorize risk sources as either fixed and localized, or mobile, and therefore general, should be resisted. The reason is that as we take a longer and longer run perspective, more and more sources of large-scale risks are mobile rather than fixed. In the multi-decade time frame, most sources of greenhouse gases will be in China and India, rather than the United States. In just a few years time, terrorist threats may originate in countries that are now virtually terrorist-free. Thus any attempt to categorize large scale risks according to whether or not a particular risk has fixed (or, to borrow the language of the federal Clean Air Act, stationary) source or instead has a mobile source would necessarily be to choose particular time frame as the relevant one for analysis. We cannot, that is to say,
categorize the source of a large scale risk as stationary, and localized, versus mobile, and hence generalized, without deciding upon the relevant time frame for analysis.

A. The Strategic Structure of Symmetric Security Games

The problem, it seems, is that risk source and risk magnitude interact in ways that make it unhelpful to distinguish among risks as either local versus general in source or impact. For identifying local versus global incentives in risk regulation, what is required is a general analytical framework that permits variation in and interaction between both risk source and risk effect.

A relatively neglected area of economic research, the economics of alliances, provides such a framework. In this model, we imagine a world of \( i = 1,2 \ldots n \) separate places or jurisdictions, each one of which chooses a level of precautions or avoidance expenditure, so that the \( ith \) jurisdiction’s avoidance effort level is given by \( e_i \). Jurisdiction \( i \)'s level of precautions may in general effect both the probability that an uncertain, harmful event occurs, and also the magnitude of the harm that results if the event occurs. Moreover, jurisdiction \( i \)'s effort level may in general impact the probability and magnitude of harm both in jurisdiction \( i \) and in one or more of the other \( (n-1) \) jurisdictions. In the language of economics, jurisdiction \( i \)'s effort level may have inter-jurisdictional spillover effects. As the following examples show, different types of disasters have different kinds of spillover effects.

i) A purely localized disaster might be defined as one where only local precautions effect the probability of a disaster, and where the harm is likewise only felt within the jurisdiction. An explosion at a small fireworks factory illustrates such a localized disaster.

ii) A disaster involving pure externalization is typified by the decision of an upstream municipality to dump raw, untreated sewage into its adjacent river. The sewage is carried away from the source, causing no harm there, but greatly increases the risk of waterborne diseases such as typhus and cholera in downstream communities. Similarly, if an upstream jurisdiction decides to dam a river, then that dam may lower the probability of a flood in the source jurisdiction, but increase both the probability and magnitude of a flood occurring downstream.

iii) A single (or limited source) disaster generalizes this by allowing for harm in the source jurisdiction as well. Such a disaster may be defined as one in which precautions in one, source jurisdiction effect both the probability and magnitude of a harmful event occurring in others. The precautions taken by a jurisdiction hosting a major laboratory for viral research or particle accelerator may be the sole determinant of the probability and magnitude of harm both in the source and in many other jurisdictions from experimental accidents or intentional sabotage.

iv) Still more generally, an interactive disaster is one where jurisdictional precautions interact to determine the probability and/or magnitude of harm in many jurisdictions. An example of precautions interacting to determine the probability of harm is terrorism, where the failure of a border jurisdiction to adopt security measures to control terrorist penetration will generally increase the probability of a terrorist attack in other jurisdictions, and also

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effect the productivity (and marginal productivity) of security measures taken in those other jurisdictions. An example of precautions interacting to determine both the probability and magnitude of harm is presented by both hurricanes and earthquakes, where the failure one jurisdiction to take precautions – in the form of construction codes lessening the risk that structures fall apart and become missiles in a hurricane, or burst into flames in an earthquake – can hugely increase both the probability and magnitude of harm in nearby jurisdictions.

In the most general case – of a fully interactive disaster – there is the obvious potential for the incentives of individual jurisdictions to take precautions to differ systematically from global incentives. We can see this just by writing down and comparing the problems faced by a benevolent, expected total cost minimizing global government, and those faced by benevolent, total expected cost minimizing local governments.

If we let \( e = (e_1, \ldots, e_n) \) denote the vector of precautions, \( p_i(e) \) the probability of harm in a particular jurisdiction \( i \), \( H_i(e) \) the harm in this jurisdiction, and \( c(e_i) \) the cost of precautions (assumed to be the identical function across jurisdictions, for the time being), then from the global point of view (that is, the point of view of all \( n \) jurisdictions), the total expected cost of disasters is given by:

\[
\sum_{i=1}^{n} (p_i(e)H_i(e) + c(e_i)).
\]

And the goal of a total expected social cost minimizing global government is to have each jurisdiction’s level of precautions, \( e_i \), chosen so as to solve the following problem:

\[
\min_{e_i} \sum_{i=1}^{n} (p_i(e)H_i(e) + c(e_i)).
\]

Each individual jurisdiction, however, cares only about the expected total local cost of disasters, which is given by \( p_i(e)H_i(e) + c(e_i) \), and so chooses its level of precautions \( e_i \) so as to solve the problem:

\[
\min_{e_i} \left( p_i(e)H_i(e) + c(e_i) \right).
\]

Problem (3) differs in general from problem (2), in that a particular jurisdiction does not consider the impact of its decisions on the probability and amount of harm in other jurisdictions. One might be tempted to conclude from this very basic fact that whenever disasters are interactive across jurisdictions, local incentives to take precautions to reduce the probability or magnitude of harm from disasters will be too weak, and that global regulation is necessary. Indeed, one’s initial intuition might well be that because local precautions against large scale risks provide a kind of public good – in the form of reduced risks in other places too – decentralized provision of such precautions will always be too low. After all, national security involves efforts to avoid a large-scale risk – external or internal attack – and national security is a textbook example of a pure public good. Introductory economics textbooks explain that because national defense is a non-rival good (one person’s “consumption” does not lower anyone else’s) and non-excludable (everyone who lives in the protected place gets the benefits of protection) the individual incentive is to free-ride on the
efforts of others, and to make no contribution to national defense. To use the language of game theory, the provision of national defense is, on the traditional story, a Prisoner’s Dilemma Game (PDG) in that regardless of what others do, the individual incentive is to refrain from contributing. The textbook solution is for the national government to provide national defense, while using its authority to coerce contributions from individuals.

This is a nice, simple story. One might think that it applies just as well to sub-national jurisdictions as to individuals. When we attempt even the simplest formal representation of the inter-jurisdictional security game, however, we see immediately that national defense is not necessarily a PDG. To see this, consider Figure 1 below, which is meant to capture the national defense, or “homeland security” game played by two identical sub-national jurisdictions that together comprise the nation. The entries in each cell in Figure 1 below show, respectively the expected total cost in jurisdiction one, and jurisdiction two, as a function of their decision whether or not to contribute to provide homeland security.

Figure 1 simplifies the general game capture in equation (3) by assuming that the harm suffered by each jurisdiction if the risk materializes – in the homeland security story, an attack occurs – is equal and given by $H$, and that the jurisdictions’ are equally effective in taking precautions against an attack, so that both the probability of a successful attack, $p$, and the cost, $e^*$, are constant across jurisdictions. I assume, for the time being, that all of the parameters that determine the game payoffs are known to both jurisdictions. The only complexity in the Figure 1 game is in the effectiveness of security efforts. I assume that if both jurisdictions contribute, then the probability of a successful attack (in either) is zero; if only one contributes, then the probability of a successful attack (in either) is $p > 0$, while if neither contribute then the probability of a successful attack is 1. Suppose, as in the PDG, that the strategy pair that minimizes total expected national cost is for both jurisdictions to spend on security. For this to be so, it is necessary that both:

$$e^* < H \text{ and } e^* < 2pH.$$  

(4)

A sufficient condition for (4) to hold is that $p < 1/2$.

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<tr>
<td>Cooperate</td>
<td>$-e^<em>, -e^</em>$</td>
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<tr>
<td>Cheat</td>
<td>$-pH, -pH - e^*$</td>
<td>$-H, -H$</td>
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**Figure 1**

*The Inter-jurisdictional Homeland Security Game*

For inter-jurisdictional homeland security to constitute a PDG, then for each jurisdiction, its own expected total cost would be minimized by choosing to cheat, regardless of the choice made by the other jurisdiction (in the language of game theory, cheating would be a dominant strategy for the local jurisdiction). But for cheating to be locally dominant strategy, we must have both:
Now it is possible that both (4) and (5) hold, and homeland security is a PDG. If, for instance, \( p = 1/2 \) then both (4) and (5) hold provided only that \( H/2 < e^* < H \). If local precautions are only moderately effective locally\(^5\), then the optimal choice for each jurisdiction is to refrain from spending on security, making both very much worse off relative to the national optimum.

However, condition (5), which makes cheating the locally dominant strategy, need not hold. Indeed, as allow \( p \), the probability of a harmful attack when either jurisdiction attempts to free ride, to decrease from 1 toward 0, the national efficiency of joint security (condition (4)) necessarily implies that condition (5) will not hold, so that security is both locally and globally optimal. Intuitively, as security efforts become more and more productive, the local benefits from security will be bigger than local costs and security will be locally optimal, regardless of what the other jurisdiction does.

Figure 1 is helpful in making the important point that the homeland security game is not necessarily a PDG. It may nonetheless still overstate the risk in decentralized provision of security and other ex ante disaster precautions. In many cases – consider, for instance, border security – the provision of the public good requires action by all local jurisdictions. It is of no use to a sub-sea level country that depends upon dyke maintenance for its security against floods that almost every jurisdiction is doing a good job with dyke maintenance, for if floodwaters penetrate anywhere, the entire country will be inundated. We can generate such a strategic structure (known as “weakest link” in the economic literature on alliances) by retaining all the assumptions that generate Figure 1, except that we now assume that if either jurisdiction fails to take precautions, then the probability of an attack is 1 – the same as it is when both fail to take precautions. With this change in assumptions, it is immediate that there now two (pure strategy) Nash equilibria in Figure 1: either both jurisdictions take precautions, or neither do.\(^6\) Between these two equilibria, the jurisdictions face a simple choice: they are both better off when they both take precautions than when neither of them do. Rather than the conflicting incentive to free-ride on each other’s efforts that characterize a PDG, in the weakest-shot game the jurisdictions share a common interest in coordinating their actions so that both take precautions.

B. Asymmetric Security Games

The symmetry imposed in Figure 1 -- through the assumptions that the two jurisdictions have identical stakes, \( H \), identical cost \( e^* \), and productivity of security effort \( (1 - p, p) \) -- may often be unrealistic. Most importantly, jurisdictions will often differ in the loss they will suffer in the event of an attack and in their national strategic significance – the effectiveness of their precautions against an attack. For both natural and human attacks, perhaps the most basic distinction is between border jurisdictions and interior jurisdictions. Neither conventional armies nor individual terrorists can inflict harm on a nation unless they can penetrate border jurisdictions. Hence the precautions taken by such jurisdictions likely have

\[ e^* > pH \text{ and } e^* > (1 - p)H. \]

\(^5\) More precisely, for \( p > 1/2 \), we have that \((1 - p) < p\), so that the global productivity of local security increases with the number of jurisdictions taking such security, for \( p = 1/2 \) the productivity of local security is invariant with respect to the number of jurisdictions taking security, and for \( p < 1/2 \), the marginal productivity of local security declines with the number of jurisdictions taking such security).

\(^6\) As is true of all games with such multiple Nash equilibria, there also exists a mixed strategy equilibrium in which each side cooperates and takes precautions with probability \( q = e^*/H \).
a very impact on the probability of a harmful attack in both other border jurisdictions and in interior jurisdictions. The national harm done by hurricanes and earthquakes is strongly dependent upon the location and precautions taken by border jurisdictions (coastline jurisdictions in the case of hurricanes, fault line jurisdictions in the case of earthquakes). The location of border development and the developmental precautions taken by border jurisdictions – their building codes and other safety measures – determine whether border structures will absorb and dissipate the force of hurricanes and earthquakes or instead crumble to become inter-jurisdictional missiles in hurricane winds and fires sources in earthquakes.

When we allow for such asymmetries in stakes and precautionary effectiveness in our simple two jurisdiction world, a variety of equilibria become possible. Perhaps most importantly, while in the symmetric case either both jurisdictions did what was in the national interest or neither did, in the asymmetric case there is the possibility of inter-jurisdictional free-riding. To see this, consider Figure 2 below. The figure has been changed so as to allow asymmetry in precautionary effectiveness (both local and global) and in the amount of local harm that will be suffered (the local stakes). Jurisdiction one harm is given by $H_1$ and jurisdiction two harm by $H_2$. When only jurisdiction one takes precautions, the probability of harm (in both places) falls by $(1 - p_1)$; when only jurisdiction two takes precautions, the probability of harm falls (in both places) by $(1 - p_2)$; when both jurisdictions take precautions, the probability of harm goes to 0.

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<td>$-p_1 H_1, -e^*, -p_1 H_2$</td>
</tr>
<tr>
<td>Cheat</td>
<td>$-p_2 H_1, -p_2 H_2 - e^*$</td>
<td>$-H_1, -H_2$</td>
</tr>
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</table>

Figure 2

An Asymmetric Inter-jurisdictional Disaster Security Game

From Figure 2, we have that joint local precautions are nationally optimal if and only if: $2e^* < H_1 + H_2$, and $2e^* < (p_1 + p_2)(H_1 + H_2)$. (5)

The conditions for precautions to be locally optimal in both jurisdictions are in turn that:

$$2e^* < (1 - p_2 - p_1) H_1$$

or, rearranging, that

$$2e^*/(1 - p_2 - p_1) < H_1$$ (6a)

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7 For a proof in the more general case, see the appendix.
8 Observe that with the linearity implied by the assumption of risk neutrality, Figure 2 captures not only the case where precautions in one jurisdiction effect the probability of harm in another – a case typical of homeland security -- but also the case where precautions in one place operate to lower the probability and magnitude of harm in another place – as may be more typical of natural disasters. Were the assumption of risk neutrality replaced with one of risk aversion, then as will be explained in more detail below, then changes in the likelihood of harm will have different incentive effects than changes in the amount of harm.
for precautions to be a dominant strategy for jurisdiction one, and,

\[ 2e^* < (1 + p_1 - p_2) H_2, \]

or, rearranging, that \( 2e^* / (1 + p_1 - p_2) < H_2, \) (6b)

for precautions to be a dominant strategy in jurisdiction two.

From (6)(a) and (6)(b), it is immediately apparent that holding all else constant, as \( p_1 \)
falls relative to \( p_2 \) – so that precautions in jurisdiction one become more and more effective
relative to precautions in jurisdiction two – jurisdiction one will have a bigger incentive to
take precautions than will jurisdiction two. Hence unless jurisdiction two suffers very large
harm, the effectiveness of precautions in jurisdiction one make jurisdiction two’s optimal
strategy that of free-riding on precautionary efforts in its more strategically situated
neighbor.9

Happily, there is a relatively simple solution for such free-riding. If, as captured by
inequalities (5), joint precaution is indeed globally efficient, then it must be that the gain (in
expected value terms) to jurisdiction one (what I will call the “target” jurisdiction) from
precautions in jurisdiction two is greater than the net cost of such precautions to jurisdiction
two (which I shall call the “free-rider” jurisdiction). Under the assumption of complete
information that I have maintained thus far, both jurisdictions would know this, and would
also know precisely how large a payment (equal to \( e^* - p_1 H_2 \)) jurisdiction one must make to
induce jurisdiction two to take precautions. The solution to the problem of inter-
jurisdictional free-riding in security precautions is to lower the transaction costs, and make
enforceable, inter-jurisdictional disaster precaution compacts.

C. Complications, and their Policy Implications for Centralization versus Decentralization

The simple model presented thus far suggests that there may well be a greater
coincidence between local and national (or global) incentives for the provision of ex ante
precautions against national-scale disasters than many people seem to assume. The analysis
has been very simple, however; too simple to carry either any useful predictions or
normative policy prescriptions. To derive such positive and normative policy implications,
we must add more reality to the analysis.

1. Asymmetric Information

Asymmetric information, and the strategic behavior that it induces, is usually a big
impediment to the efficiency of decentralized bargaining. In the case of inter-jurisdictional
bargaining over disaster precautions, however, asymmetric information is likely to be less
problematic than in typical private bargaining. Still, bargaining between governments is
perhaps even more likely to be afflicted by incentives for posturing and other kinds of
strategic behavior than is private bargaining. Jurisdictional representatives in a centralized
legislature, by contrast, play a long-term game in which they have strong incentives to
acquire and maintain a reputation for cooperation. Hence centralized legislation – an
agreement among central legislators – is the likely mechanism implementing inter-
jurisdictional disaster precaution cooperation.

Consider first asymmetric information regarding local payoffs. This kind of information
asymmetry is first of all not likely to obtain with respect to the cost of precautions in the

\[ ^9 \] Of course, in extreme situations, where local precautions are perfect compliments (the “weakest link” game
structure considered above, where neither jurisdiction can effectively lower the risk unless the other jurisdiction
also takes precautions), free-riding is impossible, and asymmetry in stakes is irrelevant if joint precautions are
indeed globally efficient.
free-rider jurisdiction. Whether the precaution is limiting or regulating land development, or installing various kinds of security precautions, its cost is likely either determined directly on national markets or easily determinable by target jurisdictions. It is true that the free-rider’s harm from the disaster may be much more idiosyncratic, and to depend upon its private information regarding the actual (as opposed to legally required) quality of residential and commercial construction within its borders, its maintenance of local infrastructure such as roads and harbors, and other highly place-specific factors. However, and most importantly, the global value of precautions is the decrease in the probability (or magnitude) of harm in target jurisdictions, and those jurisdictions are likely to have better information about this than does the free-rider jurisdiction.

In the inter-jurisdictional disaster precautions bargaining game, the target jurisdiction may be thought of as offering to pay some amount to the free-rider jurisdiction to induce it to take the globally optimal level of precautions. Assuming that the cost of precautions is, for the reasons just given, common knowledge, the target jurisdiction knows that by paying the free-rider jurisdiction just slightly more than its cost of precautions, the free-rider will be better off taking precautions (and getting that payment) than it would be were it to fail to take precautions. The free-rider knows this, and knows also that the target knows this, and so on. The free-rider would of course like to get more, to demand a payment equal to the value to the target of getting the free-rider to take precautions. If my earlier argument is correct, however, then the free-rider does not have very good information regarding how much the target would be willing to pay for free-rider precautions. Hence if the free-rider refuses a cost-plus offer from the target, then it risks protracted bargaining and the possibility of getting nothing.

Still, private individuals sometimes walk away from deals because of bargaining breakdown, and it is surely at least as possible that officials of a sub-national government would risk bargaining breakdown rather than agree to a barebones cost-plus offer from another jurisdiction. Moreover, even if the jurisdictions reached agreement, the value of that agreement to a target jurisdiction would depend upon actual implementation of precautions in the free-rider jurisdiction. That is, were precautions difficult to monitor and verify, there would be an incentive for government officials representing free-rider jurisdictions to accept precautionary payments and then divert those payments to projects that were of greater personal or political benefit than disaster precautions. Given that a virtually defining feature of any political federation is the territorial limitation of the police powers of sub-national governments, it would seem that inter-jurisdictional agreements could be effective only for the most easily verifiable kinds of disaster precautions.

Thus because it harms both the possibility of efficient inter-jurisdictional bargaining and the value of any inter-jurisdictional disaster precautions agreement reached, the net effect of imperfect information is to generate a case for centralized intervention. Such intervention is valuable both at the bargaining stage, where it would ideally be used to constrain inter-jurisdictional strategic behavior, and at the implementation stage, where it would be employed to monitor and verify that promised disaster precautions are in fact being taken by sub-national governments. If it is true that centralized legislators desire to obtain and maintain a reputation for cooperative legislative behavior, then such legislatures would constitute a forum in which incentives for inter-jurisdictional strategic behavior are significantly lessened relative to direct bargaining by decentralized government leaders.

A positive prediction of the analysis here is that efficient bargains to overcome inter-jurisdictional free-riding in the disaster precautions game will have the general feature that free-rider jurisdictions – those that have relatively less to lose, and are not the most effective
in reducing the probability of harm, but which are nonetheless important to overall disaster control -- will receive subsidies from target jurisdictions -- those that have high stakes, and whose efforts are especially effective to the overall national effort to reduce the probability of harm. Such a redistributational pattern of subsidies has in fact been widely noted, and just as widely decried in the relatively large grants going to rural western states under the federal block grant program for state terrorism protection efforts. On the analysis here, this criticism is likely misdirected. The federal block grant program seems to be sending money to states that would otherwise have, from a national point of view, too little incentive to spend on terrorism precautions.

2. Strategic Harms

A complication that is taken to be of special importance in the particular context of precautions against terrorism is strategic targeting of harms. Such strategic targeting has been analyzed in the terrorism context, where it seems reasonable to assume that if some places are better protected than others, terrorists will intentionally target the more vulnerable places. With such strategic targeting, at least some kinds of precautions in one place generate a negative externality for other places, as they simply divert rather than reduce the global probability of the risk.

While it might seem that such strategic harm targeting can in fact be true only of harms due to intentional human agency, viewed more generally -- as inter-jurisdictional harm diversion -- the problem can in fact be true of natural hazards as well. Indeed, one of the most common problems in dealing with coastal storm damage is that many of the protective efforts taken by local beachfront communities -- such as seawalls, groins and other kinds of "hard stabilization" -- lower local storm damage but only by diverting storm damage to nearby downwind communities. As this example clarifies, inter-jurisdictional harm diversion is just a variant on the general inter-jurisdictional externality problem considered earlier, one in which there is a negative rather than positive externality. Unlike the positive externality -- where free rider jurisdictions may know what precautions could be taken, but simply do not have sufficient willingness to pay for those precautions -- the negative externality arises not because less vulnerable communities are unwilling to pay, but because more vulnerable targets spend more than others, and because they spend on projects that reduce their own risks while increasing risks elsewhere. The simplest solution is to have threatened jurisdictions subsidize and also regulate the kind of precautions taken, shifting local preferences in the vulnerable jurisdictions that take precautions. Indeed, were all jurisdictions vulnerable (something that is possible in the case of harm diversion, since all are by definition engaging in decentralized provision), then if there is an alternative to the diverting precautionary method, they would all be better off choosing that method. More generally, of course, a diverting jurisdiction will need to be paid to abandon its current, externalizing precautionary strategy in favor of a globally, but not locally, superior approach.

3. The Strong Case for Centralization: Economies of Scale in “Best Shot” Games

One version of the security game not yet considered is known in the economic literature as “best shot.” In this version of the game, the overall or global level of risk reduction

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depends solely upon the highest level of expenditure in any particular jurisdiction. We can obtain such a game by modifying Figure 1 to assume that there are two possible levels of investment in disaster security, high, denoted by \( e_h \), and low, denoted by \( e_l \), with \( e_l < e_h \).

Assume that if either jurisdiction invests at the high level, then the risk goes to zero, while low level investment is (for simplicity) assumed to lower the hazard risk from 1 to \( p \). As can be seen from Figure 3, if we assume only that \( e_h < 2(pH + e_l) \), then the global optimum is for one and only one jurisdiction to take precautions. As for what is optimal at the level of the individual jurisdiction, this depends upon whether or not \( e_h < pH + e_l \). If this second inequality also holds, then there are two Nash equilibria in the best shot game: one of the two jurisdictions makes a high level of investment, while the other fails to invest.

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<th>High Level Security Investment</th>
<th>Low Level Security Investment</th>
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<tr>
<td>High Level Investment</td>
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<td>(-e_h, 0)</td>
</tr>
<tr>
<td>Low Level Investment</td>
<td>(0, -e_h)</td>
<td>(-pH - e_l)</td>
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Figure 3

The “Best Shot” Disaster Security Game

The problem in best-shot games of this sort is one of coordination, to avoid a situation in which neither party invests at the high because they each expect (or hope to force) the other to do so. The natural solution to such a dilemma is for the parties to agree to make, and share the costs, of a high level of investment in disaster precautions. Centralized provision of such a high level of investment may be understood as solution of precisely this sort. An example would be defense against missile attacks. Here, an effective air defense system that intercepts missiles far away from national borders will protect both jurisdictions equally. The question is not whether such a system is optimal, but rather how its cost will be allocated.

III. Centralized Disaster Creation: The Natural Hazards Problem and other Variants

In several ways, losses from natural hazards such as hurricanes and earthquakes differ from the kind of large-scale loss considered thus far. Some places are at much greater risk from natural hazards than others, and while large in amount, losses are often relatively concentrated geographically. Protection against natural hazards does not generally confer a national public good, but a local or regional public good. The natural hazards problem would seem to be that of local incentives for a local public good, one that is quite unlike—and one would think, much easier to solve—than the problem of local incentives for global public goods considered above.

\[13 \text{ And observe that as the number of jurisdictions that benefit from one jurisdiction’s best shot increases, we have in effect very strong economies of scale in protection.} \]

\[14 \text{ There is also of course a mixed strategy equilibrium with the probability of high investment, } q, \text{ defined by } q/(1-q) = (pH - e_l)/e_h. \]
This intuition is based on a common sense understanding of natural hazards. Part of this understanding – that whether a place is subject to risk from a natural hazard such as hurricane or earthquake is dependent simply upon its location – is correct. The other part of the common sense view – the implicit assumption that losses are both local in extent and locally determined – is both conceptually and, at least in the United States, historically false. In this part of (this early) version, of the article, I briefly explain both the conceptual and historical error behind the common sense understanding of natural hazards.

A. Natural Hazards and Intra-Jurisdictional Public Goods

The first, foundational thing to see is that the models of the previous section do indeed apply to natural hazards. The reason is that those models captured the general situation in which interacting groups of differentially located people make precautionary decisions that effect not only their own hazard probability and amount of loss, but also the probability and amount of loss suffered by other groups. This is to say that the model applies just as well to interactions among locationally distinct groups of people within a jurisdiction as it does to interactions across jurisdictional boundaries. The only real functional distinction is that whereas sub-national inter-jurisdictional bargaining (in the U.S., bargaining by States) involves bargaining by governments (unless it occurs within the national legislature), when we get down to the truly local level (as opposed, in the U.S., to the state level), intra-jurisdictional bargaining is between groups, within the institutional context of local government.

There is a strong economic justification for local government. The local analogy to the global public goods problem modeled above involves a situation where actions by one group determine not only their own probability and amount of loss, but also the probability and amount of loss of neighboring groups. When the problem is put this way, we see that the externality problem will generally be much more common at the local than at the larger national or global level. For this reason, we would expect to find almost continuous bargaining among local groups, bargaining that takes place within local government institutions.

When we move to the concrete local level, however, it is immediately apparent that the “actions” that some people take, and which affect other people’s probability and amount of loss, are generally market choices. When someone decides whether or not and how intensively to develop a floodplain, he or she is making a profit (or utility) driven choice. Indeed, the two primary decisions that determine both the probability and amount of loss from natural hazards such as hurricanes and earthquakes are whether or not to put a structure in a risky area, and how to construct it. The existing empirical evidence shows that like most other goods, protection against natural hazards is a normal to luxury good, in that the amount a person is willing to pay for natural hazard protection increases with his or her income. Hence the people who are most exposed to natural hazard risk are the poor, those with the lowest willingness to pay for market protection against natural hazards.

The truth of this statement is borne out abundantly by American natural disaster history. The many horrors suffered by the poor people of New Orleans as a consequence of Hurricane Katrina were entirely predictable given their relative location. Indeed, fifteen years before Katrina, John McPhee wrote:

“Something like half of New Orleans is now below sea level. New Orleans, surrounded by levees, is emplaced between Lake Pontchatrain and the Mississippi like a

15 [add cite].
broad shallow bowl. Nowhere is New Orleans higher than the river’s natural bank. Underprivileged people live in the lower elevations, and always have. The rich — by the river — occupy the highest ground. In New Orleans, income and elevation can be correlated in a literally sliding scale.\textsuperscript{16}

In differentially impacting the poor, Hurricane Katrina was typical of most American natural disasters. The working poor who lived south of Market Street were the main victims of the 1906 San Francisco earthquake (and the same area was the worst hit in the 1989 Loma Prieta quake); it was poor Dade County mobile home dwellers, and their homes, that suffered the worst destruction in Hurricane Andrew in 1992; the 1993 Mississippi River floods in the midwest were most devastating to the poor residents of river bottomlands;\textsuperscript{17} more obscurely, perhaps, it was children who suffered most of the deaths in the 1888 “Schoolchildren’s Blizzard” that swept the Minnesota, Nebraska and the Dakotas.\textsuperscript{18}

The fact that it is the poor who suffer the most from natural hazards does not mean that the reason they suffer is the kind of externalization captured by the models developed earlier. The rich may simply be able to afford to live in safer dwellings in safer locations. But the poor also might suffer disproportionately because the rich are willing to take precautions that generate benefits for the poor, or even make choices that systematically increase the probability and harm suffered by the poor. Such cases are strategically similar to the problem captured by Figure 2 above, where the external effects of precautions are large enough so that those precautions are socially desirable, but still external to the jurisdiction that incurs their cost, so that the precautions are not locally (privately) desirable. In such situations, the remedy is for those who suffer the harm to bargain with the strategically situated actors, and to pay them to increase their level of precautions. When it is the poor who suffer harm, however, even when efficient, such bargains are unlikely. The reason is that precautions to lessen the probability or harm from natural hazards are generally a form of investment in relatively long-lived assets. Indeed, especially for natural hazards that are low probability and infrequent — and so have a long average duration between occurrence -- precautionary measures must take the form of investments in correspondingly long-lived assets. In order to finance the cost of such investments, one must borrow against existing assets. But when the poor are wealth-constrained, they do not own the kind of physical assets necessary to lower the cost of obtaining external financing. Thus market provision of the financing necessary for the poor to purchase increased natural hazard precautions from the rich are unlikely.

On this line of analysis, we should seldom observe the reverse problem, where inadequate precautions by the poor cause a socially supra-optimal probability and/or magnitude of natural hazard risk to the rich. Rather, where the direction of causality runs from the poor to the rich, thus corresponding very closely to the free-rider problem analyzed in Figure 2 above, we should see the rich using their existing wealth to subsidize increased natural hazard precautions from the poor.

\textsuperscript{17} This and the preceding two examples are from Ted Steinberg, Acts of God: The Unnatural History of Natural Disaster in America 44-45, 91-96, 103-106 (2000).
\textsuperscript{18} As David Laskin, The Children’s Blizzard 269 (2005) writes about the lessons to be drawn from this catastrophic storm: “Or should we condemn an economic system that gave some families mansions on Summit Avenue and left others so poor that they would risk their children and their own lives for the sake of a single cow. They called it “The School Children's Blizzard” because so many of the victims were young – but in a way the entire pioneer period was a kind of children's disaster. Children were either the unpaid workforce of the prairie, the hands that did the work no one else had time or stomach for.”
natural hazard precautions in poor areas. A positive prediction of the model developed here is thus that the typical pattern of destruction in natural disasters should be either that of spillovers from rich to poor areas, in which development and protection of rich areas increases the harm suffered by poor areas, or one where destruction in poor areas is confined there, and has no significant spillover effects to wealthier areas. Conversely, we should rarely observe situations in which harm from poor areas exacerbates harm in wealthier areas.

B. Natural Hazards as Product of Centralized, Inter-jurisdictional Development Subsidies

A limitation of the analysis just presented is that it assumes that the baseline land development and disaster precaution decisions within any given jurisdiction are market decisions made without any local or central government assistance. At least in the United States, this is false. The federal government not only provides centralized disaster relief — disaster insurance paid for in large by taxpayers across the nation, rather than insureds — but also provides substantial subsidies for land development. By prompting the development of floodplains and other high-risk areas that would not otherwise be profitable to develop, such federal subsidies quite literally create the natural hazard: without people or property at a particular location, natural events such as hurricanes and earthquakes do not cause harm.

In this section (and this version), I begin the task of incorporating centralized development subsidies into the earlier analysis. First I provide some institutional detail on the evolution and operation of the federal disaster relief and flood insurance programs — the centralized American disaster compensation scheme. Virtually all recent work on the reformation of American natural hazards regulation has focused on this compensation aspect of centralized disaster regulation. The general recommendation from this literature — that the federal government should compensate less, and that local governments should be required to take more precautions against natural hazards — is, I shall argue, seriously misguided, for it has failed to take account of federal development subsidies that generate the natural hazards problem in the first place.

1. The Stylized Facts of Centralized Natural Hazard Regulation in the U.S.

The first “permanent and general” federal disaster relief law in the United States was the Disaster Relief Act of 1950, which initially covered only local public costs and was intended to help with the cost of repairing rural roads in recently flooded areas along the Red River in Minnesota and North Dakota.19 Congress originally intended the disaster relief program to be limited in the amount of federal money provided, with federal relief contingent upon a presidential disaster declaration.20 In a series of laws passed between 1950 and 1980, however, Congress greatly expanded the scope of the federal disaster relief program to include benefits to individuals as well as public entities, and Congressional funding of disaster assistance has increasingly come from off-budget “supplementary appropriations” that are only sometimes offset with rescissions of prior disaster relief appropriations.21 While the amount of congressional disaster relief varies with the scope of the disasters funded, during the 1990’s such relief averaged roughly $5 billion per year (in constant 1993 dollars).22

Although Congress has not eliminated the Presidential disaster declaration requirement, it has passed laws that have both broadened the types of disasters to which the

20 Platt, Disasters and Democracy at 15.
21 Platt, Disasters and Democracy, at 24.
22 Platt, Disasters and Democracy, Table 1-4 at page 25.
presidential declaration process applies, and added a new category of “emergencies” that are eligible for federal disaster relief. Between 1953 and 1994, there were 1258 major disasters and 114 emergencies declared, with the fraction of disaster declaration requests granted rising from roughly two-thirds from the 1950’s to 1988 to 85 per cent in 1996, and direct federal assistance costs increasing from $3.8 billion over the 1970-1981 period to $34 billion over the 1989-1994 period. After being administered by a variety of different federal agencies, in 1979 disaster relief became housed within the newly created Federal Emergency Management Agency (FEMA), where it resided until all of FEMA’s responsibilities were transferred to the Department of Homeland Security by the 2002 Homeland Security Act. Despite calls during the 1980’s by the GAO and a Senate Task Force for more certain, objective criteria determining when disaster declarations should be issued, and for greater cost-sharing by states (increased state co-insurance, as it were), Congress failed to act, so that the current federal disaster declaration and relief process codified in the 1988 Stafford Act is one over which the President has wide political discretion.

The federal Disaster Relief fund is not the only source of federal disaster-assistance. Indeed, there are about 30 federal programs that offer some form of disaster service or compensation. Prominent among these are the National Flood Insurance Program, the Small Business Administration disaster loan program for homes and businesses, the Farmers Home Administration disaster loan program, the Federal Crop Insurance Program, and disaster-related Community Development Block Grants (CDBG’s) issued by the department of Housing and Urban Development. Since ninety per cent of natural disasters in the U.S. are flood related, the most important of these is the NFIP. As of November, 2005, the NFIP had over 4.8 million policyholders in about 20,000 communities. Hurricanes Katrina, Rita and Wilma together are estimated to generate claims and NFIP payments of about $23 billion, an amount that is significantly more than the $15 billion paid

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23 Platt, Disasters and Democracy at 18-19. As amended, the relevant portion of the Disaster Relief Act, 42 U.S.C. §5122 (2000) now reads: (1) Emergency --“Emergency” means any occasion or instance for which, in the determination of the President, Federal assistance is needed to supplement State and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the United States. (2) Major Disaster -- “Major disaster” means any natural catastrophe (including any hurricane, tornado, storm, high water, winddriven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this chapter to supplement the efforts and available resources of States, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.

24 Platt, Disasters and Democracy at 19-20, 22.
26 Platt, Disasters and Democracy, at 20-22.
27 Platt, Disasters and Democracy at 26.
28 Platt, Disasters and Democracy, at 28.
29 Platt, Disasters and Democracy, at 28. The NFIP was established by the national Flood Insurance Act of 1968, 42 U.S.C. §§4001-4129 (2000). Except where otherwise noted, the succeeding paragraph is based on Platt, Disasters and Democracy, pp. 28-33.
out by the NFIP over its previous 1968-2005 history and orders of magnitude more than NFIP’s annual ability to pay.

The NFIP was structured as a deal between the government as insurer and interest groups of the insured – homeowners, homebuilders and communities. Under the terms of this deal, the federal government would make available low-cost flood insurance but only to those property owners whose local communities enacted floodplain management regulations sufficient to meet minimum federal standards. Only properties within the 100 year flood plain and whose mortgages are written by federally insured lenders are required to be covered by NFIP policies (and those policies max out at $350,000 in coverage for single family homes and $1 million for businesses). Although nationally, only 20 to 25 per cent of floodprone properties are covered under the NFIP, as of 1997, 58.7 per cent of NFIP policies and 62.8 per cent of insurance coverage in force were for coastal communities. Hence in such coastal areas, NFIP coverage covers a far higher percentage of properties. Moreover, about one-quarter of NFIP policyholders (roughly 1.2 million) get their flood insurance at rates that are explicitly subsidized (in the sense that the rates are lower than those necessary for the program to break even in the long run). The main subsidy, built into the program by statute, is for older properties built before the completion of a local community’s flood hazard map. For such properties, FEMA estimates that the average NFIP premium is about 40 per cent of the actuarially fair rate (a subsidized rate of $710 versus an actuarially fair premium of $1800). These are average premiums: for structures at the lowest elevation relative to the floodplain, actuarially fair, full-risk rates would be 10 times higher than subsidized rates. The incentive effects of the subsidy are clearly evident in data from Hurricane Katrina: about 122,000 of 200,000 damage claims reported by FEMA as of November 30, 2005, or 61 per cent, were for subsidized properties.

While the federal government provided the promised subsidized insurance, there is a widespread perception that local communities have failed to keep up their end of the bargain by limiting floodplain development so as to reduce their vulnerability to loss from natural hazards. Even prior to passage of the NFIP, federal task forces were well aware that the cycle of “losses, protection, and more losses” could only be dealt with if local communities took steps to “assure that their citizens would not unknowingly acquire and develop property where it is subject to known flood hazards.” To encourage such sound local land use regulation, the NFIP from its inception incorporated four forms of mitigation: 1) identification and mapping of 100 year floodplains; 2) establishment of minimum federal

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31 GAO, Federal Emergency Management, at 3.
32 Which is determined by NFIP’s roughly $2 billion annual income and (recently increased) $18.5 line of credit from Treasury. GAO report at 5.
33 Platt, Disasters and Democracy, at 28, citing Peter May, Recovering from Catastrophe: Federal Disaster Relief Policy and Politics 19 (1985).
34 Platt, Disasters and Democracy, at 28.
36 Platt, Disasters and Democracy, at 31.
37 Marron, The Budgetary Treatment of Subsidies in the National Flood Insurance Program, at 4
38 Marron, The Budgetary Treatment of Subsidies in the National Flood Insurance Program, at 5.
40 Marron, The Budgetary Treatment of Subsidies in the National Flood Insurance Program, at 5.
41 Platt, Disasters and Democracy, at 77.
standards for new construction in mapped floodplains; charging actuarially fair rates for new construction; and, authority for public purchase of floodprone properties. The 1988 Stafford Act reiterated that state and local governments were only eligible for federal disaster monies if they took “appropriate action to mitigate...hazards, including safe land use and construction practices.” When Congress amended the NFIP in 1994, it acted to shift the cost of mitigation from states and localities to the federal level by providing NFIP coverage for the cost of bringing floodprone structures up to federal standards, federal coverage of 75 per cent of the cost of state and local mitigation projects such as demolition and relocation of structures, acquisition of floodprone properties, and beach nourishment, and discounted insurance rates for communities whose floodplain management regulations were tougher than federally required.

The increased federal share under the NFIP was supposedly conditioned upon the adoption by states and localities of a new approach to disaster mitigation. Known as “sustainable hazards mitigation, this approach holds that “[h]azard mitigation activities should be linked to efforts to control and ultimately reverse environmental degradation by coupling hazard reduction efforts to natural resource management and environmental preservation.” The new approach eschews structural fixes, such as levees and floodwalls in riverine environments and seawalls, revetments, and groins in coastal environments. Instead, it prefers avoidance strategies such as floodplain buyouts in which people and property are removed from areas that are known to carry a high risk. A primary example of the new approach to hazards mitigation is the Clinton Administration’s response to the Midwest floods of 1993, which was to buyout and relocate people who were located in the riskiest floodplain locations. Using a combination of Section 404 Hazard Mitigation Grant Program (HMGP) and HUD-administered Community Development Block Grant (50%) funds, “virtually all” mitigation in the state of Missouri after the 1993 floods consisted of floodplain buyouts and relocations: for the summer, 1993 floods alone, some $60 million was expended in buying approximately 2,400 primary residences, 1,100 mobile home pads, 4 apartment buildings and 38 vacant lots.

42 The primary such standard is that the lowest floor of any structures built within the floodplain after the completion of the local flood insurance rate map must be elevated to or above the base flood level – the highest elevation at which there is a one per cent chance of flooding in any given year. U.S.G.A.O., Testimony before the Subcommittee on Housing and Community Opportunity, Committee on Financial Services, House of Representatives, Flood Insurance: Challenges Facing the National Flood Insurance Program (GAO-03-606T, April 1, 2003).
43 Platt, Disasters and Democracy, at 77.
44 Platt, Disasters and Democracy, at 83.
45 Platt, Disasters and Democracy, at 93.
46 Mileti, Disasters by Design at 31.
48 Godschalk, et. al., Natural Hazard Mitigation, at 67.
49 Administered by FEMA, the Hazard Mitigation Grant Program (HMGP) was created in 1988 by Section 404 of the Stafford Disaster Relief and Emergency Assistance Act. According to Godschalk, et.al., Natural Hazard Mitigation, at 393, “[t]he purpose of the Section 404 program is to assist states and local communities in implementing long-term hazard mitigation measures following a presidential disaster declaration.” Originally limited to 10 per cent of the federal assistance provided under the Public Assistance Program under Section 406 of the Stafford Act and as much as 50% of a project’s total cost, the Volkmer Act of 1993 increased the cap on HMGP funding to 15 per cent of the estimated federal assistance under both the Public Assistance and Individual Assistance programs. Godschalk, et. al., at 394.
50 Godschalk, et. al., Natural Hazard Mitigation, at 169.
Buyout strategies have not, however, been uniformly successful. In Iowa, only 1013 structures were purchased as mitigation after the 1993 flood, such a small number that instead of generating a continuous buffer of undeveloped floodplain, the buyouts simply reduced the density of floodplain development, leaving unaffected the basic pattern of floodplain development. Over time, moreover, the clear trend in the NFIP has been a “decreasing emphasis on land use planning and management in flood hazard areas.” The clear original objective of requiring “states and local governments to adopt and enforce meaningful restrictions over new construction and reconstruction in floodplains” was gradually but steadily softened; to the 1979 policy statement that although “avoidance of development in high hazard areas is the preferred approach,” the “public interest” would be consistent with construction in high hazards areas given the lack of “suitable alternative,” to, finally, 1994’s proposal to “develop and implement a process to encourage positive attitudes toward floodplain management.” By 1995, even state floodplain managers were complaining that:

“Our flood policies have not embraced hazard mitigation and in part are to blame for escalating disaster damages. On an individual project basis, flood control projects have reduced flooding for design floods. But at the same time these policies have enticed additional development increasing the damage potential for severe floods, or have silently promoted the transfer of flood damage from one property to another. Likewise, with a benevolent federal government, there has been little incentive at the local and state levels of government to minimize the creation of new hazards.”

As Platt aptly summarizes its evolution, the National Policy on the role of local land use regulation in floodplain loss mitigation had “shifted from mandatory local regulation pursuant to minimum federal standards to cultivation of ‘positive attitudes’ and ‘public understanding.’”

The weakness in all recent schemes to improve local incentives in natural hazard regulation is that they fail to really analyze the interaction between federal development subsidies –implemented by project agencies such as the Army Corps of Engineers – and federal disaster relief program. It is not that people do not recognize the problem. One commentator has recently complained that federal insurance and relief programs have subsidized development in hazard-prone areas, and the expectation of federal assistance even after repeat losses has created a severe moral hazard problem, while risk reduction and risk transfer policies have:

“effectively shifted liability for the occupation of hazardous areas to Washington and to a lesser degree state capitols, thus relieving local governments of their traditional responsibility for managing these areas. The federal and state government top-down approach to dealing with local stakeholders has done little to foster the ‘local

51 Godschalk, et. al, Natural Hazard Mitigation, at 205. Over the entire period 1988-1995, 58% of HMGP funds obligated were for acquisition and relocation projects, but more than 81% of these were obligated in 1994 as a result of the 1993 midwest floods. Godschalk, et. al., at 413.
52 Platt, Disasters and Democracy, at 94.
53 Platt, Disasters and Democracy, at 95-96.
54 Platt, Disasters and Democracy, at 40, quoting Doug Plasencia, Testimony of the Association of State Floodplain Managers before the Senate Subcommittee on Transportation and Infrastructure, February 14, 1995.
55 Platt, Disasters and Democracy, at 96.
56 Mileti, Disasters by Design, at 158.
involvement, responsibility and accountability’ called for in the most recent comprehensive review of federal policy.”

Yet the very same commentator admits that local governments have a limited ability to use land-use management for natural hazard mitigation, because “increased exposure of people and property to flooding has been abetted by federal financing of highway construction, sewers, and other infrastructure that increase development potential in flood-prone areas while also reducing development costs.”

Indeed, the traditional approach to federal natural hazard management in fact construes development projects as natural hazard control projects. A prime example of this is the lower Mississippi. Before the Corps of Engineers’ Mississippi flood control projects, silt from the great river constantly replenished marshes and coastal barrier islands that provided natural protection for New Orleans against coastal storms. Without the silt, the coastline has eroded, leaving New Orleans without natural defenses to storms such as Katrina. Similar examples abound: “[i]n the United States the settlement of hazardous areas has destroyed local ecosystems that could mitigate those hazards. Draining swamps in Florida or bulldozing steep hillsides in California for homesites are examples of human actions that expose more people to natural hazards while destroying natural systems that would have helped minimize flooding.” And yet for all the talk about “sustainable mitigation,” the first response to Katrina has been to question the soundness of the levees and to call for a new, stronger levee system. While widespread, such reaction misses a central lesson about hardscape protection against floods, a lesson clearly stated in the following comment on the 1997 floods in California’s central valley but equally applicable to Katrina:

“Much of the flooding that occurred last year was associated with structural failure of levees, rather than with over-topping. In most cases, levees failed due to prolonged high flood stages associated with unusually large runoff in a system divorced from its ancestral flood plain. Other failures resulted from poor levee maintenance…But several spectacular failures also occurred on levees that were well-engineered, well-maintained, recently inspected and operating within design capacity. It’s easy, but politically and economically naïve, to state that the silver-bullet solution to preventing levee failures is to simply do a better job of design and maintenance. It’s more difficult to acknowledge the most worrisome aspect of levees: No matter how rigorous the engineering and maintenance, even the best levees fail occasionally.”

2. The Natural Hazards Problem with Centralized Development Subsidies: Some Initial Theoretical Observations

What I take from the natural hazards literature is the firm belief that the contemporary natural hazards problem is largely the product of federal ex ante development subsidies and federal ex post disaster insurance and relief schemes. Together, the two programs have not only increased the scale of private development, massively increasing the size of natural hazard losses, but also literally created natural hazards by making millions of acres of land economic to develop that would never have been developed otherwise. If this

57 Mileti, Disasters by Design, at 158-159.
58 Mileti, Disasters by Design, at 159.
59 Ben Wisner, Piers Blaikie, Terry Cannon and Ian Davis, At Risk: Natural Hazards, People’s Vulnerability and Disasters 204 (2d ed. 2004).
is the cause of the natural hazards problem today, then it would seem that there is a simple solution: eliminate both the ex ante federal subsidies and the ex post federal compensation. Joint elimination of these programs is not likely to be politically feasible anytime soon. Indeed, despite longstanding recognition of the development subsidy problem – the Corps of Engineers is, after all, virtually the poster child for federal pork barrel spending – most of the discussion about disaster relief has focused on cutting federal disaster assistance or requiring states and localities to pick up a larger share of both ex ante mitigation and ex post damages. Yet in my view the driving force behind the explosion in natural hazard costs is the system of ex ante centralized development subsidies. The first goal in reducing natural hazard costs should be to create disincentives to those centralized development subsidies.

Non-intuitively, from this point of view, recent efforts to impose a greater share of ex ante mitigation and ex post disaster costs on localities are likely to be inferior to the opposite – increasing the federal share of disaster mitigation and disaster relief costs.

[To be completed. Model will be presented at UVA.]