DISASTER POLICY IN THE U.S. FEDERATION: INTERGOVERNMENTAL INCENTIVES AND INSTITUTIONAL REFORM*

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INTRODUCTION

IN THE U.S. FEDERATION, DISASTER POLICY IS A shared responsibility of federal, state, and local governments. Recent experience suggests, however, that the assignment of responsibilities embedded in the current institutional structure, and the policies that flow from it, are far from optimal. In particular, much of the devastation resulting from the Gulf Coast hurricanes of 2005 could have been avoided at relatively modest cost, evidence of a significant "policy failure."

This paper identifies misaligned incentives among levels of government as a potentially important source of policy failure, arguing, in particular, that existing institutions and policies do not reward state and local governments for costly but socially efficient policies that avoid or limit disaster losses.[1] In brief, because the federal government has assumed a leading role in the provision of *ex post* disaster relief, the benefits of *ex ante* subnational government efforts to avoid disaster losses accrue to the federal government, giving rise to incentives for subnational governments to pursue policies that are insufficiently disaster-averse.[2]

Is it possible to strengthen the incentives for subnational governments to implement policies that limit future disasters? The federal government already undertakes some efforts to induce disaster-avoidance at the micro-spatial level; for instance, the National Flood Insurance Program (NFIP) attempts to limit access to flood insurance to properties that meet certain flood-mitigation standards. Such policies could and perhaps should be strengthened, although doing so raises a host of difficult problems.[3] An alternative, directed specifically toward subnational governments, would be to require the establishment of *ex ante* financial reserves to be utilized in the event of disasters.

The rationale for such mandatory "rainy day funds" is discussed at greater length elsewhere (Wildasin, 2006). The next section of the present paper briefly summarizes the basic logic behind such a policy option. The third section discusses some of the policy issues that would inevitably arise if such an option were to be implemented. This section also presents tabulations providing rough estimates of the potential fiscal burdens that the states would face in complying with a flood reserve funding requirement. Although these estimates fall far short of a serious actuarial analysis of the flood risks facing each state, they suffice to demonstrate two crucially important points. First, these risks vary substantially among the states. Second, the fiscal burdens associated with the accumulation of disaster reserves, though nontrivial, would not require drastic changes in fiscal policy in any state.

PROBLEMS OF MORAL HAZARD IN INTERGOVERNMENTAL FISCAL RELATIONS

As evidenced by the Katrina disaster, the national government in the United States takes major responsibility for the financial losses associated with large natural disasters. Its response after 9/11 indicates that the same is true for terrorism or other man-made disasters. Given its unparalleled capacity to marshall vast financial resources, a persuasive and perhaps compelling normative case can be made for such a federal government role. More to the point for present purposes, the federal government has in fact assumed a major role in financial relief and recovery from recent large disasters, an indication of the presence of very powerful and perhaps irresistible political forces behind such *ex post* disaster interventions.

This federal role in *ex post* disaster policy has not, however, supplanted the role of subnational governments in *ex ante* disaster preparation and avoidance. State and local land use controls, regional and urban economic development policies, environmental policies, transportation, electrical power, water, sewerage, and other infrastructure policies, health, education, and tax policies all influence the spatial distribution of people and property within a state and thus their exposure to spatially-concentrated disaster risks. New Orleans provides

a particularly clear-cut illustration: with about half of the city lying below sea level, a large portion of the population was obviously (and remains) exposed to major (and well-known) flood risks. In all cities, however, land use regulations and other policy instruments can be (and to some extent are) used to limit exposure to floods and other hazards, and all states have policy instruments that can be used to limit or expand development (and of course the density and type of development) in coastal and other areas that face high flood risks. In addition to policies that channel development toward or away from high-risk areas, subnational governments also can (and to some degree do) invest in emergency preparedness (e.g., by investing in infrastructure for emergency communications, evacuation, and emergency care, and in institutional infrastructure such as emergency training for government officials and the general public).

Disaster avoidance and preparation policies by subnational governments are costly and compete for scarce public sector resources. The present intergovernmental assignment of responsibilities for *ex ante* disaster avoidance (where subnational governments play a large role) and *ex post* disaster relief (where the federal government plays a large role) certainly weakens the incentives for subnational governments to devote costly effort and resources to disaster avoidance, since the disaster-avoidance resources expended *ex ante* by subnational governments reduces the fiscal burden of *ex post* disaster relief for the federal government. The benefits of such precautionary behavior thus accrue largely to the rest of society, not to the state and local taxpayers who must bear its cost. These misaligned incentives are conducive to inefficiently low levels of *ex ante* disaster avoidance by subnational governments.

The incentives for state and local governments to implement costly disaster avoidance policies would be strengthened if they were mandated to build substantial financial reserves that would be tapped in the event of a major disaster as a condition of receiving *ex post* federal disaster relief. States and localities already maintain modest financial reserve funds ("rainy day funds") in order to facilitate orderly management of ongoing budgetary operations and, to some degree, to provide a cushion in the event of adverse fiscal or financial shocks, but these reserves are entirely discretionary. The disaster reserve funds proposed here would be mandated by the federal government, in amounts commensurate with the disaster risks faced by different states. Furthermore, these financial reserves – henceforth, "mandated disaster reserves," or MDRs -- would only be released for state use in the event of a presidential disaster declaration. Under existing policy, such declarations are already a precondition for the release of federal disaster assistance to state governments. With a system of MDRs in place, states would likewise qualify for federal disaster assistance in addition to the release of their reserves, but the state reserves would constitute the initial source of financial resources for disaster recovery and relief.

The most important design issues for a system of MDRs concern the terms on which money is paid into and distributed from them and would presumably follow standard insurance principles. To achieve the fundamental goal of strengthening disaster-avoidance incentives, state reserve requirements would be determined by state-specific actuarial estimates derived from historical disaster loss experience, to be adjusted over time in accordance with favorable or unfavorable loss experiences. This is a nontrivial actuarial exercise because it depends on a determination not only of underlying probability distributions of disaster losses, but of *shifts* in these distributions. Such shifts – hopefully, in the direction of reduced disaster losses – can only be discerned with a lag, during which time disaster reserves would be overfunded or underfunded. However, provided that states and localities retain ownership of these reserves and provided that the reserves can be invested in suitable financial instruments, reserve overfunding creates no net burden on a state in present-value terms. Persistent underfunding would require increased contributions.

When disasters strike, MDRs would provide an initial source of post-disaster relief and recovery funding, augmented by federal funds. Under a simple linear distribution formula, states would cover the entirety of their disaster losses from accumulated MDR funds up to some maximum level D (a "deductible") and would then pay a fraction c of all losses above this amount (a co-payment), supplemented by federal government contributions at the rate $1 - c$, up to the point where the reserve fund is exhausted. In the event of very large disasters, a state's MDR would be depleted and the federal government would presumably implement some supplementary disaster relief program at that stage. The determination of the optimal

coinsurance and deductible parameters c and D, a standard (though nontrivial) insurance problem, is not analyzed further here. For present purposes, the important point is simply that states would face non-zero deductibles and co-payments under any actuarially-fair reserve system, in contrast to current policy which, as revealed by the federal response to Katrina, sets these values close to zero, providing minimal incentives for subnational governments to undertake costly disaster avoidance.[4] An actuarially-fair MDR program would strengthen these incentives considerably.

In the absence of MDRs, it is of course possible in principle for the federal government to limit the assistance that it offers to a state or region in the event of a major disaster, just as private insurance policies provide limited benefits under specified terms. Such a policy is not credible, however (see Wildasin, 1997 and Caplan et al., 2000). Once disaster strikes, a state and its subsidiary local governments are in financial and fiscal distress, including limited (or unusually costly) access to financial markets. As noted earlier, the case for federal assistance in such instances is normatively persuasive or perhaps compelling, and in any case may be politically irresistible. On the other hand, no such distress circumstances block the accumulation of MDRs and there would presumably be little political objection to the use of these funds in times of emergency. In this case, costly *ex ante* disaster-avoidance efforts by the state and its localities would enable it to save real resources by reducing the magnitude and probability of payouts from its mandated reserve fund.

STATE-SPECIFIC FLOOD RISKS

In order to provide some insight into the likely cost of a system of MDRs, this section presents some illustrative state-level calculations of funding requirements. The discussion henceforth focuses solely on flood disasters, primarily because data on flood losses are readily available.[5] Since flood damages exceed all other types of disaster losses, this case is by no means empirically uninteresting, but calculations for other types of disasters, similar to those presented later, could (and should) be undertaken in future analysis.

Some notation will clarify the calculations and the simplifying assumptions on which they are based. First, let the total flood losses experienced by state i in year t be denoted by L_{it}. Most of these losses

accrue to households and firms, while some represent the destruction of public-sector assets, including the disruption of normal governmental operations. Some fraction of these losses will fall upon the state or its subsidiary local governments, while the remainder is borne by private agents. For simplicity, assume that this fraction s is the same for all states, taken as $s = .3$ in the following calculations. That is, the calculations assume that 30 percent of total disaster losses are borne by the public sector which, in the absence of any assistance from the federal government, means that this is the proportion of flood losses borne by state and local governments.[6] The calculations that follow assume that, that is, 30 percent of total disaster losses must be paid by the state and local governments, in the absence of any offsetting federal relief.[7] Thus, the disaster risk facing state i is represented by the random variable sL_{it}.

Under a system of actuarially fair MDRs, each state maintains a reserve fund sufficient to pay an average annual loss of $E[sL_{it}]$. In practice, holding constant the underlying natural hazard risks and ignoring the possible strengthening (or weakening) of disaster-avoidance policies over time, flood losses rise over time because of economic and population growth. As an alternative, consider the income-normalized flood losses for each state, denoted by L_{it}/Y_{it} where Y_{it} denotes state personal income. At the national level, total flood losses display no significant trend relative to personal income, either for the entire period 1929-2003 for which national-level data are available or for the 1955-2003 sub-period covered by the state-level data. Let us therefore assume that each state's income-normalized flood loss L_{it}/Y_{it} is identically and independently distributed over time with a mean that is well estimated by the observed state-specific sample mean.[8] That is, denoting the latter by M_i, we assume that $M_i = E[L_{it}/Y_{it}]$ for each state i. It follows that flood damages impose an expected annual fiscal burden of sM_i on state i relative to state income. A proportional income tax at this rate would generate a stream of annual tax revenues equal to sM_iY_{it}, which would be sufficient to fund an actuarially fair MDR. With a real interest rate of r, and assuming constant growth in personal income over time, this revenue stream has a present value, expressed as a share of current state income, equal to sM_{it}/r. Assuming $s = .3$ and $r = .03$, this means that each state's MDR should be 10 times larger than its mean annual flood losses.

Table 1 presents illustrative calculations based on the foregoing methodology. For each state, the

Table 1
**Flood Losses, Fiscal Burdens, and Reserve Funds By State,
as Percentage of State Personal Income**

State	Total Flood Losses	Annual Fiscal Burden	Reserve Fund
AL	0.06%	0.02%	0.61%
AK	0.23%	0.07%	2.26%
AZ	0.07%	0.02%	0.70%
AR	0.17%	0.05%	1.71%
CA	0.06%	0.02%	0.58%
CO	0.22%	0.07%	2.24%
CT	0.15%	0.05%	1.53%
DE	0.00%	0.00%	0.05%
FL	0.03%	0.01%	0.26%
GA	0.02%	0.00%	0.15%
HI	0.02%	0.01%	0.24%
ID	0.40%	0.12%	4.05%
IL	0.05%	0.01%	0.49%
IN	0.07%	0.02%	0.65%
IA	0.35%	0.11%	3.55%
KS	0.11%	0.03%	1.08%
KY	0.14%	0.04%	1.40%
LA	0.28%	0.08%	2.81%
ME	0.03%	0.01%	0.27%
MD/DC	0.03%	0.01%	0.26%
MA	0.04%	0.01%	0.42%
MI	0.01%	0.00%	0.11%
MN	0.11%	0.03%	1.10%
MS	0.25%	0.07%	2.49%
MO	0.16%	0.05%	1.63%
MT	0.11%	0.03%	1.13%
NE	0.13%	0.04%	1.30%
NV	0.08%	0.02%	0.79%
NH	0.03%	0.01%	0.25%
NJ	0.05%	0.01%	0.49%
NM	0.03%	0.01%	0.29%
NY	0.03%	0.01%	0.27%
NC	0.05%	0.02%	0.54%
ND	0.89%	0.27%	8.85%
OH	0.03%	0.01%	0.28%
OK	0.12%	0.04%	1.21%
OR	0.22%	0.07%	2.18%
PA	0.15%	0.05%	1.53%
RI	0.05%	0.01%	0.46%
SC	0.01%	0.00%	0.10%
SD	0.41%	0.12%	4.12%
TN	0.03%	0.01%	0.31%
TX	0.12%	0.04%	1.20%
UT	0.13%	0.04%	1.33%
VT	0.10%	0.03%	1.05%
VA	0.09%	0.03%	0.86%
WA	0.04%	0.01%	0.35%
WV	0.20%	0.06%	2.01%
WI	0.04%	0.01%	0.43%
WY	0.03%	0.01%	0.33%

Unweighted Mean, All States: 0.12%

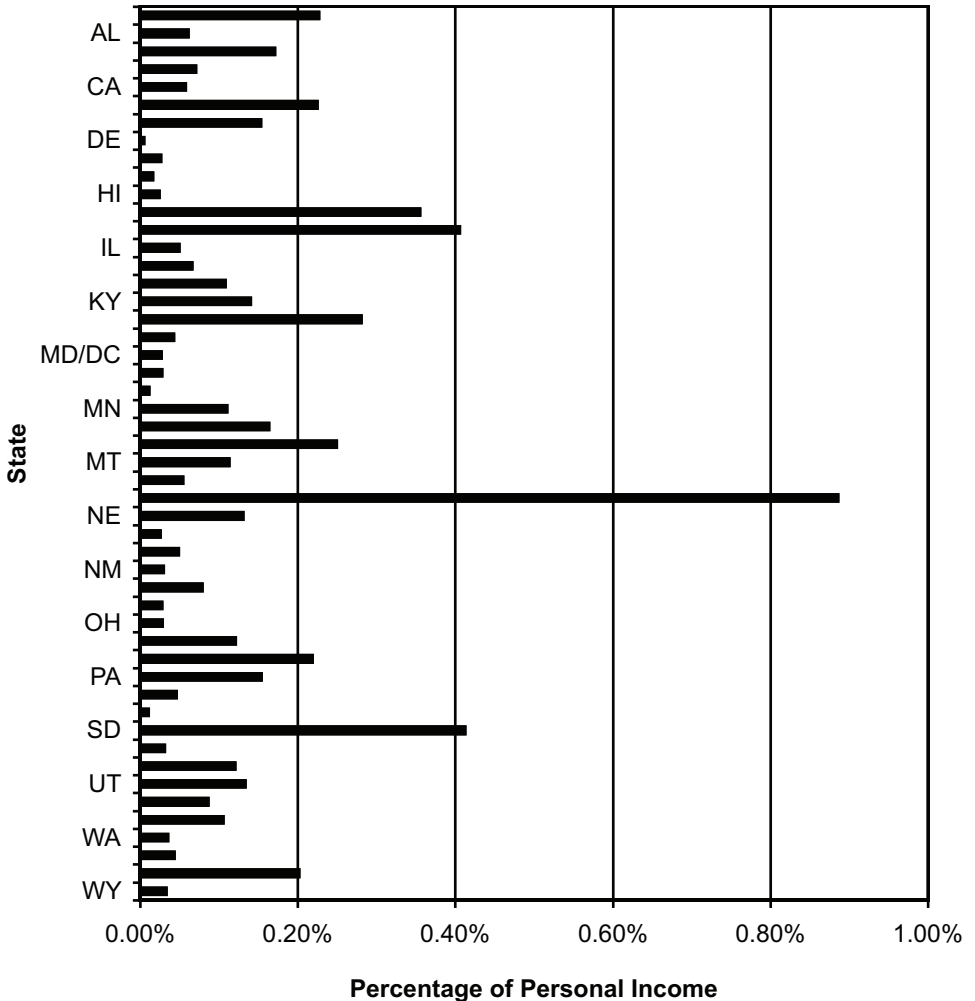Louisiana, including estimated 2005 flood losses:

	0.37%	0.11%	3.70%

Source: Pielke et al. (2002), Bureau of Economic Analysis, author's calculations.

first column ("Total Flood Losses") shows mean annual flood losses, expressed as a proportion of state personal income, for the period 1955-2003 (omitting 1980-1982, as noted earlier). These data are also displayed graphically in Figure 1. The second column ("Annual Fiscal Burden") is simply 30 percent of the first. Ignoring the behavioral responses to tax policies, it is a rough estimate of the effective personal income tax rate that would have to be imposed in each state, on average, in order to maintain an actuarially fair flood loss reserve fund. The final column ("Reserve Fund") shows the size of the reserve fund itself (a stock), expressed as a proportion of state income (a flow); assuming a real interest rate of 3 percent, it is simply one order of magnitude larger than the figures in the first column. Since states do not now have such funds, they could theoretically impose a one-time tax with an effective tax rate on personal income given by the figures in the last column in order to fund their reserves in a single year. More realistically, of course, the necessary reserves could be built up over a period of a decade or so, thus spreading out the cost of initial

Figure 1: **Flood Losses by State As Percentage of State Personal Income**

reserve funding and requiring much more modest initial tax increases. Although the figures in Table 1 are drawn from data covering the period 1955-2003, the last row shows how the calculations for Louisiana are affected if one incorporates flood losses for 2005 with an estimated value of $80 billion.

Although the total annual flood losses in the United States amount to about 0.08 percent of national income, the figures in the first column of Table 1 show that the incidence of flood damages is far from uniform across the states. The median loss is 0.07 percent, but 10 states have annual losses of 0.20 percent of personal income or more. In ascending order, these high-risk states are West Virginia, Oregon, Colorado, Arkansas, Mississippi, Louisiana, Iowa, Idaho, South Dakota, and North Dakota – the last, with flood losses at 0.89 percent of personal income, the state with the highest flood losses, by a factor of more than two. The states with flood losses of less than 0.03 percent of personal income, in ascending order, are Delaware, South Carolina, Michigan, Georgia, Hawaii, New Hampshire, Florida, Maryland/DC, Maine, New York, Ohio, and New Mexico. As these lists indicate, not only are the magnitudes of flood losses widely different among states, these losses are also widely dispersed geographically.

As shown in the second column of the table, the effective income tax rates needed to finance MDRs vary among the states in accordance with flood risks. In North Dakota, the effective tax rate would amount to about one quarter of a percent – certainly a nontrivial fiscal burden. But the fiscal burdens of MDRs would be much smaller in other states, exceeding 0.1 percent in only four states. The MDRs themselves would exceed 1 percent of state income in about half of the states and would be larger than 2 percent of personal income in the 10 states with the highest flood losses.

Had a system of MDRs been in place before 2005, the state of Lousiana would have accumulated a disaster reserve of about 2.8 percent of state personal income, or slightly more than $3 billion – less than one-tenth of total flood damages from Katrina. Thus, the pressure for substantial *ex post* federal disaster relief following Katrina would have been little affected by the existence of the MDR. On the other hand, this reserve would have been sufficient to have paid a large fraction of flood losses in the state in all past years, thus significantly reducing the amount of federal

emergency assistance paid out. More importantly, having a $3 billion disaster reserve directly at risk in the event of flooding (compared to annual state and local spending of about $20 billion annually) might have affected state and local policymaking in past years in a way that would have lessened the massive losses caused by Katrina.

Finally, to illustrate the importance of large disasters and the challenges that they create for the design and management of MDRs, consider the impact of Katrina on the Table 1 estimates of Louisiana flood losses. The precise amount of the total losses from Katrina is not known with certainty but a figure of $80 billion is realistic; conservatively, losses amounted to 50 percent of state income. To extend the 1955-2003 data forward to include Katrina, then, suppose that this figure is accepted for 2005, and that there were no flood losses in 2004. The new estimated mean flood loss for Louisiana, as a percentage of state income, now increases from 0.28 percent to 0.37 percent. Clearly, this one event would have a large impact on the level of contributions to the state MDR and the size of the reserve itself, just as the 1997 Grand Forks flood approximately doubled the mean annual flood loss (as a share of income) in the state of North Dakota. Indeed, it is well-known that infrequent but large disasters typically account for a very large share of all disaster losses, and the experiences of North Dakota and Louisiana simply illustrate this fact. Determining optimal disaster reserves for rare large events is a statistically challenging task, but one that is inherent in disaster insurance. In the private insurance sector, reinsurance provides a useful instrument for management of such risks, and it is possible that similar mechanisms could be utilized in the management of state-level disaster risks. This possibility must await further investigation, however.

CONCLUSION

Intergovernmental policy coordination is often a very challenging problem, and it appears that this is true in the case of disaster policy. In particular, many subnational government policy instruments affect the spatial distribution of people and economic activity and thus their exposure to risks from floods and other natural disasters. The incentives for these governments to undertake costly risk-avoiding policies are weakened if the benefits from doing so accrue substantially to the federal

government, in the form of reduced disaster relief expenditures. Mandated disaster reserve funds would strengthen the incentives for states and their subsidiary governments to pursue policies that reduce disaster losses. Illustrative calculations, focusing exclusively on flood losses, show that flood risks vary widely among the states. The fiscal burdens of an actuarially fair MDR system would vary accordingly among the states. Although modest, they would give rise to interstate fiscal differentials that reflect real social costs of disaster risk and would thus contribute to more efficient interstate allocations of resources.

Many specific questions regarding the design and implementation of any system of MDRs have not been touched upon here. Some of these questions are legal in nature; for instance, it is not clear (at least to this author) whether federally mandated reserves would be constitutional.[9] MDR funding requirements could (and presumably should) be based on the imputed value of lives lost in addition to property losses.[10] These and many other issues deserve more discussion than can be provided here.

Although much of the earlier discussion focuses on floods, the basic policy issues arise with respect to all types of disasters. Floods are quantitatively the largest disasters that occur with much regularity and therefore deserve attention because of their magnitude. However, similar policy issues arise with respect to earthquakes, terrorism, and other hazards. An extension of the analysis to cover such hazards is straightforward, in principle, but lies beyond the scope of this paper.

Notes

[1] These ideas are developed at greater length in Wildasin (2006, forthcoming).

[2] The New Orleans case illustrates policy failures at all levels of government. For instance, had the Army Corps of Engineers not built the levee system around New Orleans that failed during Hurricane Katrina, perhaps neither the state of Louisiana nor the city of New Orleans would have done so. In this case, below-sea-level development in New Orleans would have been substantially curtailed and the damages from Katrina would have been far smaller. Of course, the city of New Orleans and state of Louisiana could have curtailed development in high-risk areas even after the levees were built, but elected not to do so. Any or all of these governments could also have elected to strengthen the levee system.

[3] Relatively few eligible property owners choose to obtain NFIP; of those who do (perhaps in order to qualify for mortgages), many allow their flood insurance policies to lapse. A reduction in premiums would increase the take-up of flood insurance, while exacerbating the problem of excessive development in areas prone to flood risks. (See Kunreuther, 2006 for further discussion of these issues.) Determining actuarially-fair premiums for the flood risks facing individual properties is a difficult task, and perhaps especially so for the federal government, which cannot easily assemble and process information on all properties and local conditions in the United States. As regularly noted in the annual reports of NFIP actuaries (e.g. Hayes and Jacobson, 2001, p. A-3), "Some of the factors that increase flood hazard (e.g., local urban drainage problems and urbanization of other parts of the watershed) are virtually impossible to quantify if the Flood Insurance Study process is to remain cost effective."

[4] Accurate data on the precise magnitude of the losses from Katrina and of federal post-Katrina assistance are not yet available (Bea, 2006) estimates the latter at about $80 billion so far) , but it appears that the state of Lousiana, in particular, has been approximately fully indemnified for the entirety of the disaster losses it faced as a result of this disaster, with a combined fiscal surplus for the past and present fiscal years of $1.6 billion and surpluses predicted for coming years, as well (Moller, 2006)).

[5] The flood loss data are taken from Pielke et al. (2002). State-level data are available for the period 1955-2003, except for 1980-1982 (when federal data collection was interrupted).

[6] In reality, s is an important policy choice for each state, since it affects the incentives for private agents to obtain private insurance and to expose themselves to flood risks.

[7] The public sector share of .3 is much lower than the loss shifted to the federal government in the Katrina disaster, which, as discussed further in Wildasin (2006, forthcoming), is probably closer to 75 percent. (See also Bea, 2006.) For smaller disasters, a figure closer to .3 may be more accurate. To see the first-order effects of different assumptions, the reader can easily rescale the figures below by a simple factor of proportionality, as desired (e.g., if state and local governments incur costs equal to .15 of total disaster losses, their funding requirements would be half the amounts shown later). To the author's knowledge, no data exist, except possibly in unpublished government archives, that would allow a more accurate assessment of the losses incurred by different levels of government in past disasters. Whatever the true figures may be, note that they represent the realized outcomes of past disasters, including not only the natural events that create them, but the policy choices that determine the underlying

total losses L_{it} as well as the policy variable represented here by the variable s. Because loss distributions are heavy tailed (see Wildasin, forthcoming for further discussion and estimates), the large disasters, such as Katrina and 9/11, should count disproportionately in any estimation of the public-sector share of disaster losses.

[8] Needless to say, this is far from a proper actuarial analysis of the state-specific flood risk distributions. See Wildasin (forthcoming) for further discussion of this problem, including estimates of a disaster loss distribution for the state of Louisiana. In that case, perhaps unsurprisingly, the estimates are quite sensitive to the inclusion of flood losses for 2005 (i.e., Katrina). Actuarial studies have shown repeatedly that disaster losses are dominated by small numbers of very large events (i.e., the probability distributions of disasters losses are heavy tailed). This presents interesting challenges for statistical modeling that unfortunately cannot be discussed further in the space available here.

[9] The federal government can try to impose mandates on states indirectly by threatening to withhold other federal funds, of course, although such relatively opaque enforcement mechanisms add still more clutter to an already complex system of intergovernmental relations.

[10] In New Orleans as in some other major flood disasters, many of the victims whose lives were lost were poor people living in poorlyserved neighborhoods. (The same is true for the Okeechobee hurricane of 1928, which killed about 2,000 people in South Florida.) In general, it is to be expected that poor people will disproportionately occupy neighborhoods and regions with high disaster risks, just as is the case for exposure to environmental hazards, crime, and other dis-amenities and hazards. An MDR system could make allowances for the "social value" of lives lost in disasters, thereby strengthening the incentives for states and localities to protect the poor. Special provision for loss of life may be justified as a paternalistic intervention on behalf of people – not only the poor – who do not well understand the nature of the disaster risks to which they are exposed.

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