Risk Management and Cost Avoidance for Extreme Events

Discussion Document

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Transportation Security Administration

Our Purpose

- **!Disclaimer!:** We are here only to exchange ideas for consideration and further research. We are not seeking consensus, or input into federal policy.
- **Our Mission: Secure the transportation system while ensuring the free flow of commerce.**
- TSA suggests the panel consider that work or research could be done to monetize Cost Avoidance
  - We think there is a business case to be made for security and that will not adversely affect commerce.
- TSA suggests the panel consider work to understand and manage the risks associated with extreme or catastrophic events
- TSA suggests the panel consider the SCC framework as a way to stay involved in policy debates for transportation security

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Managing Risks associated with Extreme Events

"Most firms have developed their own methods of risk assessment but have not translated this into quantifiable business impact" (MIT)

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Risk in a connected world

- "The scope of supply chains sources and the markets are global. So are the risks" (Jack Barry)
  - Greater scope means greater exposure to low-probability/high-consequence events
- Interdependent Security
  - Interconnections between firms will greatly increase their exposure to risk
  - "The expectation that others will not adopt protective measures reduces the incentive that a particular [company] has to incur these costs."
- The answer is not to disconnect
  - Firms rely on their supply chain partners to innovate
- Analyzing extreme events is difficult (terrorism & natural hazards)
  - Irrelevance or absence of historical data
  - Consequences involve cascading failures

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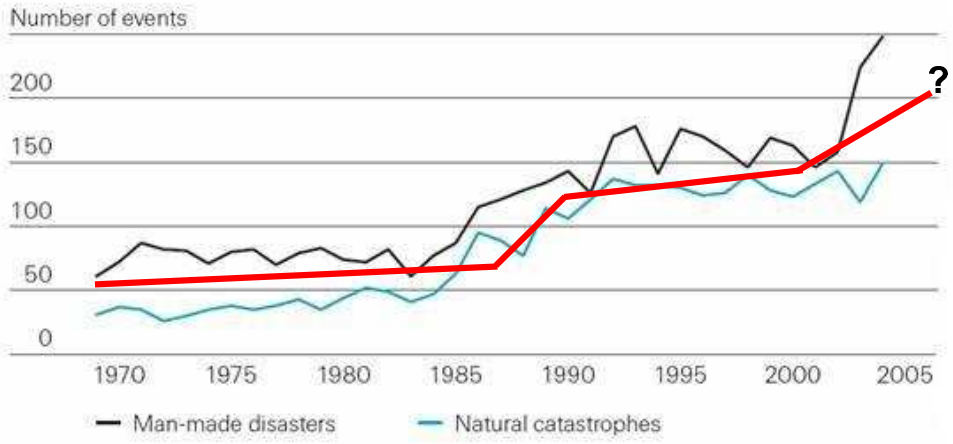
- Scope
  - "The greater uncertainties in supply and demand, globalization of the market, shorter and shorter product and technology life cycles, and the increased use of manufacturing, distribution and logistics partners resulting in complex international supply network relationships, have led to higher exposure to risks in the supply chain" (Lee)
  - "supply chains…are in fact networks connecting businesses, industries, and economies. Consequently the diverse range of effects triggered by even a modest incident can fail to lead to underlying weakness being diagnosed if they are considered in isolation and not as part of the wider, overarching system." (Cransfield University)
- Interdependent
  - "interconnections between firms will greatly increase their exposure to terrorism risk"
  - Case Studies
    - Phillips and Ericcson
    - SARS
    - Taiwan earthquake
    - the volcanic destruction of the Javan island of Krakatoa (or the flood disaster of Bangladesh) was unbelievable - but, the US had not outsourced to it
- Don't Disconnect
  - 2002 Economist survey of CEOs found that over 65% of the respondents reported that they have become and will become more dependent on external relations to achieve their business objectives

Swiss Re estimate of Man-Made and Natural Castrophes



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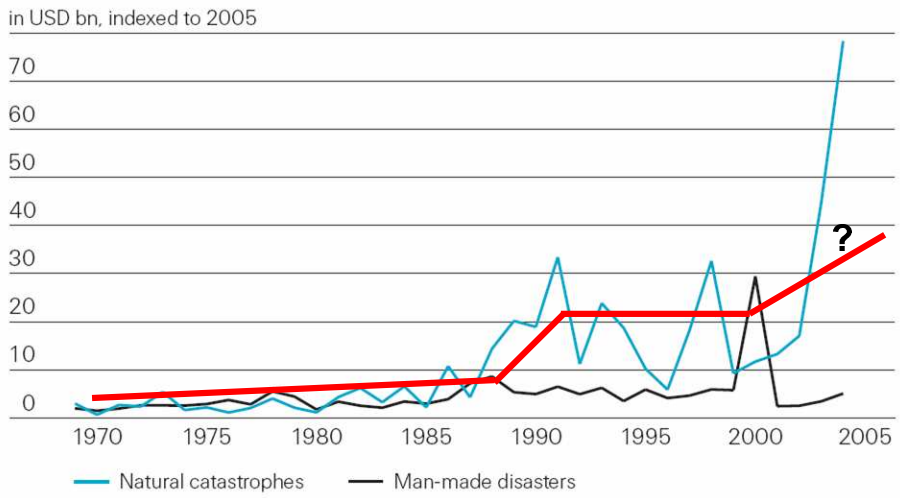
Swiss Re estimate Insured Catastrophe Losses



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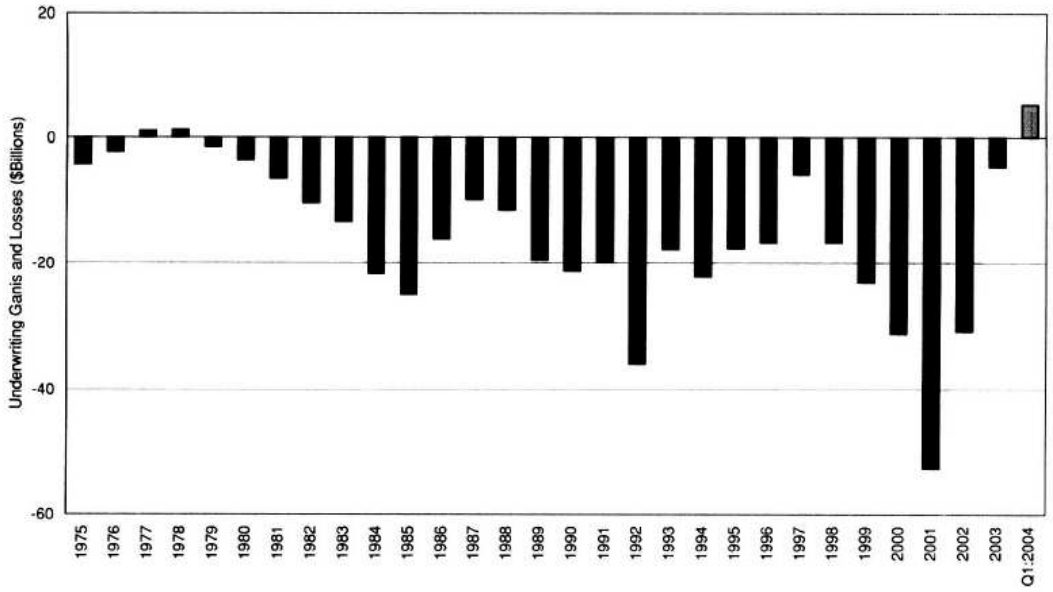
- 9/11 caused 30billion in insured losses (OECD)
- Katrina caused 40billion in insured losses (WSJ, July, 2006)
- While the vast majority of the monetary loss was isolated into a few extreme events (e.g. Katrina, 9/11), the majority of events were fires and explosions in the industrial sector (gas, oil). Appx $5 billion
- Most of the increase in monetary losses is due to extreme natural disasters. Perhaps because we have more valuable infrastructure to lose?
- Industrialized nations dominate insurance loss because of higher insurance density
- Lack of engineering safety features in highly exposed areas (especially in developing countries)

Insurance Services Office estimate of Underwriting Gains and Losses

Total U.S. Property and Casualty Insurance Industry Underwriting Gains and Losses 1975-Q1:2004 ($ Billions).



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- ...In a recent speech, Allstate Chief Executive Edward M. Liddy painted a vivid picture of how a tightly packed set of storms could erase first the profits, then potentially the financial stability, of an insurer in a quick blast.

- "When Hurricane Andrew hit the coast of Florida in 1992," Liddy told a Washington audience in January, "it wiped out all of the profits Allstate ever made in the state from all lines of insurance over the course of our history.... And when four hurricanes hit in 2004, they wiped out all the profits from 1992 to 2004.

- "That's not a viable economic proposition for a company," he told his audience. "It's not a viable economic proposition for an industry."

- http://www.latimes.com/news/nationworld/nation/la-na-insure5apr05,0,49873,full.story?coll=la-home-nation

Interdependent Risk: Items to keep in mind

- Risk of Extreme Events
- Agility and Resilience
- Collaboration and Coordination
- Network perspective
- Analytical Difficulties
- **Quantifying Cost Avoidance**

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- "Most of us have been affected by the growing number of extreme events. We've looked for cost effective ways to improve agility and resilience - perhaps by increasing collaboration and coordination with other entities, buying more insurance - engaging in derivatives trading and looking for other ways to quantify catastrophic cost avoidance measures, and founding or growing risk management departments to increase insight into and control of the supply chain network. The next few slides will did deeper into these concepts."

Organizational Excellence: Agility and Resilience

- The array of risks faced by global firms is too complex to rely on prevention. Resilience or Adaptive Capacity must be a pillar of a firm
  - C.S. Hollings and the Adaptive Cycle
- "Agility has become more critical in the past few years because sudden shocks to supply chains have become frequent" (Lee)
  - Informational rather than physical activities form the core of security measures
- Resilience: "The ability to react to unexpected disruption and restore normal supply network operations". (Sheffi)
  - Resilient companies rely on their organization rather than technology to develop resilience and security
- Short run efficiency can effect long run robustness against market shocks.
  - Design security and resilience into processes
- Flexibility & Redundancy
  - Toyota/Aisin Fire
  - Nokia and Phillips

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- C.S. Hollings: Three properties of the adaptive cycle
  - Wealth: The inherent potential of a system that is available for change, since that potential determines the range of future options possible. This property can be thought of, loosely, as the "wealth" of a system.
  - Controllability: The internal controllability of a system; that is, the degree of connectedness between internal controlling variables and processes, a measure that reflects the degree of flexibility or rigidity of such controls, such as their sensitivity or not to perturbation.
  - Adaptive Capacity: The adaptive capacity; that is, the resilience of the system, a measure of its vulnerability to unexpected or unpredictable shocks. This property can be thought of as the opposite of the vulnerability of the system.

- Resilient
  - Previously experienced major disruptions
  - Redesigned their supply networks for flexibility and redundancy
  - Used failure modes analysis to develop business continuity plans
  - Relied on their organization rather than technology to develop resilience and security (MIT—Sheffi, Rice)
- Efficiency
  - **"Ceteris Paribus, companies whose supply chains became more efficient and cost-effective didn't gain a sustainable advantage over their rivals. In fact, the performance of those supply chains steadily deteriorated." (Lee)**

Collaboration and Coordination

- Interdependent Security necessitates greater collaboration between organizations
  - "focusing on internal security and operations does not address the aforementioned dependence on infrastructure or the external supply network system" (MIT Report)
  - "Collaboration will be the most strategic capability in the extended supply chains" (Kemppainen, Vepsalainen)
- Disruptions can be caused not by an attack but by the government's response to an attack (Sheffi)
- Managing risk requires partnerships between government and industry
  - Government has information on threat
  - Industry understands its vulnerabilities
- "…a key priority for supply chain risk reduction has to be the creation of a supply chain community to enable the exchange of information between members of the community. The aim is to create a high level of 'supply chain intelligence' where by there is a greater visibility of upstream and downstream risk profiles" (Cransfield University)
- Higher levels of trust = lower transaction costs.

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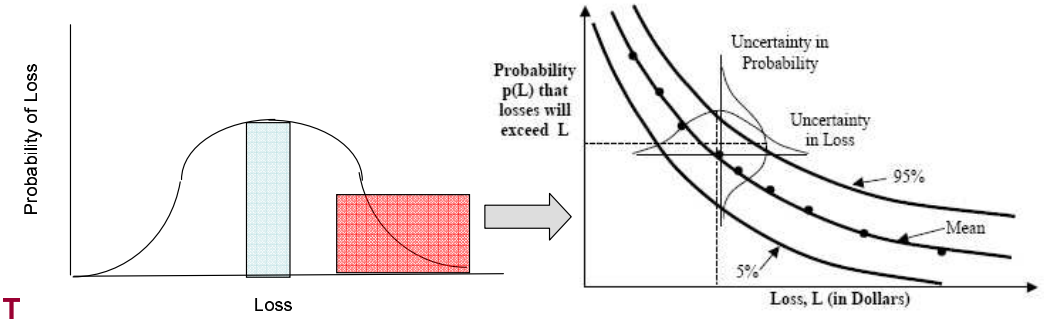
- "given that firms are exposed to vulnerabilities outside the auspices of the firm (risks associated with the other firms in the supply network), a more formal process to assess the network risk seems appropriate…specifically, focusing on internal security and operations does not address the aforementioned dependence on infrastructure or the external supply network system" (MIT—Sheffi, Rice)
  - Gov disruptions
    - •Ford has 13% drop in production in 4th quarter of 2001 because it couldn't get parts from Canada
    - •Longer and less reliable lead times (Sheffi) (Lee)
    - •Politically more feasible for gov to over-react rather than under-react (MIT—Sheffi, Rice)
  - Trust
    - •"Businesses…fail to recognize the damaging effect that the lack of trust by [the supply chain's] users and members can have" (Lee)
    - •"A lack of trust causes companies to duplicate activities between its own operations and its outsource partners." (Scott Beth)
    - •Joint metrics on risk is the only way to get trust (Chris Gopal)
    - •Searching costs, bargaining costs, control costs (Skjoett-Larsen, Thernoe, Andresen)
    - •Level of uncertainty, frequency, and assets specificity of transaction
    - •"A supply chain works well if its companies' incentives are aligned—that is, if the risks, costs, and rewards of doing business are distributed fairly across the network." (Narayanan, Raman)

Risk of Extreme Events and the Fallacy of Expected Value

- Why worry about low-probability/extreme consequence events?
  - **Greatly expanded scope of operations leads to increased exposure extreme events**
  - **Consequences may not be reversible**
- Typically, measures of risk use expected value as a representative measure
  - However, "the mathematical expected value concept pre-commensurates low-frequency events of extreme or catastrophic consequences with high frequency events of minor impact." -Haimes
- Instead, start with a consequence threshold and work backwards.
  - Partitioned Multi-Objective Method (See Appendix)



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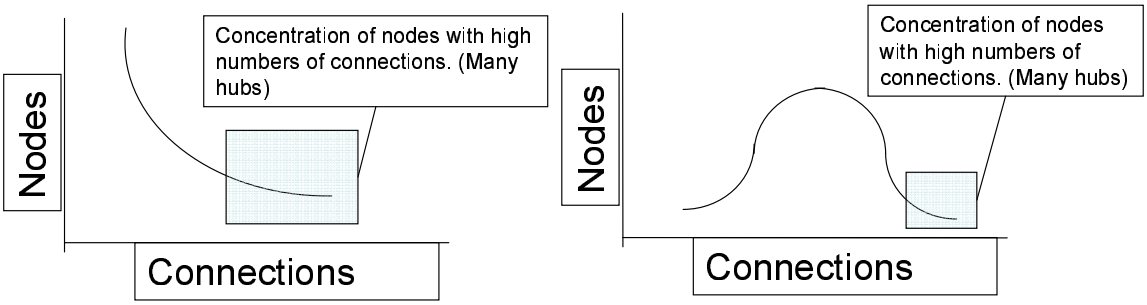
- "The ultimate utility of decisions analysis, including risk-based decision-making, is not necessarily to articulate the best policy option, but rather to avoid the extreme, the worst, and the most disastrous policies—those actions in which the cure is worse than the disease" - Haimes
- Other fallacies of expected value---Imagine if (Runyon, 1977)
  - "Highways were constructed to accommodate the average traffic load of vehicles of average weight"
  - "Mass transit systems were only designed to move the average number of passengers"
  - "Bridges, homes, and buildings were designed to withstand the average wind or average earthquake"

Network Perspective

- It is not possible to predict and mitigate all threats. It is especially difficult to handle the "unknown unknowns".
- But we can determine how vulnerable the whole network will be depending on the disruption we want to prevent.
  - By discerning a network's global structure, we can determine the most critical nodes in a network to protect.
- Determining what kind of network we are dealing with will determine the appropriate strategy and how to distribute resources.



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- There are two basic types of networks.
  "Scale-free" Networks (e.g. Airport System)
  "Random" Networks (e.g. Highway System)
- Determining what kind of network we are dealing with will determine the appropriate strategy and how to distribute resources.

- **Scale-free networks are extremely tolerant of random failures.** In a random network, a small number of random failures can collapse the network. A scale-free network can absorb random failures up to 80% of its nodes before it collapses. The reason for this is the heterogeneity of the nodes on the network -- failures are much more likely to occur on relatively small nodes.

- **Scale-free networks are extremely vulnerable to intentional attacks on their hubs.** Attacks that simultaneously eliminate as few as 5-15% of a scale-free network's hubs can collapse the network. Simultaneity of an attack on hubs is important. Scale-free networks can heal themselves rapidly if an insufficient number of hubs necessary for a systemic collapse are removed.

- **Scale-free networks are extremely vulnerable to epidemics.** In random networks, epidemics need to surpass a critical threshold (a number of nodes infected) before it propagates system-wide. Below the threshold, the epidemic dies out. Above the threshold, the epidemic spreads exponentially. Recent evidence indicates that the threshold for epidemics on scale-free networks is zero.

Analyzing Extreme Events: Terrorism vs. Natural Hazards

	Natural Hazards Potential Catastrophic Losses	Terrorism Risks Potential Catastrophic Losses
Historical Data	Some historical data: Record of several extreme events already occurred	Very limited historical data: 9/11 events were the first terrorist attacks worldwide with such a huge concentration of victims and insured damages
Risk of Occurrence	Reasonably well specified: well-developed models for estimating risks based on historical data and expert's judgement	Considerable ambiguity: Terrorists can purposefully adapt their strategy depending on their information on vulnerability—dynamic uncertainty
Geographic Risk	Specific areas at risk (California, Florida)	All areas at risk: some cities riskier than others, but terrorists can strike anywhere anytime
Information	Information Sharing: New scientific information can be shared with others	Asymmetry of information: governments keep secret new information on terrorism for obvious national security reasons
Event Type	Natural Event: To date, no one can influence the occurrence of a natural event	Resulting Event: Governments can influence terrorism
Preparedness and Prevention	Insured can invest in well-known mitigation measures	Weapons and configurations are numerous. Negative externalities of protection efforts; substitution effect in terrorist activity.
Catastrophe Modeling	Developed in late 80s and dearly 90s	The first models were developed in 2002

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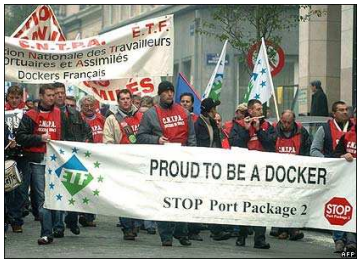
Cost Avoidance—Extreme Risk and Finance Options

Secure the transportation system while ensuring the free flow of commerce



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- It starts with our mission---Secure the transportation system while ensuring the free flow of commerce. TSA is advocating for Cost Avoidance because we think there is a business case to be made for security and that will not adversely affect commerce. Security may not currently be sufficient in supply chains because there are not adequate methods for assessing risk to make the business case for it. Or there may not be an understanding that there are collateral commerce benefits to improved security. However, if industry can develop those risk methods and tools by engaging in an exchange of ideas of how to do it among themselves and with the government, we may raise security while ensuring the free-flow of commerce.

- simple example of cost avoidance..."replace a human with a machine...", more complex cost avoidance "this 15 acre parcel in New Orleans is 3 times more expensive than that one...however, the more expensive one is 30 feet higher...". What gets missed in the second example is the cost to REPLACE AN ENTIRE factory as well as the potential loss of SHELF SPACE from non-delivered products, the loss of market share, the loss of market cap...(this is the point I plan to make in my remarks).

Financing for extreme events: Insurability

- Insurable risks depend on… (OECD)
  - Quantifying the probability and severity of losses (assessability)
  - Event must be unpredictable and occurrence of the event must be independent of the will of the insured (randomness)
  - A risk community must exist to share and diversify the risk (mutuality)
  - It must be possible to calculate a premium commensurate with the risk (economic insurability)
- Traditional risk management options for extreme events are becoming less available/affordable
  - Difficult to analyze—especially in calculating probability
  - Lack of access to capital
  - Many insurance companies pulled out of the terrorism insurance business immediately after 9/11.
  - Many insurance companies are pulling out of the Gulf Coast area for hurricane insurance.

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- Firms develop their own methods
  - Lack useful tools to assess risk of loss
  - Those who could quantify assessments in terms of $$ loss found greater success in gaining support for investment (MIT—Sheffi, Rice)

Financing for extreme events: Difficulties and Barriers

- Losses associated with a very large events remain beyond the capacity of private insurance to price and absorb alone (OECD)
- Re-insurers are hesitant to fund risk especially after Katrina. Exception is Warren Buffet
  - "If you like to watch football, you probably enjoy the game a little more if you have a bet on it…I like to watch the weather channel." (WSJ, July 2006)
- GAAP precludes an insurance firms from earmarking capital or retaining earnings for use only to pay for the future (not yet occurred) catastrophe losses
- Retained earnings are heavily taxed, so there is a heavy cost to maintaining a pool of capital.
- A firm acquiring capital would be open to the risk of being taken over.
  - An acquiring entity would have to just wait one year for all policies to expire and then take over the company with its capital trove.

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Financing for extreme events: Alternatives

- Secure access to future financing opportunities under prearranged conditions
  - "Sidecars": Hedge funds provide capital to back coverage for very specific risks.
- Securitizing Extreme Risks: Catastrophe Bonds
  - Securitize a portion of the risk and spread cost of losses among large number of investors
  - Hurricane Andrew and Northridge Earthquake--World Cup Terrorism Bonds
- **In 2003, Golden Globe Financing Ltd securitized risk for the World Cup (FIFA) by selling terrorism bonds.**
  - **Over-subscribed**
- Catastrophe Risk Exchange
  - http://www.catex.com/
  - In 1994 CATEX launched the CATEX Global Market, the world's first online exchange for transacting insurance and reinsurance business. The exchange sits at the centre of CATEX Markets and enables buyers and sellers of insurance and reinsurance to transact or swap risks.

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- Sidecars
  - Investing in re-insurance risk pools exposes investors to all kinds of risk. Sidecars allow investors to be more choosy. (WSJ, July 2006)
  - But you lose diversity of portfolio of course
  - If disaster strikes, capital is tapped. If not, investors get their money back.
  - 3.2 billion in sidecars
- Catastrophe Bonds
  - **In 2003, Golden Globe Financing Ltd securitized risk for the World Cup (FIFA) by selling terrorism bonds.**
  - **Over-subscribed--the market is making an attempt to adjust**
  - Swiss Re securitized risk to cover an event with extreme mortality.

Financing for extreme events: Alternatives and Barriers

- Market Issues:
  - Very specific scenarios must be described. Issueing firm must know its risks
  - Steep learning curve to evaluate the risk
  - Ambiguity aversion in the market: Capital markets require greater specificity because they are transaction based and need more precision—no standard methodology for pricing risks.
  - Magnitude of the event means access to large capital is a pre-requisite
- Regulatory and Accounting Standard Issues
  - Accounting standards do **not** allow insurance firms to reflect the risk transfer achieved by non-indemnity catastrophe bonds on their financial reports filed with the state insurance regulators
  - Cat bonds use offshore Special Purpose Vehicles to keep down transaction costs. Enron scandal may end that possibility
  - Is there a need to treat catastrophe bonds (and similar vehicles) in the same way mortgages are encouraged by tax policy?

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Market Failure? Financing of Extreme Event Risk

- Govt intervention rises because of either
  - Limited availability of financial capacity
  - Generalized uncertainty & risk ambiguity so private sector drops out
  - Regulatory and Accounting standards haven't caught up (see previous slide)
- Government typically acts as either primary insurer or lender (re-insurer) of last resort for extreme events
  - Take on the form of Quasi-Private government entities (like in Florida and California)
  - Terrorism risk insurance schemas are typically centered around a re-insurance model
  - Have access to large pools of capital (tax base)
  - Can spread risk across the entire population
  - Can avoid take-over and onerous tax and regulatory schemas by fiat.
- Could crowd out private markets
- Displace private actions to mitigate damages (moral hazard)

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- The automobile insurance industry over the last few decades realized that changes in the physical world were needed to make their risks acceptable and profitable...thus, they promoted seat belts, seat belt laws, air bags etc. The health insurance industry gives lower premiums to those who don't smoke etc etc. These are really all efforts to increase systemic resiliance by improving individual resilience where the vendor or individual actor has financial or personal interests (profit/enjoyment) counter to the betterment of the overall system.

The Need: Linking Risk Management to Cost Avoidance

- **Firms and Supply Networks must search for ways to monetize cost avoidance actions**
- **Meaningful risk will be assessed at the System/Supply Network level.**
  - Individual firm risk is not a useful measure in isolation from the supply network.
- **Requires collaboration and trust**
  - What are the transaction costs of engaging in this kind of collaboration?
  - What are the costs of not collaborating?
- **Supply Network security isn't just about physical measures. It's about organizational and informational solutions**
  - Monetizing Cost avoidance through Collateral Benefits—the first step?
  - Manufacturing Institute, IBM, and Stanford conducted an initial study to see if monetization could be done through collateral benefits

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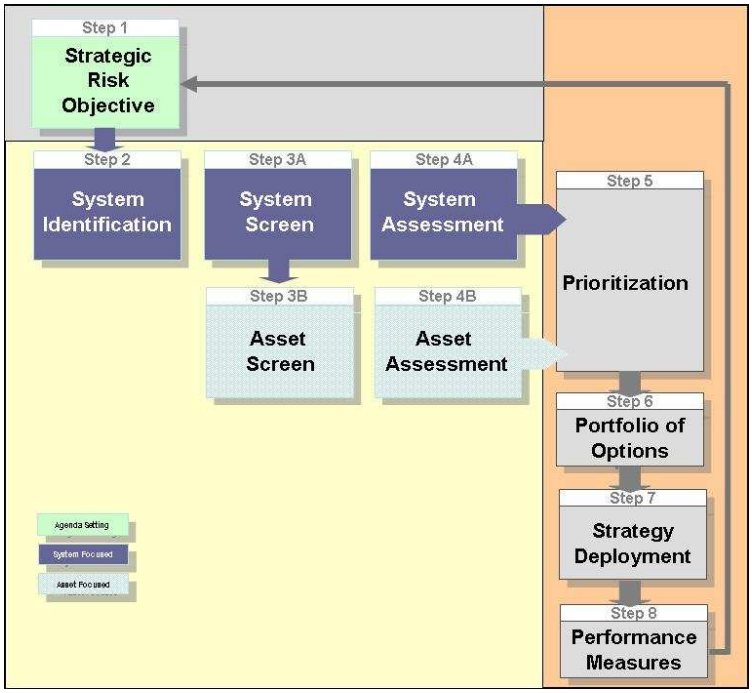
- 11 manufacturers and 3 carriers/logistics service providers
  - Higher supply chain visibility
  - Improved supply chain efficiency
  - Better customer satisfaction
  - Improved inventory management
  - Reduced cycle time and shipping time

Systems-based Risk Management Methodology



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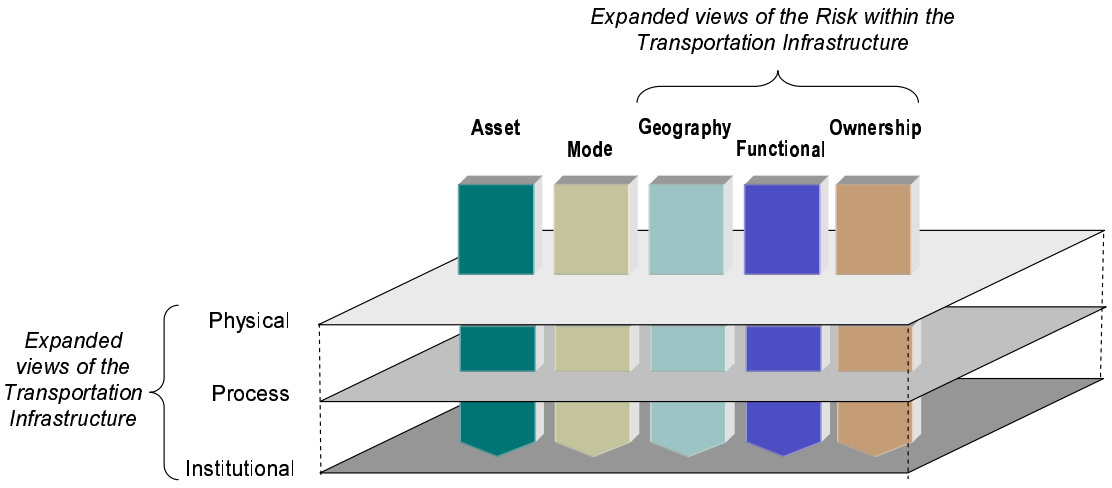
Systems Views



Transportation Systems Risk Ontology

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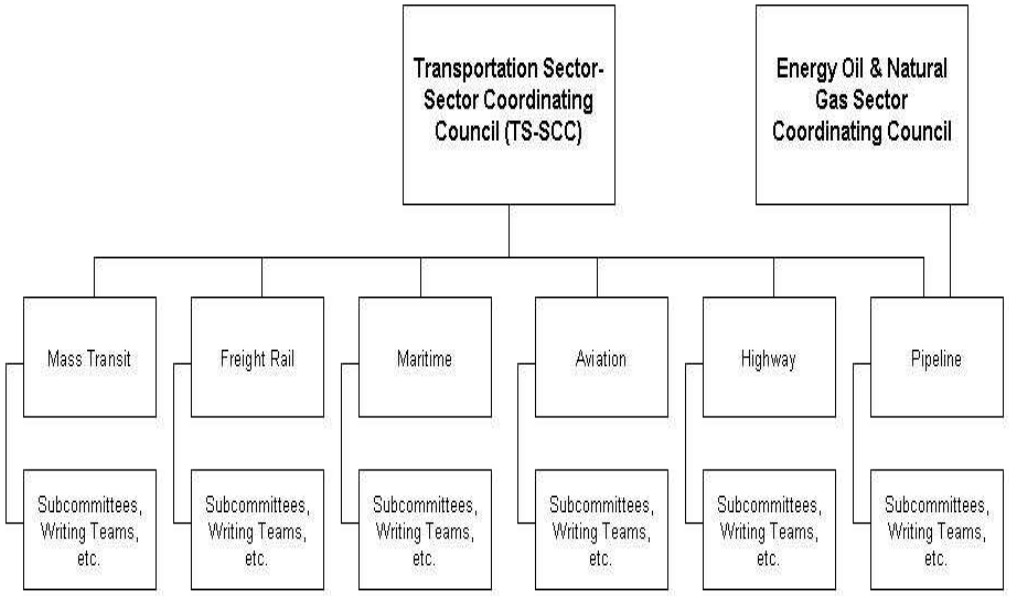
Sector Coordinating Council—Getting involved in Policy



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Appendix: Government intervention in Terrorism Risk Markets

	National program	Year started	Definition of terrorism	Program overview
 France	Gestion de l'Assurance et de la Réassurance des Risques Attentats et Actes de Terrorisme	2002	All acts of terrorism, based on the French Criminal Code, including nuclear, biological, and chemical.	Insurers transfer a proportion of their terrorism risk to the GAREAT pool. Unlimited state guarantee on reinsurance provided by CCR.
 Spain	Consorcio de Compensación de Seguros	1954	Acts with social repercussions: terrorism, rebellion, insurrection, riots, civil commotion, acts or actions of the Armed Forces or Security Services in peacetime.	All policyholders pay premium surchage, collected by insurers, for coverage provided by the state-owned Consorcio. Unlimited state guarantee.
 Germany	Extremus	2002	Acts by persons or groups of persons committed for political, religious, ethnic or ideological purposes suitable to create fear in the population or any section of the population and thus to influence a government or public body.	Specialized insurance company formed by insurers to provide terrorism coverage. Capped state guarantee.
 United Kingdom	Pool Re	1993	Acts of persons acting on behalf of, or in connection with, any organization, which carries out activities directed towards the overthrowing or influencing, by force or violence, of the government in the UK or any other government de jure or de facto.	Mutual insurance company that provides its members reinsurance for terrorism risk. Unlimited state guarantee.
 Italy	None	N/A	N/A	Majority of insurers are excluding terrorism from general coverage. Limited coverage available from private insurers for additional premiums.
 Switzerland	None	N/A	Violent acts or the threat of violence for achieving political, religious, ethnic, or ideological aims. The violent acts or threat of violence are such as to spread fear and anxiety among the population or sections of the population or exert influence on a government or state institutions. Does not include civil unrest.	Terrorism excluded from general coverage above 10 million Swiss francs. Joint reinsurance coverage above 10 million Swiss francs available in limited capacity through agreement between private insurers' association and an international group of reinsurers.

Sources: GAO analysis based on information from the Organization for Economic Cooperation and Development (OECD), Guy Carpenter, American Insurance Association, and interviews of insurance industry participants and insurance supervisory authority officials in each country; Nova Development (maps).

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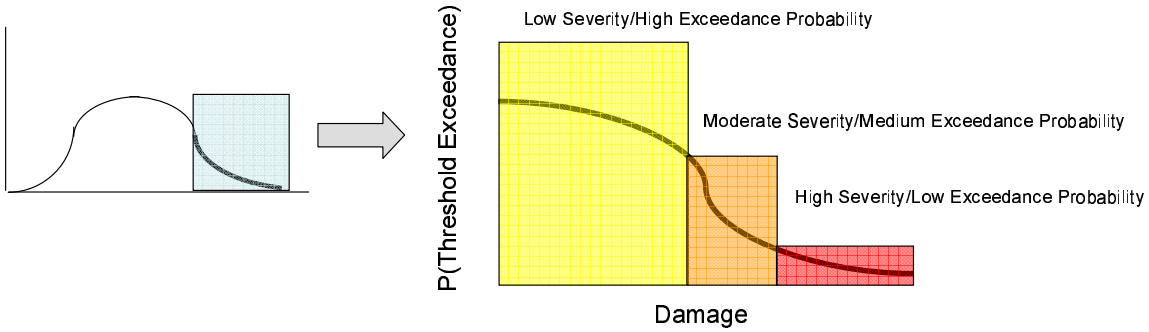
Appendix: Partitioned Multi-Objective Risk

- Partitioned Multi-Objective Risk Method
  - *Isolates a number of damage ranges* and generates conditional expectations of damage, given that damage falls within a particular range.
  - The policy-maker *subjectively chooses their* ***consequence threshold***



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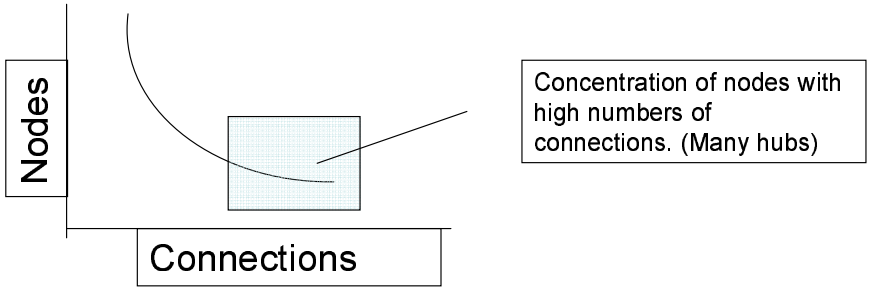
Appendix: Scale-Free Networks

- "Scale-free" networks have nodes which possess a significantly higher concentration of connections that the average node.
  - This network often resembles a hub and spoke network
- These networks are very robust when faced with naturally occurring errors because the odds of a disruption hitting a key node (e.g. Chicago O'Hare) are very low.
- These networks are very vulnerable to attack because if a key node is targeted, the disruption will effect the whole system.



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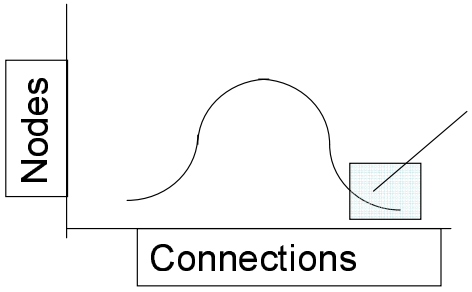
Appendix: Random/Homogenous Networks

- Random networks have a higher concentration of nodes with an average amount of connections. Extreme amount of connections are rare.
  - This network looks much more randomly and evenly distributed.
- These networks are very robust when faced with attacks because there are very few "key nodes" to disrupt.
- These networks are more vulnerable to error because all nodes are appx equally important thus diminishing the performance more rapidly than a "scale-free" network. .



Very few nodes with high numbers of connections. (very few hubs)

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Appendix: Scale Free Network Reliability

- **Scale-free networks are extremely tolerant of random failures.** In a random network, a small number of random failures can collapse the network. A scale-free network can absorb random failures up to 80% of its nodes before it collapses. The reason for this is the heterogeneity of the nodes on the network -- failures are much more likely to occur on relatively small nodes.

- **Scale-free networks are extremely vulnerable to intentional attacks on their hubs.** Attacks that simultaneously eliminate as few as 5-15% of a scale-free network's hubs can collapse the network. Simultaneity of an attack on hubs is important. Scale-free networks can heal themselves rapidly if an insufficient number of hubs necessary for a systemic collapse are removed.

- **Scale-free networks are extremely vulnerable to epidemics.** In random networks, epidemics need to surpass a critical threshold (a number of nodes infected) before it propagates system-wide. Below the threshold, the epidemic dies out. Above the threshold, the epidemic spreads exponentially. Recent evidence indicates that the threshold for epidemics on scale-free networks is zero.

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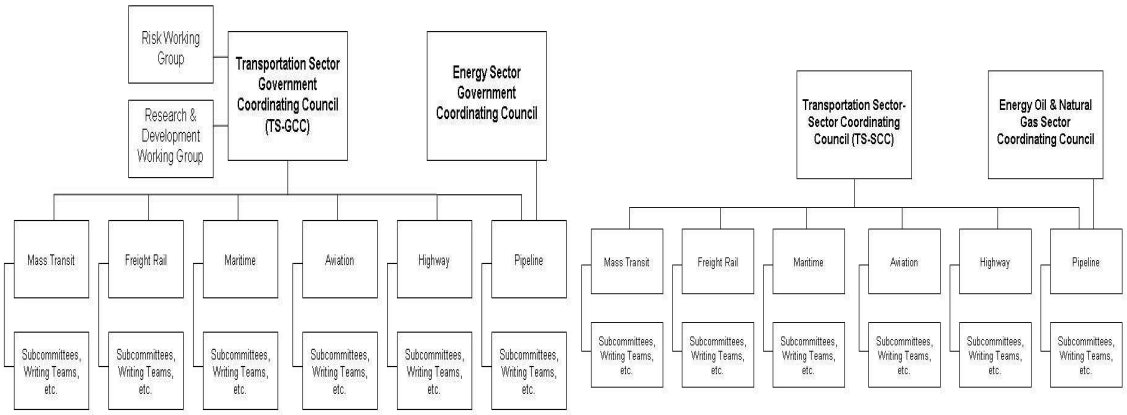
Sector Coordinating Council—Getting involved in Policy

- The TSGCC and proposed TSSCC is subdivided into modal coordinating council to ensure that the TSSP is applicable to stakeholders in each mode of transportation.



Note: The Energy Sector GCC serves as the Pipeline GCC. See Pipeline Modal Implementation Plan for further information.

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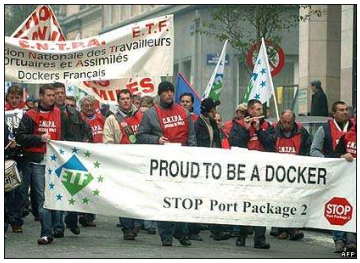
Appendix: Cost Avoidance

- **Our Mission: Secure the transportation system while ensuring the free flow of commerce.**
  - TSA is advocating for Cost Avoidance because we think there is a business case to be made for security and that will not adversely affect commerce



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- It starts with our mission---Secure the transportation system while ensuring the free flow of commerce. TSA is advocating for Cost Avoidance because we think there is a business case to be made for security and that will not adversely affect commerce. Security may not currently be sufficient in supply chains because there are not adequate methods for assessing risk to make the business case for it. Or there may not be an understanding that there are collateral commerce benefits to improved security. However, if industry can develop those risk methods and tools by engaging in an exchange of ideas of how to do it among themselves and with the government, we may raise security while ensuring the free-flow of commerce.

- simple example of cost avoidance..."replace a human with a machine...", more complex cost avoidance "this 15 acre parcel in New Orleans is 3 times more expensive than that one...however, the more expensive one is 30 feet higher...". What gets missed in the second example is the cost to REPLACE AN ENTIRE factory as well as the potential loss of SHELF SPACE from non-delivered products, the loss of market share, the loss of market cap...(this is the point I plan to make in my remarks).

Various Cost Avoidance Techniques

- Insurance
- Government regulation
- Competitive bidding
- Religious belief (tithing etc)
- Active ignorance
- Diplomacy -> War
- Government driven market systems (Emissions Trading/pollution credits[sulfur dioxide])
- Government driven industry branding (Energy Star)

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Cost Avoidance

- Where the market can set a price on the value of a future good, cost avoidance transactions are easily understood and readily pursued
  - Price reductions
  - Substitution (butter vs. margarine)
  - Birth control
  - Insurance
  - Futures trading
  - Derivatives

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Non Market Cost Avoidance

- Some eventualities are extremely difficult for markets to operate upon.
  - Events that are unpredictable as to time, place or person to whom it may happen
    - Asteroid impact
  - Costs for which insurance cannot financially cope
    - Major War
  - Pool and nature of risk is diffuse and unpredictable
    - Terrorism
- AKA “Acts of God” or “Force Majeur”

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Transportation Security and Cost Avoidance

- Mature/competitive markets have extreme difficulty affording non-revenue producing cost avoidance measures, and will not (cannot) do it unless everyone must do it.

- The electric utility market and its pollution posed this problem – solution was to measure pollution output (easy) and to mandate stretch limits.

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Markets born of Regulation

- Perhaps the most successful emission trading system to date is the SO2 trading system under the framework of the 'Acid Rain Program' of the 1990 Clean Air Act. Under the program, which is essentially a cap-and-trade emissions trading system, SO2 emissions are to be reduced by 50 % from 1980 to 2010. (from Wikipedia)

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Transportation Security and Cost Avoidance

- I bang these two sticks together to keep the elephants away…and sure enough, there haven't been any elephants around here for years
  - You must be able to measure the offending outcome (pollution, poor security) in order to create a market, set a target and create a market clearing pricing function
  - You must affect the Profit and Loss statement to truly affect long term private sector attention.

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