# Scenarios IV: Planning for Disasters and then Dealing with them

In the aftermath of Katrina Bill Ziemba discusses planning for the economic and financial effects of natural disasters

A s I write this it is the fourth anniversary of September 11, 2001. Aside from the anniversary specials airing today, there is little in the news these days about Osama Bin Laden. The news today is about another crisis: how to recover from the huge disaster of hurricane Katrina's strike on the Gulf Coast two weeks ago. When CNN has broken away from Katrina coverage, we turn to the lingering instability in Iraq, which has made some of our economic interactions more precarious and our future investments harder to predict. Both of these reconstruction efforts are not likely to be completed overnight and their effects are likely to reverberate through the US and global economies. The effects of Hurricane Katrina, like that of so many disasters and crises, are exacerbated by existing positions and any instability. It reminds us that we must choose our positions to hedge against anticipated and unanticipated risks.

As you read this, some time will have passed so I would like to draw some lessons from this crisis to show how to draw up scenarios and analysis that is useful for the future. The question is whether we have learned anything about risk and disaster preparedness since the 9/11 terrorist
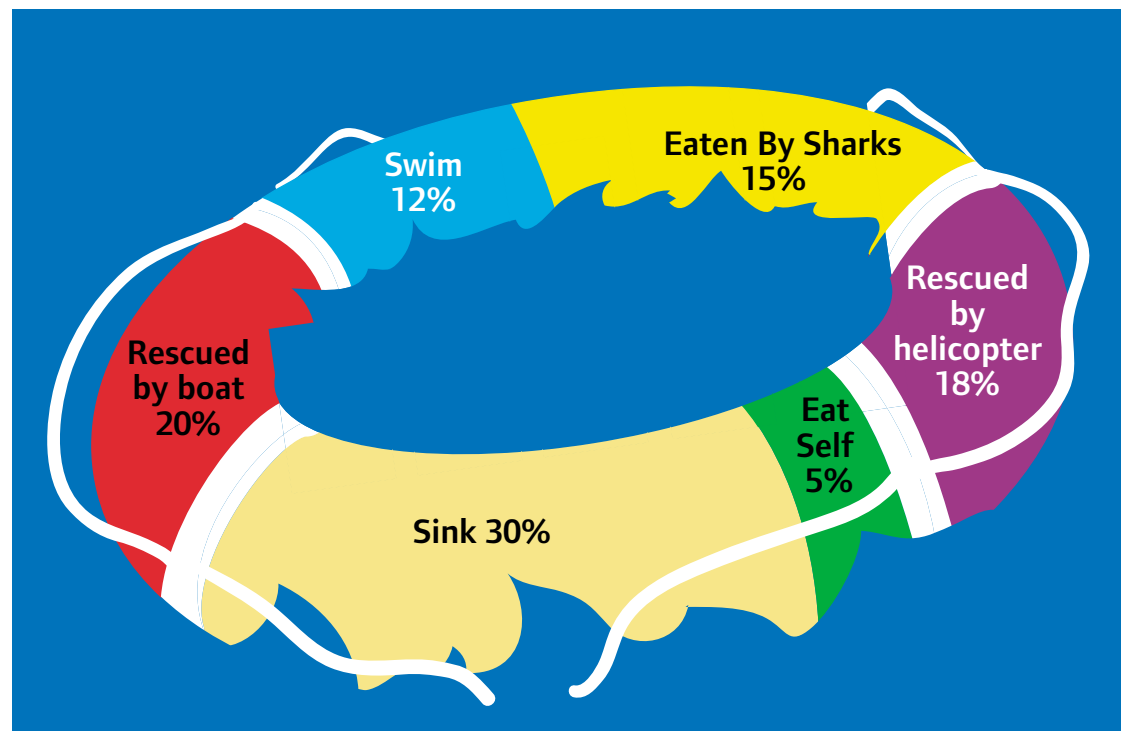
attacks? At first glance, it seems that there was a tremendous failure by the different levels of government in predicting and dealing with the Katrina crisis despite warnings, analyses and even mock emergency tests of preparedness. I do not want to engage in the blame game but rather to set out some aspects of the planning process to deal with such disasters and the economy and financial market impacts.

Planning in advance: stage one of a two period stochastic program

It was well known that New Orleans, much of which is below sea level and includes a large lake, was extremely vulnerable to a huge hurri-

cane. The fact that a big hurricane like Katrina could hit New Orleans and its aftermath were well known. For example in a five part series published by the New Orleans newspaper *The Times Piccayne*, June 23-27 2003 a scenario very similar to the August 2005 outcome, was outlined. The conclusion of the series called *Washing Away* was that there was a disaster in waiting as the levees were not strong enough to withstand a category four hurricane. The Army Corps of Engineers had plans to upgrade the levees but funding was withheld.

The problem can be well modeled as a two stage stochastic program. Thus one should plan in advance against essentially all scenarios then

Table 1: Relative hurricane costs

Hurricane	Category	Date	Damage (Bil. $)	Infl. Adj. Damage (Bil. $)
Katrina (LA, MS, AL)	4	8/05	$50.0E	$50.0E
Andrew (FL, LA)	5	8/92	$26.5	$34.1
Charley (FL)	4	8/04	$15.0	$15.3
Ivan (AL, FL)	3	9/04	$14.2	$14.5
Frances (FL)	2	9/04	$8.9	$9.1
Jeanne (FL)	3	9/04	$6.9	$7.0
Hugo (SC, GA, NC, VA)	4	9/89	$7.0	$10.0
Georges (FL, MS, AL)	2	9/98	$5.0	$5.8
Floyd (Mid-Atl., NE)	2	9/99	$4.5	$5.1
Fran (NC, SC, Mid-Atl.)	3	9/96	$3.2	$3.8
Opal (FL, AL)	3	10/95	$3.0	$3.6

Source: Action Economics

Figure 2: Inflation-adjusted catastrophe losses

Total losses: $221.3bn

Tornadoes 33.7
All tropical cyclones 27.1
Terrorism 11.0
Winter storms 10.6
Earthquakes 9.4
Wind/hail/flood 4.0
Fire 3.3
Civil disorders 0.5
Water damage 0.2

Source: Insurance Information Institute; Insurance Services Office

if a bad scenario actually occurs one can optimally revise. It sounds simple but it provides a way to plan stage one. How optimal was the crisis preparation? Stochastic programming computer codes and applications to many areas of finance, production, energy policy, etc are detailed in my new book (Wallace and Ziemba, 2005) from SIAM-Mathematical Programming Society. In fact the evidence is that the planners in New Orleans did just that. They foresaw an event like Katrina and planned for it. The trouble was largely in the response by the various stakeholders, the predictions may have been there but the financial response was not.

Katrina was officially a category four hurricane when it hit just towards the outskirts of New Orleans. Earlier predictions feared it would reach New Orleans as a category five built up from a category one when it hit Florida and then returned to sea gathering momentum and water for its strike on the Gulf Coast on August 30.

I got a brief glimpse of this act of nature. I was at Saratoga (NY) racetrack on August 31 and witnessed the torrential rains for two plus hours under a tent there. For us it was no big deal and I could bet the simulcast at Del Mar and edit papers for my *North Holland Asset-Liability Management Handbook* (Zenios and Ziemba editors, April 2006), which has several papers of interest to read-

ers of *Wilmott* including very good surveys of Kelly betting in two chapters by Ed Thorp and by Len MacLean and myself. This atypical downpour did give us an idea of the strength of the storm even more than a thousand miles away and more than a day after it hit New Orleans.

How much hedging is there against various risks?

Figure 1 shows that as of August 2003, the world's top 500 companies as of August 2003 hedge most of their interest rate and currency risk but little of their commodity and equity risks.
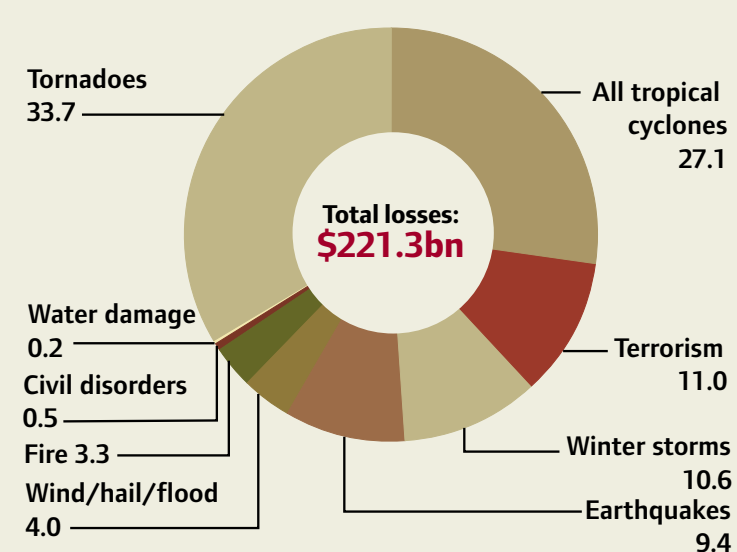
Table 1 shows how large the predicted impact

Figure 1: Covered? Use of derivatives by type of risk

	0	20	40	60	80	100

Interest-rate
Currency
Commodity
Equity
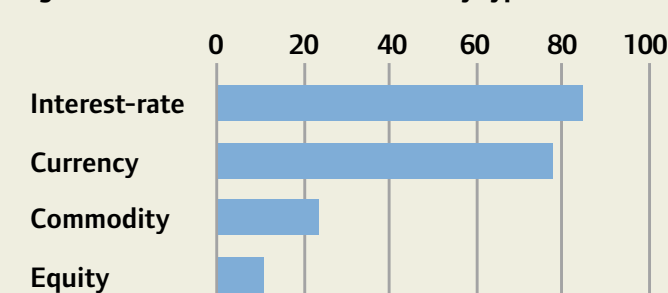
Source: International Swaps and Derivatives Association

is for Katrina relative to previous large hurricanes in terms of damage. Insurance companies did predict some of these losses. The insurance companies (essentially put sellers) have a substantial loss which is hard to estimate since water damage is not usually covered in policies and the coverage for other damage is unclear. However their loss is estimated to be about $25 billion of the up to $100 billion in total expected costs. This in part is due to their greater scrutiny following the liabilities of and the increase in hurricanes along the Gulf Coast and in Florida which induced up the premiums, tripling them is some parts of New Orleans and forced some to either self-insure or cobble together a mixed bag of policies. See Figure 2 for insurance losses from 1984-2004.

Despite the fact that almost everyone lost a lot, there were some redistribution effects and some short term winners such as:

● Traders who bet on the overreaction of initial price moves and the subsequent drop and the eventual rise of oil prices, the euro, interest rates, S&P 500, etc. made considerable profits. See Table 2.

Table 2: Price overreaction evolution in several key financial markets around Katrina's hit on New Orleans

	August 29	August 30	Sept 9
10-year bond rate %		4.01	4.12
Euro/dollar	122	125.51	124.19
Odds on a 0.25% rise in short term interest rates on Betfair*	1.08	1.33	1.13
Dec Crude Oil	66.50	70.70	65.41
S&P 500	1212.28	1208.41	1241.48

*Odds of 1+x means you bet one to either win x or lose one. Experience shows that the odds on the favorite shorten as one approaches the event. So 1.13 is much larger than 1.08 than one might think.

● Construction companies who will be called on the rebuild and the various suppliers, this profit may not result until early 2006.

● Gasoline companies who could take short term advantage of higher energy prices.

● The 25 university students from Gulf area schools now temporarily attending Harvard and others at MIT, Brown and other top US universities. These students are recipients of the generosity of the colleges and the students already enrolled. Their lives are not on hold.

A few comments on Table 2. The 10-year bond rate first experienced a large drop then a gradual rise while the euro/dollar rate had a large rise then a reversal when the changes of the FED interest rate increases moderated then increased. Hawkish statements by San Francisco Fed president Janet Yellen, Chicago Fed president Michael Moskow and Philadelphia Fed president Anthony Santomero that the measured pace of short term interest rate increases would continue since inflation uncertainty on the upside if anything are greater not less after Katrina's hit on the Gulf coast. Still Fed chairman Greenspan does not usually raise rates in a crisis. Goldman Sachs thus expects a pause and no rate increase on September 20. But at odds of 4.7 (bid) to 7.4 (ask) on Betfair, the market thinks the 0.25 per cent rise is by far the most likely scenario.

The equity markets liked the idea of lower interest rates so they rose throughout this period consistent with the bond-stock yield crash model's prediction that a crash from high inter-

**Figure 3: Crude oil prices**
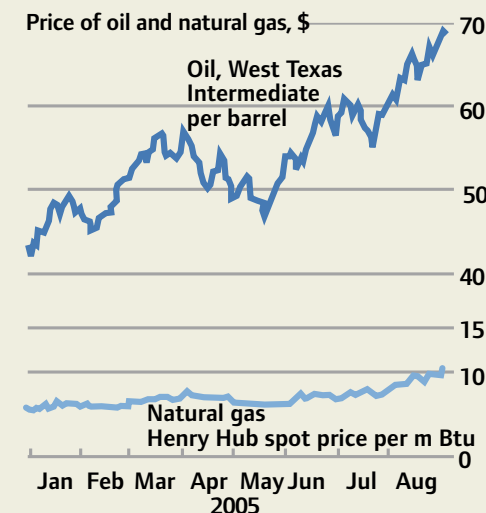
Source: Thomson Datastream

est rates is unlikely, see the discussion below in the volatility section.

Some key markets: crude oil, the S&P 500, short and long term interest rates and bond prices

Katrina was a classic case of the immediate over-reaction of certain key commodities. Given the already significant price rises and instability of commodity prices, this crisis exacerbated the moves of these prices. There is a considerable academic finance literature on the controversial subject of over-reaction and under-reaction. It is an active and controversial subject. See papers of Richard Thaler, University of Chicago and Sheridan Titman, University of Texas, especially. Katrina was a classic case. As CNN reported the approaching storm, December crude exploded from the $66 per barrel area to peak around $71.70 on Globex on Sunday night August 28. By Monday morning before the US markets opened, it fell to the $70.40 area. A few hours later it was $68 only to return the next day to $70.70 and then in subsequent days, back to pre Katrina levels. See Figure 3.

Crude oil prices in September 2005 were more than 50 per cent above those a year earlier but well below the $90 inflation adjusted, in 2005 dollars,

Figure 4: The real story of oil prices
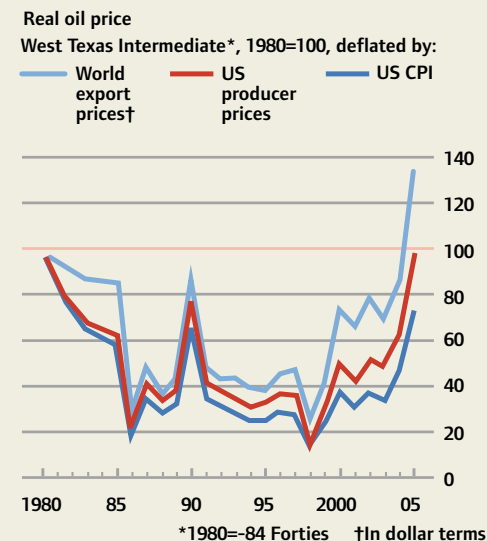
Source: Thomson Datastream; IMF;BLS

highs of the early 1980s. The worldwide supply-demand graph shown in Figures 5 and 6 show why. Worldwide demand has caught up with supply hence any disturbance or uncertainty essentially anywhere in the world would push up oil prices. Of course, early release of the strategic petroleum reserves and other emergency and humanitarian measures including increased production from OPEC, Canada, etc. which dampened the impact of Katrina on the price rise in the medium term. But

Figure 5: Worldwide refining capacity and oil demand is now essentially equal
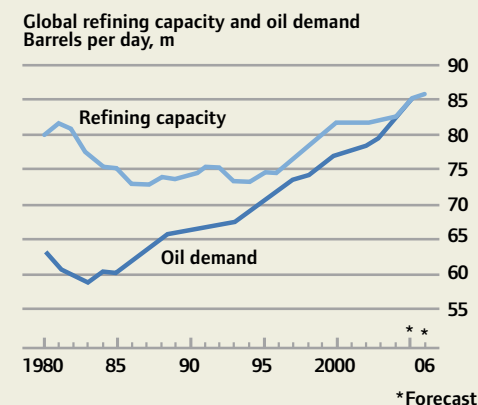

Source: John S. Herold

Figure 6: Trying to keep up: there is a small amount of imported gasoline but the major imports are of crude oil to be refined
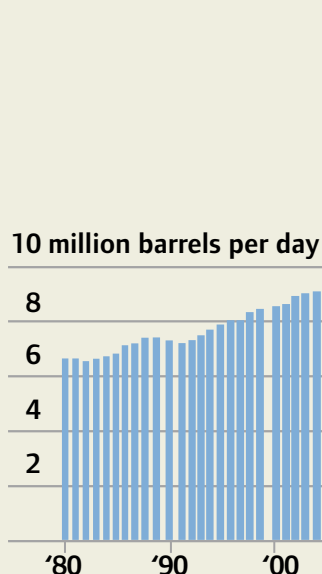
Refining capacity has dropped over the last two decades…

…but the country's appetite for gasoline has climbed steadily…

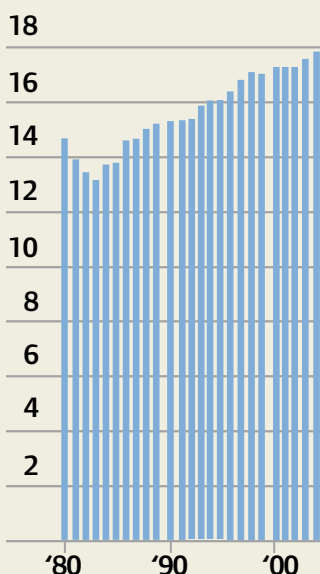…forcing refineries to increase their output to keep up with demand

U.S. refinery capacity
20 million barrels per day
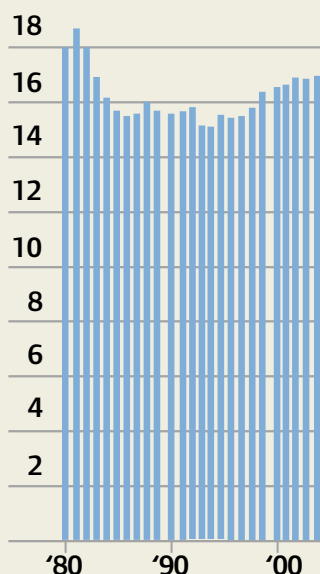
Gasoline consumption

U.S. refinery output*
20 million barrels per day

10 million barrels per day

*Output of gasoline and other products can be greater than oil refining capacity because of additives introduced during processing

Source: Energy Information Administration

Figure 7: CBOE Volatility Index

O N D J F M A M J J A S

Source: *Barron's*, September 9, 2005.

Figure 8: After the storm: sector perform-ance, relative to the S&P 500, after 13 previous hurricanes over the past 20 years

Relative performance

Health-care services

Retail

Household products

Home builders

Oil & gas services

Trading days after a hurricane

Source: *Barron's*, September 9, 2005.

it is clear that the case for higher prices is strong, especially since Saudi Arabia, Iran, Iraq and Venezuela, four of the top five oil producing countries, are potentially trouble spots. The market will likely continue to build in a cost premium due to this potential for instability.

Volatility

The VIX index of CBOE, equity implied volatility, was little changed by the event. Volatility remains at historically low levels and was 13.52 per cent on August 29, 13.65 per cent on August 30 and then was basically flat, closing at 11.98 per cent on September 9. See Figure 7. Since September is historically the worst stock market month, see for example, studies in Keim and Ziemba (2000), and there was a major catastrophe, this non event has to be attributed to:
● The lower interest rates of both the long 10-year bond and the lower odds of more FED short term hikes, especially the much lower odds of

increases in the short term rate of 4.00 and 4.25, and < 0
● The fact that the bond stock yield difference model suggests that the odds of a large fall in the S&P 500 are very low.

The calculation on September 9 is 4.09 per cent for 10-year T-bonds or 4.40 per cent for 30-year T-bonds minus the earnings/price ratio of 5.11 so the measure is . Historically for there to be trouble, this measure must be about 3; see my previous *Wilmott* columns or my AIMR monograph, Ziemba (2003) on this. As well, the confidential sentiment model that I use for my own and client trading using option prices is also not close to the danger zone.
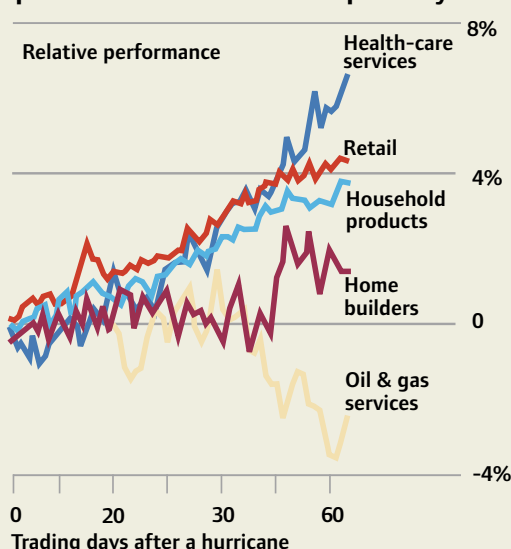
Future prospects and the 2006 outlook

It is too early to estimate accurately the 2006 impacts of Katrina. Many, but not all, believe that the reconstruction effort will turn positive
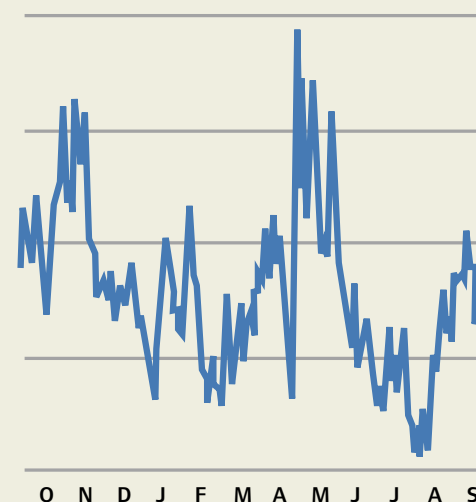
in 2006. However some like the Maxim group argue that:

A major American city has been all but wiped off the map, taking the country's largest port with it. To put this into context, the costs for rebuilding New Orleans after Katrina will exceed

Figure 9: Yield curves in early September 2005, August 2005 and September 2004
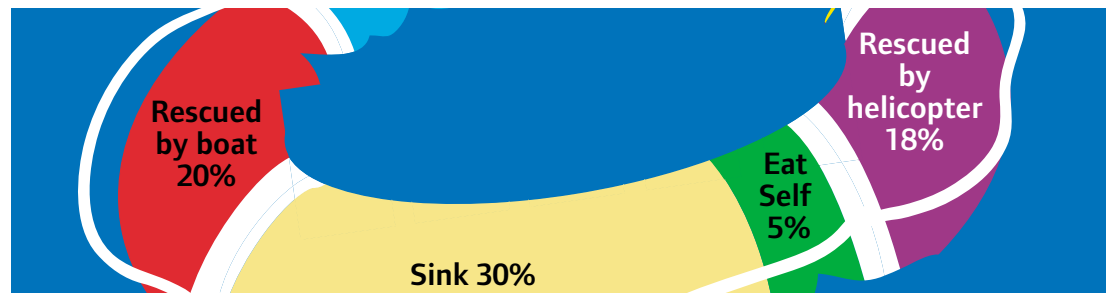

1 month ago

Thursday

1 year ago

5.0%

4.0%

3.0%

2.0%

1.0%

0.0%

1 3 6 2 5 10 30

months(s)   years

maturity

Source: Reuters

Rescued by boat 20%

Sink 30%

Eat Self 5%

Rescued by helicopter 18%

Rescued by boat

A major American city has been all but wiped off the map, taking the country's largest port with it
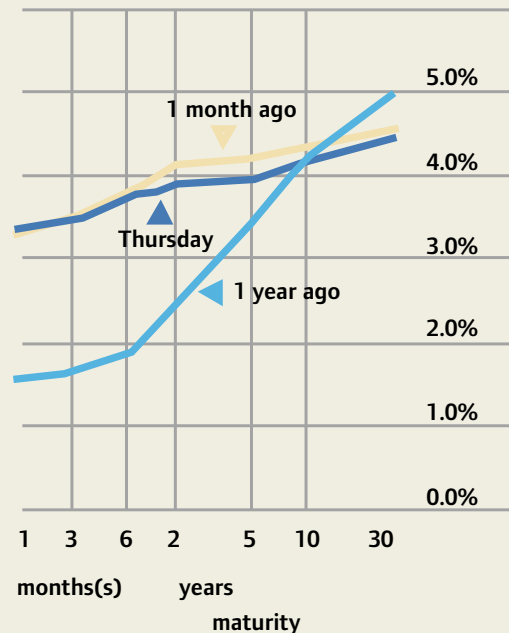
those of rebuilding Chicago after the great fire, San Francisco after the 1906 earthquake and New York and DC after September 11th – combined. And that's after adjusting for inflation. Despite what some of the more bullish pundits have been saying, the stimulus of rebuilding New Orleans will not outweigh the overall loss to the economy. If it did, we would level a different city each year and rebuild it from the ground up, shiny and new. But it doesn't, and so we don't.

I think this is overreaction and if so, relates not just to the crisis itself but its exacerbating role for the pre-existing outflow of people and business from New Orleans,but costs of rebuilding are high. The success of Chicago and San Francisco after their disasters was partly due to the strategic place they played geographically and economically. New Orleans will only return to its place if those who have been displaced and others are convinced to return, rebuild and regenerate the city, something which the distrust of the government reaction may dampen.

Warren Buffett, quoting Benjamin Graham, says: In the short term, the market is a voting machine. In the long term, it's a weighting machine. That means it's cash flow in the long run that'll determine the value of a business. Source: Barron's, Friday, September 9, 2005

My Japanese factor model discussed in a previous issue of *Wilmott* indicates that Buffett is right: the best variable for predicting future stock prices is future earnings/price, a variable I called EST-LACT. See also the complete article in Keim and Ziemba (2000).

So I will go along with Warren and the models I have used since 1989. Watch the long bond and watch earnings. Figure 8 hints at some sectors to watch. There are several obstacles to this growth in the US such as the huge trade and current account deficits, the huge cost of the Iraq and Afghanistan operations, and other possible crises such as one originating from hedge fund disasters. But it will be those earnings and interest rates that will likely prevail. Inverted yield

curves, see my last column, are also a danger as shown in Figure 9. Should the yield curve actually invert, the historical evidence predicts a recession. So even if the other measures are positive, extreme caution should be used.

These steps outlined here show how certain actors (planners, insurance companies, short term investors) planned for and then reacted to the government. They also provide a model for how investors and government actors could and do plan for a react to crises. However, in the case of Katrina, the focus on the relatively narrow vision of homeland security allowed the appropriation of resources away from natural disaster planning. Stochastic optimization and comparison to previous instability promoting crisis allows investors to assess their room for maneuver and we can at least draw lessons to hope that we will not be doomed to repeat.

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