Disaster Risk

Fink Masters Student Seminar Presentation

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The Question

- The average geometric (compounded) stock return above the risk-free rate from 1926–2012 was 6% per year.
- This means a $1 investment in stocks did about 100 times better than a $1 investment in bonds over the last 80 years—despite the 1929, 1987, 2000, etc., crashes.
- Why so much?

One Answer: The PESO problem

- There was an 0.001% chance that the stock market but not the bond market would have collapsed.
- We just happen to live in a world where the disaster did not come about.
- For example, what would your long-run expected return in stocks be if you had a 0.1% chance of losing it all?

$$E(R) = (1 + 0.001 \times (-100\%) + 0.999 \times 0.06)^{T} \Rightarrow \_\_\_\_$$

- But, if this is true, couldn't we explain anything by ex-post circumstance? 8%? 2%?

Data

- R_M: CRSP Value-Weighted Returns, 1926–2012.
- R_F: 30-day Treasury.
- Work in Excess Returns: $R_M - R_F$.
- Monthly frequency, annualized.

	Mean	Sd	% Pos
Mean (not Draws)	0.0596	0.0211	0.998

Significant?

- Economically, yes.
- Statistically, ?
- Excess returns are highly kurtotic, but not skewed.
- Use resampling (bootstrap) for inference, assuming no Peso problem. Assumes equal probability of observed.

Min	5th	25th	Med	75th	95th	Max
−0.0298	0.0253	0.0453	0.0594	0.0736	0.0945	0.1509

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Peso Distribution

$$(1+x_{\text{true}})^{t+s} = \left\{\prod_t (1+x_{t\text{ realized}})\right\} \times \left\{\prod_s (1+x_{s\text{ dark}})\right\}$$

$$(1+x_{\text{true}})^{t+s} \approx 1.0594^{87} \times \prod_s (1+x_{s\text{ dark}}) \approx 151 \times D\,.$$

- If $D = 0.47$, then the true rate of return would have been

$$\sqrt[88]{151 \times 0.47} - 1 \approx 5\%$$

- A D of 0.47 is a one-time return of –53%, because $[1 + (-53\%)] = 0.47$.
- Or two returns of –31%, because $(1-0.31)^2 \approx 0.47$.

D Factors

Maps of different D factors into different true equity premia.

If True	0%	1%	3%	4%	5%
		True Annualized Equity Premium			
D Factor	0.006	0.016	0.087	0.202	0.465
≡ 1 Dark	–99.3%	–98.4%	–91.3%	–79.8%	–53.5%
≡ 2 Dark	–91.8%	–87.4%	–70.5%	–55.0%	–31.8%

Two Basic Thought Experiments

(Conceptually interesting, but not data.)

- How confident are you that the world is not risk-neutral, given what you have seen now?
- How confident will you be next month that the world is not risk-neutral, if you will see a disaster tomorrow?

Prob of Missing Disasters

- Each Dark Event: Prob = 0.000 (0/1000 Months):
  Prob Zero Dark Events in 87 Years: = 100% (max lik)
- Each Dark Event: Prob = 0.001 (1/1000 Months):
  Prob Zero Dark Events in 87 Years: = 37% (plausible)
- Each Dark Event: Prob = 0.002 (2/1000):
  Prob Zero Dark Events in 87 Years: = 13% (unlikely)
- Each Dark Event: Prob = 0.003 (3/1000):
  Prob Zero Dark Events in 87 Years: = 5% (implausible)

Posterior, Given One Disaster

Say you just observed a –65% event.

1. Equity Premium: Historical = 4.8% (not 6.0%).
2. Now bootstrap: (one extra –65% prob in there).
   - Prob of Risk-Neutral: 95%.
3. Maybe add increased Peso prob of disaster from 0.001 to 0.0015.
   - No longer able to reject risk-neutrality.

Options Data

Let’s look at options data. Real Meat of the paper.

Options Data

But option prices can't tell us anything about expected returns??

- only if we do not assume risk-aversion. with risk-aversion, we can bound returns.
- for example, $E(r_S) > r_F$. or $r_F < E(r_{S+P}) < E(r_S)$. or $E(r_P) < r_F$. or ...
- ... but no equality signs.

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Quoting Put Costs

- I do not use the B-S model for pricing anything.
- But it is convenient to quote put prices in "implied BS volatilities."
- I have an intuitive feel what it means that one put is priced at 10% implied vol above prevailing volatility. I can compare different types of options.
- I don't have a feel what it menas that a put at –15% moneyness costs 2 cents while a put at –12% moneyness and 1 more week to expiration costs 30 cents. Which one seems "cheap"?

Put Costs

Put Implied Volatility Net of 18.5%	0.235 0.050	0.285 0.100	0.305 0.120	0.325 0.140
Monthly Cost Per $100	$0.017	$0.069	$0.104	$0.147
Annualized Return Cost	0.002	0.008	0.013	0.018

Put Implied Volatility Net of 18.5%	**0.335** **0.150**	0.345 0.160	0.365 0.180	0.385 0.200
Monthly Cost Per $100	**$0.172**	$0.198	$0.259	$0.328
Annualized Return Cost	**0.021**	0.024	0.032	0.040

Insurance converts, say, –50% into –15%. Not full insurance.

Given Put Costs, What Is Worst Disaster?

$$151 \times (1+\mathbf{M})^T$$
$$\geq$$
$$\left(\prod_t \{1+\max[-0.15, x_{m,t}] - P\}\right) \times [1-0.15-P]^T$$

- S is riskier than S+P. If P is too cheap, S+P would outperform S with high disaster return(s).
- Min-bound for risk-neutral market. If market were risk-averse, max disaster would be less painful.

- I will just show historical data. 1985- has same mean as 1926-. Ignore sampling variation.
- Ignore correlation of ex-post returns with put-costs. Dynamic strategy (get out of S whenever market put cost is too high) has almost no net disaster insurance cost.
- Implied-vol cost can be non-linear in moneyness. Can be different at different times.
- None is a problem. It's in the paper.

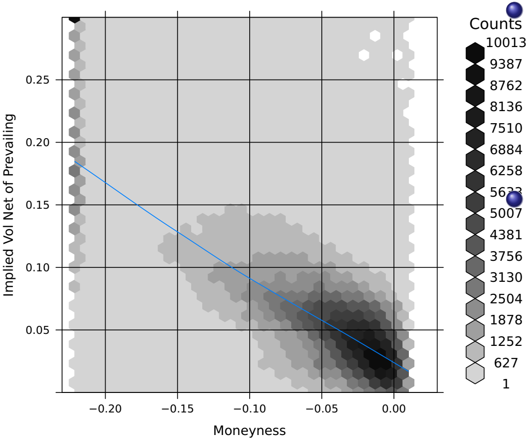
Put-Implied Vol Cost and Equity Premium

Solve above inequality to find worst disaster:

IVol – 18.5%	0.12	0.14	**0.15**	0.16	0.18	0.25
T=1, $M \geq$	–0.42	–0.63	**–0.72**	–0.79	–0.89	–0.99
EqPrem$\geq$	0.053	0.047	**0.044**	0.041	0.033	–0.000
T=2 $M \geq$	–0.30	–0.44	**–0.51**	–0.57	–0.69	–0.93
EqPrem$\geq$	0.051	0.045	**0.042**	0.039	0.031	–0.002

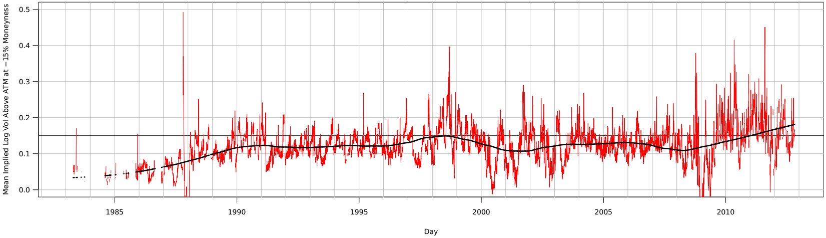
- Anything worse, and the S+P position would have had both lower risk and higher mean than naked S.
- Now I need to show you that IVOL of 15% is reasonable for –15% put.

Vol Smile



- I am conservative with ivol-cost of 15%. But, with enough adverse variations in specification, I can sometimes get to 15%.
- I also tried absolute (not net of 18.5%) option cost. Inference is the same.

Time Series



- Based on one price per day.
- Get out of market when implied-vol cost is too high, instead of buying S+P. after all, if IVOL(P) > 25%, you are pretty sure that the E(R) of S+P should be less than 0.
- This does **not** give you a time-series of exp eq prem point forecast, but only a time-series of a min bound on eq prem forecast.

Conclusion

- A 1-2% disaster premium is reasonable. Smile suggests it's not 0. 1-2% is nothing to sneeze at.
- ...but a $> 2\%$ premium is not only not justified by the put-pricing data, it would also have some nasty model consequences, principally the potential to make it difficult to reject risk-neutrality.
- we need to pay more attention to ordinary standard errors. 3% equity premium? Not rejectable by the data.
- Paper is *very* new. Available at:

  `http://temp.ivo-welch.info/eqprem-disaster-0.pdf`