Comment on “Disasters Implied by Equity Index Options” by D. Backus, M. Chernov and I. Martin

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Introduction

Rare disasters: infrequent events with large magnitude, with negative effect on an economy (e.g. substantial drop of at least 10% in consumption or output).

- Important events: provide an explanation of the equity premium puzzle (Rietz 1988, Barro 2006). People are compensated for extreme events they are aware of, but never occur during their lives.

- These events are too rare, making their probability distribution hard to estimate.

This paper

The authors use options prices to infer the distribution of extreme events.

- Letting option prices speak about disasters is original
- The methodology can be followed very easily
- Macro and finance approaches are examined and compared.
- Disasters implied by macro variables appear less frequent and more extreme than suggested by option prices.

Outline

- Summary
- Modeling Disasters in Asset Pricing
- Possible Extensions

Summary

1. The entropy of the pricing kernel is the maximum attainable equity premium:

$$L(M) = \ln E[M] - E \ln M \geq E[\ln R_i - \ln R_f]$$

2. Departure from normality of the log pricing kernel is crucial:

$$L(M) = L(\exp(m)) = \sum_{j=2}^{\infty} \frac{\kappa_j(m)}{j!}$$

High order cumulants can contribute to the equity premium by increasing the entropy of the pricing kernel.

Summary

1. Do you mean departure from symmetry? Otherwise, what if the log pricing kernel is symmetric with positive excess kurtosis and even cumulants in general?

2. The higher probability of extreme negative events (rare disasters) relative to extreme positive events generates positive skewness of the log pricing kernel.

Summary

1. Important to model the pricing kernel such that its conditional log-characteristic function exists in closed-form.

2. With $m_{t,t+1} = \ln \beta - \gamma \Delta c_{t+1}$, negative skewness of Δc_{t+1} leads to positive skewness of $m_{t,t+1}$. In the iid case, you want something like:

$$\Delta c_{t+1} = \mu_c + \sigma_c \varepsilon_{c,t+1}$$

   where $\varepsilon_{c,t+1}$ has zero mean, unit variance and negative skewness, but has a closed-form cumulant generating function.

3. Examples of processes are Markov-switching, Gaussian, Gamma, Inverse Gaussian, Binormal, Poisson, or their linear combinations.

Summary

1. Barro 2006 has such a process:

$$\varepsilon_{c,t+1} = \sqrt{1-\rho_c^2}\eta_{c,t+1} + \rho_c\zeta_{c,t+1}$$

   where

$$\eta_{c,t+1} \sim \mathcal{N}(0,1) \quad \text{and} \quad \zeta_{c,t+1} = \frac{s_{c,t+1}-\omega_c}{\sqrt{\omega_c(1-\omega_c)}}$$

   where $s_{c,t+1}$ is a two-state Markov chain taking 0 with proba $1-\omega_c$ and 1 with proba ω_c, and

$$\rho_c = \frac{\theta_c}{\sigma_c}\sqrt{\omega_c(1-\omega_c)}$$

2. Does the combination of the gaussian and a skewed matters? What is for example $\varepsilon_{c,t+1} \sim SIG(\nu_c)$ in which ν_c is the skewness. Also notice that $SIG(0) \equiv \mathcal{N}(0,1)$.

Summary

1. Skewness (excess kurtosis as well) of consumption growth is reported. But models are not calibrate to match consumption growth skewness, which is negative and low (-0.35 and -0.59), implying a relative low probability of extreme negative events.

2. Calibration based on macro data of the Poisson gives a skewness of -11.02. Calibration based on macro data of the Bernoulli with $\theta_c = -30\%$ and $\omega_c = 1/100$ leads to a skewness of -6.11. With $\omega_c = 1/1000$, skewness falls to -0.63. But what does $\omega_c = 1/1000$ implies in other dimensions?

Summary

1. The relative probability of rare events as estimated from the macro data should be consistent with the actual skewness of consumption growth. It seems not to be the case. A thorough sensitive analysis is needed.

2. With calibration based on option data, skewness falls to -0.80, which matches the actual! Need to understand what drives this result, given that rare disasters are more frequent in this case compared to the macro case. Another motivation for a sensitive analysis to model and preference parameters.

Possible extensions

1. Persistence of disasters: depart from the iid assumption.
2. Which extreme event? Maybe what matters most is a large drop in people's expectation about consumption growth, not a large drop in consumption growth itself.
3. Assume expected consumption growth and volatility of consumption growth varies through time (e.g. Bansal and Yaron 2004):

   $$\Delta c_{t+1} = \mu_{c,t} + \sigma_{c,t}\epsilon_{c,t+1} \quad \text{and} \quad \epsilon_{c,t+1} \sim \mathcal{N}(0,1)$$

   Negative skewness in expected growth and positive skewness in consumption volatility would generate positive skewness in the log pricing kernel with Epstein and Zin (1989) recursive utility.
4. Extreme events and predictability

Conclusion

1. Regain of popularity of rare disaster models since Barro 2006.

2. This is important paper that enhances our understanding of how extreme events are valued in derivative markets