Crude oil price dynamics with crash risk under fundamental shocks

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Summary

Our paper presents a crude oil price model in which the price is confined in a wide moving band. A price crash occurs when the price breaches the lower boundary where a smooth-pasting condition is imposed. Using an asymmetric mean-reverting fundamental (supply/demand) shock, the solution derived from the oil price equation for the model shows the oil price follows a mean-reverting square-root process, which is quasi-bounded at the boundary. The oil price dynamics generates left-skewed price distributions consistent with empirical observations. A weakened mean-reverting force for the price increases the probability leakage for the price across the boundary and the risk of a price crash. The empirical results show the oil price dynamics can be calibrated according to the model, where the mean reversion of the price dynamics is positively co-integrated with the oil production reaction to negative demand shocks, and with the risk reversals of the

commodity currencies, the Canadian dollar and the Australian dollar in currency option markets. The results are consistent with an increased price crash risk with negative demand shocks and negative risk reversals. The forecasting performance of the oil price model is better than the futures-spread models and random walk models during the crash periods. While the price of oil was above the lower boundary for most of the time, the conditions for breaching the boundary were met in 2008 and 2014 when the price fell sharply.