COMPARATIVE STATICS FOR REAL OPTIONS ON OIL: WHAT STYLIZED FACTS TO USE?

Diderik Lund, University of Oslo, +47 22855129, diderik.lund@econ.uio.no
P.O.Box 1095, Blindern, NO-0317 Oslo, Norway
Ragnar Nymoen, University of Oslo, +47 22855148, ragnar.nymoen@econ.uio.no

Overview

The theory of real options is a major new development in investment theory over the last three decades. Oil investments have been an important application. Many authors have relied on two results well known from the theory of financial options, that option value is increasing in the volatility of the underlying asset, and that higher volatility leads to postponed investment. However, these comparative statics results do not carry over unconditionally to real options. This depends on which other variables are kept constant, and on the sign of a correlation.

We present a widespread version of the theory, relying on the Capital Asset Pricing Model to find the required rate of return. Based on this, two commonly used assumptions are tested empirically. One is that the correlation between the increase in the oil price and the rate of return on the market portfolio is invariant to changes in the oil price volatility. The other is that the correlation is positive, which is rejected in previous empirical studies, but nevertheless assumed by most applied theorists. An alternative version of the first assumption is that the covariance, not the correlation, is invariant. All three hypotheses are rejected.

We also discuss the interpretation of the comparative statics results, what it means to consider a change in volatility. The most useful application of the results seems to be a prediction of what would happen if a particular price process becomes more volatile. From a purist point of view, this is unsatisfactory, since the theory is not valid if the volatility is not constant. From a pragmatic point of view, the change could be conceived of as an unanticipated increase in volatility. This seems to be the prevailing view in the applied literature.

Methods

The hypotheses are tested using daily data for crude oil spot prices and the Standard and Poor's 500 index of the U.S. stock market, for 15 years, 1993 – 2008. Using the same data, Ewing and Malik (2008) find three structural breaks in oil price volatility, defining four subperiods. These breaks are used to test whether correlations or covariances are invariant to changes in volatility. Moreover, we test whether correlations are positive.

The test of correlation invariance is taken from Omelka and Pauly (2012), who derive its asymptotic properties.

Results

The hypothesis that the correlation (and thus also the covariance) is positive can be rejected for each of the four subperiods. It can also be rejected for all but 1.6 percent of overlapping rolling windows of length 80 working days. But it is not significantly negative for more than 9.4 percent of these windows. Based on this, one could say that it is non-positive.

The correlation is not invariant to the breaks in volatility. This can be rejected for all three breaks.

To illustrate the economic significance of the results, the CAPM risk premium is calculated, based on these estimates. They are very small, less than 40 basis points, except for the first year. For this year, mid–1993 to mid–1994, there are also signs that the assumption of a geometric Brownian motion is not suitable.

Conclusions

Two commonly used assumptions in the literature on real options on oil are rejected. More care should be taken when "stylized facts" are used to underpin applications of theoretical results in this field.

References

(There are 55 references in the current version of the paper, 12 May 2014.)

Ewing, B.T. and F. Malik (2010). "Estimating Volatility Persistence in Oil Prices under Structural Breaks." *The Financial Review* 45: 1011–1023.

Omelka, M. and M. Pauly (2012). "Testing Equality of Correlation Coefficients in Two Populations via Permutation Methods." *Journal of Statistical Planning and Inference* 142: 1396–1406.