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Options on fixed exchange rates and the Argentine peso devaluatio

James Kennan of BNP Paribas New York, provides a basis for pricing and evaluating such options usin practical methods, and some simple estimation techniques for relative valuation

Valuing options on a fixed exchange rate, or on any asset price set by official decree, is problematic. To the casual observer, such options may seem illogical, since the cash rate does not move. Yet active markets have existed on such options despite explicitly pegged exchange rate regimes. Exchange rate crises in which currency pegs were abandoned, such as Mexico (1994), Russia (1998), Brazil (1999), and Argentina (2002) have also shown that options with strikes 'outside the band' are not worthless[1]. Such options can offer valuable information about the probability of a peg holding over a given period. This article provides a basis for pricing and evaluating such

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options using practical methods, and some simple estimation techniques for relative valuation.

Brownian motion is a reasonable approximation for the behaviour of a broad range of financial asset prices. Consequently, the Black-Scholes application of Brownian motion to options pricing has become a widely-used yardstick, allowing traders to express prices in terms of implied volatility rather than premium, and providing a benchmark for institutions to value non-tradable assets with embedded options. But not all asset prices move in a random walk. Some governments fix the external value of their currencies, generally to promote trade or reduce inflation.[2]

Historical volatility is generally a rough proxy for implied volatility. But implied volatilities of pegged currencies are generally much higher than the historical volatilities of their forward rates because the market estimates that the underlying distribution of returns is not normal, unlike the observed distribution of returns (which is roughly normal). The underlying distribution includes all possible events, as opposed observed distribution, which represents only the events that a occurred over the period of observation. The underlying distribution Argentine peso prior to devaluation can be approximated as bi-mo shown in figure 1 (overleaf): a graph of the spot rate at maturity[3].

As long as the peg holds, the spot rate remains at parity. If th rate ever varies much, the act of abandoning the peg itself im loss of confidence, reviving fears of Argentina's former hyperin Prior to devaluation, the currency was thought to be overvalued 20–30% on a purchasing power parity basis, further shifting th ance of risk toward devaluation rather than revaluation. Because uation would be so potentially destructive, considering that m the country's debt (both domestic and foreign) was denominated dollars, the authorities were likely to strongly resist devaluation fact they did. This implies that if devaluation occurred, it would b den and large, with virtually no prices observed between th modes, as was essentially the case.

One might consider pricing options on a bi-modally distr asset using a model incorporating two distributions, each with i standard deviation, or via a Merton-type jump-diffusion model[4]. E guesswork of estimating parameters for the right-tail distr makes such models impractical. A more useful method is to e the ratio of the right tail relative to the whole distribution via a probability, allowing one to price options with strikes between t modes. This provides a simple estimate for a large region whe

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[1] Many countries have employed more complicated systems where the rate fluctuates within a specified band, which may be stationary or 'crawling'. The l typically used to reflect inflation differentials between the pegged currency an anchor. Many countries have also employed pegs comprised of a basket of currencies. This analysis may be applied to such systems equally well, with allowances for the peculiarities of each regime

[2] Examples of trade-related pegs include Bretton Woods and the ERM, while IMF programmes have used fixed exchange rates as price-stabilising anchors

[3] This is a stylised depiction; in reality, the area under the left-hand mode is ty greater than under the right-hand mode, such that the spike located at the sp is very, very high

[4] See Merton, "Option Pricing When Underlying Stock Returns are Discontinu Journal of Financial Economics, 3 (March 1976), 125–44

option price behaves linearly. Under this assumption, the option price reflects information about both the probability and expected magnitude of devaluation.

To calculate the probability, assume a spot rate of 1.00 Argentine peso (ARS) per US dollar (USD), a USD deposit rate of 6.0%, and a one-year forward rate of 1.05, (implying an ARS deposit rate of 11.2%), and suppose the at-the-money-forward (ATMF) call on ARS (put on USD) trades at a premium of 4.16% of USD (equal to an implied volatility of 11.0%). If there is no change in the peg, the option buyer has an expected profit of [(1.05/1.00) – 1] x [(1/(1 + .06)] = 4.71%. In present value terms, the call option buyer risks 4.16% to make 4.71%, implying a no-devaluation probability of (4.16/4.71) = 88.3%. The devaluation probability is therefore (100.0% – 88.3%) = 11.7%.

The expected magnitude of devaluation can be derived from the price of the ATMF put on the currency, since the buyer of the put has an expected profit corresponding to the devaluation probability and the cost of the option. The put buyer risks 4.16% to make an uncertain profit. The present value of the buyer's expected profit is thus (premium/devaluation probability) = (4.16%/11.7%) = 35.6%. This corresponds to a spot rate of [strike/(1 – devaluation magnitude)] = [1.0500 / (1–35.6%)] = 1.6304.

A short position in the naked ATMF call on ARS makes a profit (equal to the premium) if the peso devalues beyond the forward prior to expiration. The present value of the forward points multiplied by the probability of no devaluation is thus a first approximation for the price of the ARS call. This assumes that the probability of revaluation is zero. In practice, the ARS call with a strike of 1.00 did not trade for zero premium, since there were potential scenarios in which the currency could revalue. Prior to devaluation, the price of the one-year 1.00 ARS call typically ranged from 0.15% to 0.30% of USD. This option was frequently quoted and its price easily observed.

This probability can be incorporated into a pricing formula by simply specifying a price for the 1.00 ARS call. We can also generalise the formula for all strikes above 1.00 and below the region of the right tail:

$$\frac{P_{strike} - P_{1.00}}{PV_{(strike-1.00)}} = 1 - Pr_{deval}$$

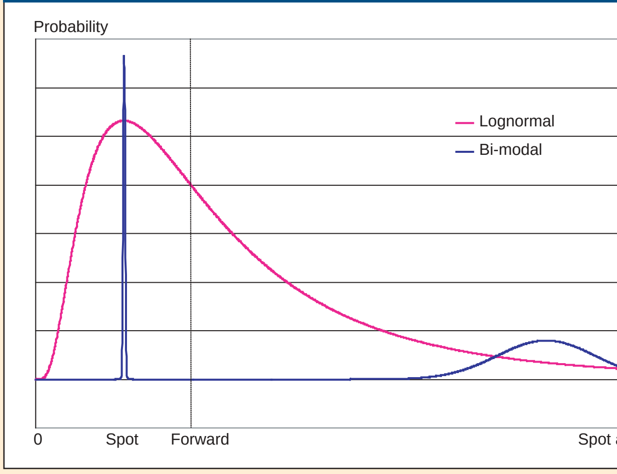
- P_{strike} = price of the call on ARS for the desired strike
- $P_{1.00}$ = price of the call on ARS with a strike of 1.00
- $PV_{(strike - 1.00)}$ = present value of the (strike – 1.00) ARS call spread
- Pr_{deval} = probability of devaluation.

The difference in price between the ARS call for a given strike (P_{strike}) and the ARS call with a strike of one, relative to the value of the spread, should be equal to the probability of no devaluation over the period of the option.

For example, to price a one-year USD call (ARS put) with a strike of 1.1500, assume the one-year 1.00 ARS call is 0.20%, the annual probability of devaluation is 25%, the one-year forward is 1.0800, and the one-year USD deposit rate is 5%. The value of the ARS call is 0.20% + (1–25%) x (1.15/1.00 – 1) x [1/(1 + 5%)] = 10.91%, implying a volatility of 19.0%. By put-call parity, the ARS put is worth 10.91% – (1.15/1.08 – 1) x [1/(1 + 5%)] = 4.74%.

This technique generates a volatility smile very much in line with observed market prices, and price strikes up to the region of the right-

Figure 1. Lognormal vs. bi-modal distribution



tail distribution. Beyond this level, the technique begins imply
tive option prices and cannot be used, since it assumes no k
of the shape of this part of the distribution. However, observe
interest in such high strikes relative to the level of forwards in
of the Argentine peso was rare.

A careful analysis of a fixed asset's underlying distribution, t
account relevant macroeconomic and policy-related drivers, c
the trader or analyst in pricing derivatives on such assets. Su
prices can be expressed in terms of two intuitive factors: a
probabilities of devaluation and values of at-the-money-spot
simple model suggested here is not intended to predict opti
though it does aim to provide a basis for relative valuation.
provides a benchmark that, like implied volatility, can be more
discussed to formulate option prices. Using this methodo
month Argentine peso options traded in September 2001 in
kered interbank market – some of the last options traded p
devaluation of January 2002 – priced in an annualised pro
devaluation of approximately 70%, with an expected devalua
nitude of around 2.10, very indicative of the actual event. ■

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this article in 'Investing in Emerging Fixed Income
Fabozzi/Pilarinu, eds. (John Wiley & Sons, I

James Kennan has traded options for seven years a
SBC Warburg, and BNP Paribas and holds a Mast
in finance from Harvard

CONTACT

James Kennan,
Vice-President, BNP Paribas, New York

Tel: +1 212 841 3432
Fax: +1 212 841 3940
e-mail: james.kennan@americas.bnpparibas.com