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An options-based analysis of emerging market exchange rate expectations: Brazil's *Real* Plan, 1994–1999

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Abstract

This paper uses currency option data to investigate market expectations on the Brazilian Real–U.S. dollar exchange rate from October 1994 through March 1999. We derive implied probability density functions (PDF) for expected future exchange rates and thus measures of the credibility of the "crawling peg" and target zone regimes governing the exchange rate. Target zone credibility was poor prior to February 1996, improved afterwards through September 1997 and later started to worsen again. The market anticipated periodic band adjustments and estimated distributions are very sensitive to political and economic news affecting the credibility of the regime.

JEL classification: F31; G15; G13; F37
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This paper uses a new data set of options on the Brazilian Real/US dollar exchange rate to extract market expectations, as embodied in the risk-neutral probability density function (PDF), of Real–Dollar exchange rates over horizons of 1 to 3 months. Unlike ordinary exchange rate forecasts that provide only a point estimate of the future exchange rate, options-based forecasts, by permitting the derivation of a PDF, describe a range of realizations and the probability attributed to each range.

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This PDF-based approach is especially effective for an analysis of the Real/$ exchange rate, which from June 1994 to January 1999, under the Real Plan, was characterized by a combination of a crawling peg and a target zone regime. Over short horizons, the exchange rate followed a crawling peg surrounded by a "miniband", but for long horizons, superimposed on the crawling peg, there was also an official "maxiband" with a fixed (non-crawling) central rate, floor, and ceiling.

The PDFs derived in this paper enable us to compare market expectations embedded in options with these two concurrent regimes. For example, we can identify whether markets in fact anticipated a faster depreciation, and if so, where (relative to the crawling peg) probability was concentrated. Relative to a single point expectation of the future exchange rate, a great advantage of a full PDF is the ability to disentangle magnitude and probability of expected depreciation. For the longer-horizon fixed target zones, we conduct "arbitrage-based tests" of credibility, developed in Campa and Chang (1996), that are virtually assumption-free. Given these target zones, we are also able to determine both "intensities" and probabilities of realignment, and to investigate possible economic determinants of realignment intensity. Thus, a single approach using Dollar–Real options permits us to analyze both facets of the Brazilian exchange rate regime during the Real Plan.

This work contributes to the growing literature on the use of options to characterize expected asset returns, and in particular to predict currency crises. Recent empirical work using options to identify the distribution of expected exchange rates includes Malz (1996b) and Campa et al. (1997, 1998). Papers specifically focusing on currency crises, especially the 1992 ERM crisis, include Campa and Chang (1996), Malz (1996a) and Mizrach (1996). These can be contrasted against measures of devaluation risk *not* based on options, as in Bertola and Svennson (1993), Kaminsky et al. (1997) and Svensson (1991).

The motivation for this research is twofold: first, to use options-based estimates of the PDF to compare market expectations with the two concurrent exchange rate regimes in the Brazilian Real Plan; and second, to observe the time path of market perceptions to gauge policy effectiveness over time. Furthermore, this is one of the first options-based tests of exchange rate regime credibility on an emerging market. Within emerging markets, this is also the first paper to deal with the data challenges of exchange-traded options, rather than over-the-counter (OTC) volatility quotes. OTC data, by construction free of arbitrage violations, are normally subject to less observation error and, hence, easier to interpret empirically. Thus, our technique could potentially be used for other emerging markets including those with only exchange-traded currency options.

The remainder of the paper is structured as follows. Section 1 describes the theoretical background to deriving risk-neutral probability density functions (PDFs) from options and for target zone regimes, the derivation of realignment intensities and probabilities, as well as arbitrage-based tests of credibility. Section 2 discusses the Real Plan and pertinent historical background, including the "miniband" and "maxiband" regimes. Section 3 introduces our option data, provides summary statistics, and conducts a preliminary analysis. Section 4 investigates the behavior of the PDF over time, and in the context of a crawling peg, describes the probability and magnitude characterizing expected deviations from this regime. Section 5 addresses the "maxiband" target zones, estimated realignment intensities and probabilities, and arbitrage-based measures of credibility. Section 6