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Dynamic characteristics of the daily yen–dollar exchange rate



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ABSTRACT

This paper explores various dynamic properties of daily data for the yen–dollar exchange rate. This empirical study shows that quantitative information articulated with technical trading acts as market-based indicators, thus contributing to the modelling of daily fluctuations in the exchange rate. Value-at-Risk analysis is also performed to demonstrate that allowing for data properties such as skewness is essential for representing the underlying volatility of the yen–dollar rate.

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1. Introduction

The objective of this study is to investigate the underlying characteristics of daily time series data for the Japanese yen–US dollar exchange rate. It is demonstrated that quantitative information associated with technical trading works as observable significant factors in the exchange rate dynamics. This study also shows that taking account of various statistical properties such as skewness is important in obtaining a well-formulated time series model for the exchange rate. The introductory section provides a brief review of related literature and also informs the research objective pursued in this paper.

It is well known that technical or chartist analysis is popular among practitioners taking part in foreign exchange markets. See [Allen and Taylor \(1990\)](#), [Cheung and Wong \(2000\)](#) and [Gehrig and Menkhoff \(2006\)](#) for extensive survey studies concerning technical trading. Thus, the potential

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importance of technical analysis has been growing and recognised in literature on foreign exchange market microstructure. For instance, [De Grauwe and Dewachter \(1993\)](#) develop a class of theoretical exchange rate models in which economic agents who are categorised as chartists play important roles. Recent empirical research has, indeed, paid much attention to technical analysis in accounting for short-term exchange rate behaviour and forecasts; see [Chang and Osler \(1999\)](#), [Osler \(2003, 2006\)](#) and [Schulmeister \(2006, 2009\)](#), *inter alia*. Although significant progress has been made in this line of research, the various roles of technical trading in foreign exchange markets have not been fully studied yet, and therefore need further empirical as well as theoretical investigations.

Technical trading involves a number of analytical methods, techniques and strategies. Candlestick chart analysis is, in particular, counted as one of the most popular methods among traders in financial markets. This method was, historically, developed in Japan in the 1700s to analyse short-term price movements in rice markets. See [Fiess and MacDonald \(1999, 2002\)](#) as well as [Marshall et al. \(2006\)](#) for details of candlestick charts. Four types of prices, classified as follows, play critical roles in candlestick chart analysis: the highest and lowest prices over a given unit of time (denoted *high* and *low*, respectively) as well as the opening and closing prices for a given unit of time (denoted *open* and *close*, respectively). The name of this analysis comes from a series of special graphs depicting these prices simultaneously; each graph fairly looks like a candle accompanied with its shadow and wick. [Marshall et al. \(2006\)](#) provide a number of examples of candlestick charts. It is conceivable, judging from the definition of these prices recorded on a daily basis, that the difference between *high* and *low* suggests the degree of intraday trend and volatility in price movements, while that between *close* and *low* implies the direction in which prices move until the closing time of a trading day. These differences between various prices on a certain trading day may, moreover, carry some information correlated with the movement of the central price from that day to the following trading day. Such information, if judged significant from a statistical viewpoint, can be seen as evidence for the underlying inter-day trend in the price movement. As a result, the price differences themselves can be reckoned as market-based trend indicators. This possibility leads to the primary impetus for the empirical investigation pursued in this paper.

Exchange rate data have been studied in literature using various methods and techniques in time series econometrics; see [Sarno and Taylor \(2002\)](#), *inter alia*, for an overview of empirical exchange rate studies. This paper, along the similar lines, employs a class of autoregressive conditional heteroscedasticity (ARCH) time series models, with a view to investigating the dynamics of the daily yen–dollar exchange rate. An ARCH model, pioneered by [Engle \(1982\)](#), paves the way for extensive research in the fields of quantitative economics and finance; a generalised ARCH or GARCH model is then introduced by [Bollerslev \(1986\)](#). For details of a GARCH model and its variants, see [Engle \(1995\)](#) as well as [Francq and Zakoian \(2010\)](#). GARCH-type analysis has contributed a great deal to a better understanding of the behaviour of high-frequency financial data; see [Francq and Zakoian \(2010\)](#) and a number of references therein. The use of GARCH-type models has, indeed, yielded fruitful outcomes in the analysis of yen–dollar exchange rate data; see [Engle et al. \(1990\)](#), [Ito et al. \(1992\)](#), [Tse \(1998\)](#), [Nagayasu \(2004\)](#), [Tsui and Ho \(2004\)](#), *inter alia*. The existing studies are certainly informative and shed useful light on various aspects of the yen–dollar exchange rate. Empirical research which makes explicit use of candlestick-chart information such as [Fiess and MacDonald, 1999](#), however, appears to be limited in literature about the yen–dollar exchange rate. It is important, from the viewpoint of effective exchange rate policy, to have a comprehensive understanding of the influences of technical trading on exchange rate behaviour. There remains room for further empirical investigation along these lines, which drives the research objective pursued in this paper.

This study, using recent developments in time series econometrics, shows that quantitative information related to candlestick chart analysis plays an important role in accounting for the dynamics of the daily yen–dollar rate. The empirical findings revealed in this study complement [Fiess and MacDonald \(1999, 2002\)](#) and provides a promising direction for further research on the roles of candlestick chart analysis in the foreign exchange markets. Accumulated research findings in this regard should be useful for policy makers as well as financial analysts.

Furthermore, as demonstrated by [Giot and Laurent \(2003, 2004\)](#), both thick-tailed and skewed distributions are often viewed as the distinguishing characteristics of high-frequency financial data. The present study shows that a GARCH-type model based on a skewed-Student *t* distribution, which

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