Available online at www.sciencedirect.com
SCIENCE DIRECT®
International Review of Financial Analysis
14 (2005) 211–246
IRFA
INTERNATIONAL REVIEW OF
Financial Analysis

Wavelet multiresolution analysis of high-frequency Asian FX rates, Summer 1997

Jeyanthi Karuppiah[a], Cornelis A. Los[b,*]

[a]*Nanyang Business School, S3-01B-62, Nanyang Technological University, 639798, Singapore*
[b]*Department of Finance, College of Business Administration and Graduate School of Management, Kent State University, Kent, OH 44242 0001, United States*

Abstract

Foreign exchange (FX) pricing processes are nonstationary: Their frequency characteristics are time dependent. Most do not conform to Geometric Brownian Motion (GBM), because they exhibit a scaling law with Hurst exponents between zero and 0.5 and fractal dimensions between 1.5 and 2. Wavelet multiresolution analysis (MRA), with Haar wavelets, is used to analyze these time and scale dependencies (self-similarity) of intraday Asian currency spot exchange rates. We use the ask and bid quotes of the currencies of eight Asian countries (Japan, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand) and, for comparison, of Germany for the crisis period May 1, 1998–August 31, 1997, provided by Telerate (U.S. dollar is the numéraire). Their time-scale-dependent spectra, which are localized in time, are observed in wavelet scalograms. The FX increments are characterized by the irregularity of their singularities. Their degrees of irregularity are measured by homogeneous Hurst exponents. These critical exponents are used to identify the global fractal dimension, relative stability, and long-term dependence, or long-term memory, of each Asian FX series. The invariance of each identified Hurst exponent is tested by comparing it at varying time and scale (frequency) resolutions. It appears that almost all investigated FX markets show antipersistent pricing behavior. The anchor currencies of the D-mark and Japanese Yen (JPY) are ultraefficient in the sense of being most antipersistent or “fast mean-reversing.” This is a surprising result because most financial analyst either assume neutral or persistent behavior in the financial markets, based on earlier research by Granger in the 1960s. This is a pedagogical paper

* Corresponding author.
E-mail address: clos@kent.edu (C.A. Los).

1057-5219/$ - see front matter
doi:10.1016/j.irfa.2004.06.014

explaining the most rational methodology for the identification of long-term memory in financial time series.

JEL classification: C22; F31; G14; G15; O53
Keywords: Foreign exchange markets; Antipersistence; Long-term dependence; Multiresolution analysis; Wavelets; Time-scale analysis; Scaling laws; Irregularity analysis; Randomness; Asia

1. Introduction

There is still a remarkable lack of scientific analysis of the crucial financial market phenomena that characterized the Asian Financial Crisis from a risk management perspective. The phenomena of financial crisis, turbulence, friction, and persistence are clearly inadequately described by the affine Markow (ARIMA) and Geometric Brownian Motion (GBM) models (Bouchaud & Potters, 2000). The main objective of this paper is to present more representative models and analytic procedures, adapted from hydrology, biometrics, and signal processing, to empirically identify foreign exchange (FX) rate models.

The measurement of the empirical efficiency of FX markets for risk management purposes dates back to the early 1970s, when the 1944 Breton Woods Agreement of fixed exchange rates was discarded in 1971 and replaced by the current system of flexible exchange rates in 1973 (Cornell & Dietrich, 1978; Friedman & Vandersteel, 1982; McFarland, Richardson, Pettit, & Ksung, 1982). But the then existing research methodology was inadequate to identify the model of the data. Recently, more discerning signal processing techniques to the same model identification problem have been proposed and appear to have more success (Bollerslev & Domowitz, 1993; Corazza & Malliaris, 2002; Gençay, Selçuk, & Whitcher, 2001a, 2001b; Van De Gucht, Dekimpe, & Kwok, 1996; Los, 2000b, 2003).

In an efficient market, the arrival of new information produces instantaneous price correction, leaving no prospect for price prediction and therefore minimal opportunity for reaping abnormal profits. The efficient market hypothesis (EMH) states that a market where the best prediction of a price τ periods into the future (=the prediction horizon), based on current and past information, $E_t\{x(t+\tau)\}$, is its current, exact, and known price, $\hat{x}(t)=x(t)$, is martingale efficient (Fama, 1970, 1991):[1]

$$E_t\{x(t+\tau)\} = \hat{x}(t) \text{ for any } \tau>0 \tag{1}$$

This implies that the martingale increments

$$\tilde{x}_{-\tau}(t) = x(t+\tau) - \hat{x}(t) \tag{2}$$

[1] We will introduce some simple notation to connect the various sections of this paper to the literature.