Journal of International Money and Finance 32 (2013) 304–323

Contents lists available at SciVerse ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Nonlinear relationship between the real exchange rate and economic fundamentals: Evidence from China and Korea

Xiaolei Tang [a,b,*], Jizhong Zhou [b]

[a] Department of Economics, National University of Ireland, Galway, Ireland
[b] School of Finance, Shanghai University of Finance and Economics, Shanghai, China

JEL classification:
F31
F41

Keywords:
Equilibrium exchange rate
Alternating Conditional Expectation algorithm
Linear cointegration
Nonlinear cointegration

A B S T R A C T

This paper investigates the potential nonlinear relationship between the real exchange rates of two currencies (Chinese *Yuan* and South Korean *Won*) and economic fundamentals using quarterly data over the period 1980Q1–2009Q4. We employ the Alternating Conditional Expectation algorithm to test for nonlinearity among the variables of interest. The results show that there does exist a nonlinear cointegrating relationship between the real exchange rates and fundamentals for China and Korea. In contrast with the conventional linear relationship, the elasticity of the real exchange rate with respect to fundamentals varies over time according to the nonlinear relationship.

1. Introduction

There is a large literature studying the relationship between exchange rates and economic fundamentals. Some studies on the determination of nominal exchange rates find a nonlinear relationship between nominal exchange rates and economic fundamentals (Chinn (1991), Meese and Rose (1991), Ma and Kanas (2000), among others). In contrast, the literature on the determination of real exchange rates has focused only on linear relationships. The possible nonlinear relationship between real exchange rates and economic fundamentals has hardly been discussed. This paper attempts to fill this gap and assess nonlinear aspects in the determination of the real exchange rate.

While differing in theoretical backgrounds and econometric specifications, the existing empirical studies on the determination of real exchange rates have a common feature that they largely focus on the linear relationship between the real exchange rate and the economic fundamentals. An implication

* Corresponding author. Department of Economics, National University of Ireland, Galway, Ireland. Tel.: +353 879748817.
E-mail address: x.tang1@nuigalway.ie (X. Tang).

0261-5606/$ – see front matter
doi:10.1016/j.jimonfin.2012.04.010

of a linear model is that, no matter how the variable varies in its value, the elasticity of the real exchange rate with respect to the explanatory variable in question is constant.[1] This is at odds with the conventional wisdom that the marginal contribution of an economic factor, or the marginal utility associated therewith, tends to diminish.

Given this unsatisfactory implication of the linear analyses, this paper attempts to investigate the nonlinear relationship between the real exchange rate and economic fundamentals. However, one practical difficulty we face is that, in contrast to linear analyses where the functional form is known *ex ante*, the exact functional form of a nonlinear relationship and its parameterization are unknown, and there can be potentially many nonlinear functional forms as suitable candidates. To address this difficulty, we apply the Alternating Conditional Expectation (ACE) algorithm to explore the nonlinear relationship between real exchange rates of the Chinese *Yuan* (CNY) and Korean *Won* (KRW) and economic fundamentals.[2] As we will see later on, the ACE algorithm conducts a nonparametric and nonlinear transformation of a variable to make it suitable for linear regression analysis. As shown by Wang and Murphy (2004), the advantage of ACE is its ability to correctly reveal a nonlinear relationship if it does exist between variables in question and to improve the model fit considerably compared with the conventional linear model.

Attracted by its flexibility and wide application, we use the behavioural approach to specify an empirical model for the determination of the real exchange rate. The selection of the variables used as proxies for economic fundamentals is based mainly on Montiel (1999), which is a synthesis of several equilibrium real exchange rate models. Specifically, the economic fundamentals chosen include productivity growth, terms of trade, net foreign assets, economic openness, and government expenditure. We find that for China and Korea the relationship between the real exchange rate and economic fundamentals is indeed highly nonlinear with rich and complex implications for policy making.

The remainder of this paper is organized as follows. Section 2 introduces the ACE algorithm and discusses nonlinear cointegration. Section 3 explains the empirical framework, the econometric methodology, and the variables used in the empirical analysis. Section 4 presents the empirical results and discusses their implications. Section 5 concludes.

2. The ACE algorithm and nonlinear cointegration

2.1. The ACE algorithm

The ACE algorithm, developed by Breiman and Friedman (1985), is a method for estimating optimal transformations for multiple regressions that maximizes the coefficient of multiple correlations, R^2. Because the optimal transformations produced by the ACE algorithm are usually nonlinear, we can uncover the nonlinearity present in the data-generating process.

Generally speaking, a linear regression model for a response variable, y, and k independent variables, x_1, x_2, ..., x_k, takes the following form[3]:

$$y_t = \sum_{i=1}^{k} \beta_i x_{it} + \varepsilon_t \tag{1}$$

where β_i ($i = 1,2,...,k$) are the regression coefficients to be estimated, and ε_t is an error term. An ACE regression model based on Eq. (1) can be written as

$$f(y_t) = \sum_{i=1}^{k} g_i(x_{it}) + e_t \tag{2}$$

where f is a function of the dependent variable y, and g_i is function of the independent variables x_i ($i = 1,2,...,k$).

[1] Because the empirical studies typically express the variables in logarithms, the linear regression coefficients are equivalent to the estimated elasticity values.

[2] The original version of this paper only studied CNY, one referee insightfully advises us to extend the study to include another freely traded currency.

[3] The independent variables may include a constant term.