



U.S. dollar real exchange rates: Nonlinearity revisited

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Abstract

Previous empirical work employing smooth transition autoregressive (STAR) models has found that U.S. dollar real exchange rates are nonlinear mean reverting processes. We utilise tests developed from time-varying smooth transition autoregressive (TV-STAR) models to re-examine dollar-based rates. These tests reveal that structural change is an important feature of the data. In some cases there is support for both nonlinearity and structural change, while in other cases there appears to be stronger support for structural change than for nonlinearity. The results raise a number of interesting issues for future research. © 2008 Elsevier Ltd. All rights reserved.

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1. Introduction

A large amount of recent empirical research on purchasing power parity (PPP) has focused on the possibility that the failure of conventional unit root tests, such as the Dickey–Fuller (DF) test (Dickey and Fuller, 1979) to confirm PPP when applied to time series on real exchange rates, may be due to the possibility that adjustment of real exchange rates to PPP equilibrium levels is nonlinear. Conventional unit root tests, such as the DF test, are computed assuming a linear specification and suffer from low power to reject the unit root hypothesis if the data

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mean reverts in a nonlinear fashion (see Taylor et al., 2001). Similarly, conventional tests of no cointegration among the nominal exchange rate, domestic prices and foreign prices will have low power if the actual cointegrating relationship is nonlinear.

The specific form of nonlinearity is thought to be relevant when testing for PPP has its origins in the transaction costs literature of, for example, Benninga and Protopapadakis (1988) and Dumas (1992). Michael et al. (1997) argue that the presence of transaction costs implies that the relationship among nominal exchange rates, domestic and foreign prices may in the long-run be cointegrating as the theory of PPP suggests, but that adjustment of these variables to long-run equilibrium levels only occurs when the dis-equilibrium is large enough relative to the level of transaction costs faced. Michael et al. (1997) propose modelling the residuals from a regression of nominal exchange rates on domestic and foreign prices as a smooth transition autoregressive (STAR) process to allow for the possibility of slow (or no) adjustment to PPP equilibrium levels when the dis-equilibrium is small, but faster adjustment when the dis-equilibrium is large. The possible nonlinear adjustment of real exchange rates has, since the work of Michael et al. (1997), motivated numerous further empirical investigations; see for example Baum et al. (2001), Taylor et al. (2001), Sollis et al. (2002), and Sarno et al. (2004).

Here we take the perspective that it might be overly restrictive to assume that the autoregressive representation of a real exchange rate series – *be it a linear or nonlinear representation* – is fixed over the typical sample periods considered. Changes in monetary policy, the tastes and preferences of investors, productivity and the presence of exogenous shocks could all have statistically significant effects on the persistence of real exchange rates, with the degree of linear or nonlinear mean reversion varying over time. The majority of the recent empirical studies that have found evidence of nonlinear mean reversion in real exchange rates employ smooth transition models such as the exponential smooth transition autoregressive (ESTAR) model. The parameters of the ESTAR model are typically assumed to be fixed across the sample. No empirical studies that we are aware of have investigated the possibility that real exchange rates are linear or nonlinear mean reverting processes with periods of structural change.

In this paper the statistical support for the hypothesis of nonlinear mean reversion in U.S. dollar real exchange rates is re-examined, allowing for the presence of structural change. To allow for both nonlinear mean reversion (of the ESTAR type) and/or structural change the recently developed time-varying smooth transition (TV-STAR) methodology of Lundbergh et al. (2003) is employed.¹ This methodology is attractive as it enables the practitioner to statistically test which of the following four competing hypotheses concerning the time series behaviour of real exchange rates has the most statistical support:

- (a) the real exchange rate is a linear mean reverting process (specifically an autoregressive – AR process);
- (b) the real exchange rate is a linear mean reverting process subject to structural change (a time-varying AR process – TV-AR);
- (c) the real exchange rate is a nonlinear mean reverting process of the ESTAR type; and
- (d) the real exchange rate is a nonlinear mean reverting process of the ESTAR type subject to structural change (a TV-STAR process).

¹ Note that in this context ‘structural change’ refers to parameter change that can be modelled using continuous functions as in Lin and Teräsvirta (1994). Since the functions employed also nest discrete indicators, this approach does in a sense allow for discrete parameter changes.

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