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Journal of International Money and Finance

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



Temporal aggregation and purchasing power parity persistence

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A B S T R A C T

JEL Classification:

F31
C22

Keywords:

Temporal aggregation
Real exchange rates
Purchasing power parity
Exchange rate persistence
Half-lives

This paper uses a unique new *monthly* US–UK real exchange rate series for the January 1794–December 2009 period to reexamine the academic debate over purchasing power parity (PPP). The consensus view described by Rogoff (1996) is that PPP holds in the long-run, but short-run deviations are very persistent, with half-lives ranging from 3 to 5 years. Most of the literature using long time series relies on the annual data developed by Lee (1976) and Lothian and Taylor (1996), which were both constructed from underlying higher-frequency data sources. Estimates of purchasing power parity persistence using these series may therefore be subject to temporal aggregation bias. We find evidence of aggregation bias which indicates the half-life of PPP deviations has been overestimated in much of the previous literature. We also find that estimates of the half-lives are further reduced once we account for the Harrod (1933)–Balassa (1964)–Samuelson (1964) effect. The result of aggregation bias appears to be robust even when considering the case that real exchange rates exhibit nonlinear dynamics.

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1. Introduction

During the course of the last two decades, a large body of literature has been devoted to characterizing and understanding the dynamics of real exchange rates. A number of these studies have used time series of real exchange rates spanning a century or more in order to test the Purchasing Power

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Parity (PPP) hypothesis. The use of such long series has been motivated, in part, by the difficulty of rejecting the random walk hypothesis in samples limited to the post-Bretton Woods floating rate era. As is more commonly understood now, the inability to reject a random walk was largely due to the low power of standard unit root tests. This has been documented by [Lothian and Taylor \(1997\)](#), among others. The use of longer data series has helped to rehabilitate the PPP hypothesis and arrive at what [Rogoff \(1996\)](#) described as a “consensus” that PPP deviations have a half-life of 3–5 years.

However, many of the studies underpinning this consensus utilize annual frequency datasets that were assembled by averaging underlying higher-frequency series. [Working \(1960\)](#) showed that such temporal aggregation creates a bias, leading to overestimates of persistence. [Taylor \(2001\)](#) made a theoretical argument that this problem has afflicted the empirical literature on PPP.

In this paper, we utilize a new 216-year monthly frequency data series of the US–UK real exchange rate assembled by [Craighead \(2010\)](#) to examine the implications of *temporal aggregation* for estimates of the persistence of PPP deviations. We show that estimated half-lives of PPP deviations are substantially lower in monthly data than in quarterly and annual data created by averaging the monthly series, which provides empirical confirmation of Taylor’s hypothesis. This remains true even after accounting for two other factors that have been shown to impact the estimated persistence of deviations: time-varying equilibria and nonlinearities.²

The standard interpretation of the PPP theory implies stationarity of the real exchange rate. However, the well-known hypothesis of [Harrod \(1933\)](#), [Balassa \(1964\)](#) and [Samuelson \(1964\)](#) suggests that a country’s real exchange rate will appreciate as it develops, which implies the long-run equilibrium may vary over time. The empirical relevance of the Harrod–Balassa–Samuelson (HBS) effect for purchasing power parity has previously been demonstrated by [Lothian and Taylor \(2008\)](#) and [Chong et al. \(2010\)](#). We find that the speed of convergence to equilibrium increases further when the HBS effect is accounted for.

[Taylor \(2001\)](#) also noted that the use of linear models potentially creates another source of over-estimated persistence of PPP deviations. An extension to a nonlinear framework for the current floating rate period illustrates this point, as the estimated persistence of PPP deviations is shown to be lower using an exponential smooth transition (ESTAR) model. Moreover, we also find that the nonlinear model exhibits temporal aggregation bias, since the estimated persistence is also lower using monthly rather than quarterly or annual data.

To summarize, we show that reducing temporal aggregation bias by using higher-frequency data, allowing for a time-varying equilibrium due to the HBS effect, and employing nonlinear estimation are complementary. Individually, all three reduce the estimated persistence of deviations from PPP, and the combined effect is a substantial increase in the speed of convergence which serves to strengthen the PPP hypothesis.

The remainder of the paper is organized as follows. Section 2 outlines the issue of temporal aggregation as it pertains to the biases that may arise when calculating half-lives. A description of the data can be found in Section 3 followed by initial estimates of the half-life from linear models of the real exchange rate. The HBS effect is incorporated in Section 4. Section 5 then relaxes the assumption of linearity and utilizes an exponential smooth transition (ESTAR) model of real exchange rates to examine bias in estimating persistence. The final section concludes.

2. Temporal aggregation and half-life estimation

In a seminal article, Holbrook [Working \(1960\)](#) examined the biases that arose as a result of time averaging for estimates of serial correlation parameters in autoregressions containing price differentials. Although the issue of biases arising from temporal aggregation is well-known, relatively few

² Other types of bias have also been suggested in the literature examining PPP. For example, [Imbs et al. \(2005\)](#) examine how sectoral heterogeneity in convergence to the law of one price can cause the estimated half-life to be biased upwards, although [Chen and Engel \(2005\)](#) do not find this source to be quantitatively important. [Boyd and Smith \(1999\)](#) consider lagged-dependent variable bias. More recently, [Crucini and Shintani \(2008\)](#) suggest that the long half-lives may be an artifact of using aggregated data, as opposed to micro-level data.

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