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Asymmetric nonlinear mean reversion in real effective exchange rates: A Fisher-type panel unit root test applied to Sub-Saharan Africa

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ABSTRACT

This study investigates the nonlinear data generating processes of real effective exchange rates in a panel of Sub-Saharan African countries; the region with the highest transportation costs, trade barriers in international arbitrage and frequent central bank intervention in the foreign exchange market, which are plausible main sources of nonlinear and asymmetric deviations from purchasing power parity. By means of Monte Carlo simulations, we use the empirical distributions of the exponential smooth transition autoregressive (ESTAR), and the asymmetric ESTAR data generating processes to test for mean reversion in monthly real effective exchange rates. We then apply Fisher's inverse chi-square test that combines the observed significance levels of independent univariate unit root tests to test for panel unit roots. The findings suggest that once nonlinearities and asymmetries are taken into account, there is more evidence in favor of the purchasing power parity hypothesis.

1. Introduction

The debate on the true data generating process (DGP) that drives real exchange rates (RER) has produced mixed results. The interest has not been in RER per se, but rather because RER helps to test one of the cornerstones of international economics—purchasing power parity (PPP). The PPP hypothesis can be dated back to the sixteenth century, but its modern application starts with the work by Cassel (1918). The stronger version of PPP, also known as the law of one price (LOOP), stipulates that when the prices of goods across countries are expressed in the same currency, a good must sell for the same price. Due to policy implications of PPP in international finance, and the fact that PPP is the basis of international comparisons of national accounts, there has been numerous studies that have tested its validity in developed countries, and to a lesser extent in developing ones.

The most tested PPP hypothesis is the relative version, which asserts that the change in the nominal exchange rate between two currencies is determined by the change in the relative price levels of the two countries, which implies that when PPP holds there exists a long-run relationship between nominal exchange rate and domestic and foreign prices.

One of the approaches and indeed the most followed to test the validity of PPP consists of unit root testing in real

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exchange rate (RER). Since RER is the nominal exchange rate adjusted for price levels, movements in RER represent deviations from PPP. If RER is stationary, it implies that it is mean reverse and thus that PPP holds. Mean reversion is an important property which assures that RER can have short-run deviations, but is expected to return to its equilibrium level in the long-run (Alba & Park, 2005). A non-stationary RER, on the other hand, indicates that there is no equilibrium exchange rate, and thus deviations from PPP are not corrected (Chang, De-Piao, Wen-Chi, & Chia-Hao, 2010).

The majority of studies have implicitly assumed that the adjustment towards PPP is linear; and have therefore applied linear model-based unit root tests. Several studies have relied on the results of the ADF test to assess the validity of PPP. However, as also argued by Sjölander (2007), the ADF and other univariate tests suffer from the low-power problem. Indeed, Lothian and Taylor (1997) demonstrates that linear univariate tests fail to reject the null hypothesis of unit root when it is in fact false.

The problem of low power, as pointed out by Maddala and Wu (1999), is dealt with by applying Panel unit root tests. Panel unit root tests combine time series information with cross-sectional variability and thus increase the power of statistical inference. This approach has been pioneered by, inter alia, Breitung (2000), Choi (2001), Levin, Lin, and Chu (2002), Quah (1994). Notwithstanding the higher power claim by proponents of panel unit root tests, their application to test the PPP hypothesis has produced mixed results. We argue that the problem is not the power of univariate unit root tests, but rather the DGP; hence the linear model-based panel unit root tests are not an adequate solution.

There are various reasons the DGP of RER might not be linear. As Bahmani-Oskooee, Kutan, and Zhou (2008) point out, nonlinearities in RER potentially arise from transportation costs and trade barriers in international arbitrage, causing a wedge among prices of one good traded in distant markets. This source of nonlinearity is very relevant in the context of developing countries. In fact, transport costs are still much higher in developing countries. Developing countries in general and African countries in particular suffer from infrastructure deficits; and it is well documented that transport costs are the highest in Africa, even sometimes higher than the cost of the goods transported (Arvis, Raballand, & Marteau, 2007). Moreover, it is important to highlight that several Sub-Saharan African countries are landlocked.[1] As pointed out by Radelet and Sachs (1998), the transportation cost burden is 50% higher in landlocked countries. In addition to transportation costs, these countries' logistics and import tariffs play an even more important role in explaining trade costs (Amjadi & Yeats, 1995).

Another source of nonlinearities in RER is related to the conduct of monetary policy. Canales-Kriljenko (2003) find that central banks in developing countries intervene more frequently in the foreign exchange market than central banks in industrialized countries do. Central banks in developing and transition countries are able to conduct foreign exchange intervention more effectively than their counterpart in developed countries issuing the major international currencies. This is because central banks in developing countries do not fully sterilize their foreign exchange intervention, and due to frequent intervention, they have an information advantage over foreign exchange market turnover. Sometimes they even use moral suasion to support their intervention. These findings suggest that, due frequent intervention in the effort to control inflation, nominal exchange rate adjustment is very likely to be nonlinear. There are other potential sources of nonlinearities that are cited in the literature, inter alia, heterogeneous opinions on the equilibrium exchange rate in the foreign exchange rate market (Taylor & Allen, 1992; Taylor, Peel, & Sarno, 2001), speculative attacks on currencies (Flood & Marion, 1998), and the target-zone regime (Krugman, 1991).

Nonlinearities in RER have motivated the development of new unit root tests that are based on nonlinear DGPs. Employing the ESTAR time series model, Kapetanios, Shin, and Snell (2003) develops a nonlinear unit root test known as symmetric ESTAR. Unlike the ADF, the nonlinear ESTAR unit root test has provided more evidence in support of the PPP hypothesis. Similarly, Sollis (2009) extends the nonlinear ESTAR unit root test, which assumes that at any point in time mean reversion is symmetric, to allow for asymmetric adjustment. Sollis's argument is very relevant for exchange rate; in reality, monetary policy-makers react differently depending on whether the currency appreciates or depreciates. As argued by Calvo and Reinhart (2002), depreciation is one of the main reasons that trigger the fear of floating. Moreover, asymmetric adjustment can be justified by the implication of exchange rate for macroeconomic in/stability. As pointed out by Calvo, Reinhart, and Vegh (1995), policy makers in developing countries target RER more than other macroeconomic variables. This is mainly due to the effect that RER can have on imports and exports, as well as coping with the 'original sin', that is, when debt is denominated in foreign currency, paying down becomes more expensive when the debtor's currency depreciates,

This paper considers both nonlinear and asymmetric adjustment in real effective exchange rates. The remainder of the paper is set out as follows. Section 2 discusses previous work. The PPP theory is amply discussed in Section 3. Section 4 presents nonlinear data generating processes, and highlights recent developments. The inverse chi-square test and the Monte Carlo experiment are also described in this section. Section 5 describes the data and discusses the results. Section 6 concludes.

[1] Stone (2001) uses freight costs and shows that in a sample of landlocked African countries, the ratio of freight payments to imports reaches 20% for some countries, while this ratio is 4.7% for industrialized countries and only 2.2% for the US.