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The behavior of real exchange rate: Nonlinearity and breaks

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ABSTRACT

We analyze the possibility of nonlinear adjustment and unknown smooth breaks in the stationarity of real exchange rates in the Group of 20 (G-20) countries over a period from January 1994 to April 2010 by applying the Panel SURADF test with Fourier function. Although most of the results from a univariate unit root test and panel unit root test indicated a fail to reject the unit root null hypothesis in the real exchange rates of G-20, the results of the Panel SURADF test with Fourier function show a strong rejection of non-stationarity of real exchange rates among the G-20 and imply that PPP is valid for all in the G-20. The evidence also implies that there are nonlinearity and smooth breaks in real exchange rates of G-20 countries.

1. Introduction

In recent years, the investigation of mean reversion in the real exchange rate has become a rising issue (O'Connell, 1998; Papell, 1997; Sarno and Taylor, 2002; Taylor and Sarno, 2001; Taylor and Taylor, 2004), because the theory of Purchasing Power Parity (hereafter, PPP) remains one of the core assumptions for long term equilibrium in a wide range of open economy macroeconomic models. The empirical evidence of PPP on the stationarity of the real exchange rate is plenty, but unfortunately, thus far, a consensus has not yet reached. For example, the results obtained using panel unit-root tests by Wu (1996); Oh (1996) and Papell (1997) support long-run PPP. Taylor and Sarno (1998), and Lothian and Taylor (2000, 2008) also provided in-depth information on the theoretical and empirical aspects of PPP and the real exchange rate. On the other hand, Mahdavi and Zhou (1994) failed to find the existence of a long-run relationship between nominal exchange rate and relative prices through the cointegration technique.

Prior studies indicate that conventional unit root tests not only have lower power when compared with near-unit-root but stationary alternatives, but also fail to consider information across regions, thereby leading to less efficient estimations (e.g., Choi and Chue, 2007; Im et al., 2003; Levin et al., 2002; Maddala and Wu, 1999; Pesaran, 2007; Taylor and Sarno, 1998). Accordingly, these factors have induced considerable doubt on many of the earlier findings, which were based on a unit root in real exchange rate. One of the ways to increase the power in testing for a unit root is to employ panel data to test the stationarity of the real exchange rate. For instance, Levin et al. (2002) and Im et al. (2003) developed the asymptotic theory and the finite-sample properties of ADF tests for the use of panel data. These two tests have significantly improved power even in relatively small panels, but the problem inherent to both

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Table 1
Summary statistics for real exchange rates of G-20.

	Mean	Maximum	Minimum	Std. dev.	Skewness	Kurtosis	Jarque–Bera
Argentina	0.953	1.709	0.438	0.417	0.088	1.240	25.547***
Brazil	0.755	1.524	0.394	0.294	0.429	1.988	14.389***
Canada	0.267	0.463	0.004	0.118	−0.326	2.233	8.278**
China	1.938	2.109	1.291	0.166	−2.029	7.545	303.252***
France	1.691	2.020	1.451	0.142	0.717	2.664	17.712***
Germany	0.465	0.793	0.214	0.144	0.570	2.608	11.872***
India	3.799	3.946	3.530	0.094	−1.022	3.714	38.280***
Indonesia	9.101	10.395	8.695	0.292	0.897	4.804	52.883***
Italy	7.409	7.729	7.131	0.137	0.568	2.761	10.996***
Japan	4.614	4.879	4.164	0.151	−0.782	3.141	20.161***
Mexico	2.463	2.945	2.261	0.135	1.096	3.850	45.112***
Russia	3.398	3.953	2.928	0.287	0.453	2.080	13.628***
Saudi Arabia	−1.299	−1.160	−1.455	0.100	0.005	1.399	20.942***
South Africa	1.759	2.452	1.373	0.219	0.739	3.458	19.537***
South Korea	6.991	7.450	6.740	0.160	0.235	2.104	8.370**
UK	−0.505	−0.330	−0.731	0.102	−0.477	2.368	10.683***

Notes:
1. The sample period is from Jan. 1994 to Apr. 2010.
2. ln (real exchange rate) = ln (nominal exchange rate) + ln (foreign price level)-ln (domestic price level); the US as the base country.
3. ** and *** indicate significance at the 5% and 1% level, respectively.

is cross-sectional dependence. Zellner (1962) proposes a simple approach to control cross-sectional dependence across countries, and use the method of seemingly unrelated regression (SUR) to estimate equations. Furthermore, O'Connell (1998) documented that using the panel-based test on SUR estimations instead of OLS estimations can avoid the consideration of size distortion without an obvious loss of power.

Taylor and Sarno (1998) and Breuer et al. (2001) indicate that the "all-or-nothing" nature of the tests has not been fully resolved by recent methods, regarding improvements to the Levin et al. (2002) test. Even though the methods of Im et al. (2003); Maddala and Wu (1999) and Taylor and Sarno (1998) allow the equation to differ across panels under the stationary alternative, they are not informative about the number of series that are stationary processes when the null hypothesis is rejected. This is because of the joint tests of the null hypothesis. Breuer et al. (2001) claim that it is not necessarily true to assume that all series in the panel are stationary when the unit-root null hypothesis is rejected. Thus, those panel-based unit root tests are joint tests of a unit root for all members of a panel and are also unable to determine the mix of I(0) and I(1) series in the panel. This study uses the technique of Panel Seemingly Unrelated Regression Augmented Dickey-Fuller tests (hereafter, Panel SURADF) to explore a separate unit-root null hypothesis for each individual panel member to achieving the purpose of this study, that is, to clearly identify how many and which series in the panel are stationary processes.

The other highlight of this study is that it applies the Fourier function for capturing the effect of structural changes. Perron (1989) indicates that the power to reject a unit root significant decreases as ignoring the presence of the structural break. Meanwhile, once ignoring the presence of structural changes in the data generating process, it is easy to accept the null hypothesis of a unit root and then distorting the empirical results. In most researches, they use dummy variables to deal with the disturbance of structural changes. However, this method has several considerations for testing unit root. First, it is difficult to affirm the exact number and timing of the structural changes and brings the problem of pre-selection bias (see Maddala and Kim, 1998). Furthermore, using dummy variables to treat the presence of multiple breaks may induce the concern of parsimony and efficiency of estimation. The other restriction in using dummies is that this technique only captures the shock changes as a trend or level. However, Leybourne et al. (1998) suggest that structural changes are more likely to be smooth and gradual processes and thus using dummies to capture structural changes is not favorable. For these reasons, we use the Fourier function to deal with the unknown structural changes problem. This method, newly developed by both Becker et al. (2004, 2006) and Enders and Lee (2009), models unknown structural changes form as a smooth process by the Flexible Fourier transforms. Becker et al. (2004) and Enders and Lee (2009), and Pascalau (2010) show that the Fourier approximation can capture well the nonlinear adjustment of an unknown function. Furthermore, the unit root test with Flexible Fourier function only requires the specification of the proper frequency in the estimating equations and thus reduces the number of estimated parameters. This is the reason that this test can not only improve the parsimonious and efficiency of estimation but also enhance the size and power of the test irrespective of the time or shape of the break. Therefore, we apply the Panel SURADF test with Fourier function and apply the property of the real exchange rate to test the validity of PPP for G-20 countries. Finally, the empirical results find that long-term PPP holds true for all sample countries when we consider the presence of structural changes.

The plan of this paper is organized as follows. Section 2 discusses the theoretical model of real exchange rates. Section 3 presents the empirical method used in our study. Section 4 explains the data we employed and then discusses the empirical findings. Finally, Section 5 concludes the results of this study.