E C O N O M I C S   B U L L E T I N

On openness and real exchange rate volatility

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Abstract

We address the puzzle concerning the inverse relationship between openness and real exchange rate volatility. We argue that the relationship can be explained by increased openness facilitating purchasing power parity. Using New Zealand data, we show that increased openness prolongs real exchange regimes characterised by fast mean-reversion and low volatility.

Citation: Holmes, Mark J. and Sayeeda Bano, (2008) "On openness and real exchange rate volatility." *Economics Bulletin,* Vol. 6, No. 14 pp. 1-12
Submitted: February 27, 2008. **Accepted:** April 1, 2008.
URL: http://economicsbulletin.vanderbilt.edu/2008/volume6/EB-08F40021A.pdf

1. Introduction

In recent years, a number of studies have considered how trade integration and openness is related to real exchange rate volatility. Theoretical contributions by Hau (2002) and Bleaney (2008) have been accompanied by empirical evidence that economies that are more open have less volatile real exchange rates. Further evidence is provided by studies such as Devereux and Lane (2003) and Stancik (2006). In this paper, we explore a new dimension to this important area of research based on the adjustment of the real exchange rate towards long-run equilibrium compatible with purchasing power parity (PPP). It seems reasonable to argue that increased openness is likely to facilitate the achievement of PPP. Since long-run PPP is characterised by a stationary real exchange rate, and stationary series have lower variances than non-stationary series, we would expect increased openness to be associated with instances where stationary behaviour and low volatility of the real exchange rate is more likely to prevail.

In conducting this investigation, a key contribution of our research is with respect to the methodology we employ. In sharp contrast to existing studies of real exchange rate behaviour, unit root testing of the real exchange rate is conducted within a Markov regime-switching framework. In doing this, we measure the speed of adjustment towards long-run equilibrium as well as volatility of the real exchange rate in each regime. Additionally, we also investigate whether changes in openness significantly influences the probability that the real exchange rate switches between regimes. Existing studies of PPP most often compute a single test statistic for testing non-stationarity across the entire study period. However, this approach can lead to a bias towards accepting the non-stationary null thereby rejecting PPP, or give a false impression of the speed of adjustment towards long-run equilibrium, because there is no distinction between alternative stationary regimes.

The paper is organised as follows. The following section discusses the relevant literature and methodology. The third section reports and discusses the results. Using New Zealand data, we find that increases in openness have affected the transition probabilities to the extent that increased openness leads to an increase in the probability of the New Zealand remaining in a relatively low volatility-low persistence regime. The final section concludes.

2. Literature and Methodology

Hau (2002) argues that trade integration and real exchange rate volatility are structurally linked such that a negative correlation between them prevails. Using a small open economy model with tradable and non-tradable sectors, it is shown that more open economies have a more flexible aggregate price level. It is this flexibility that reduces the effect of unanticipated money supply shocks (or unanticipated labour supply shocks) on the real exchange rate. This results in lower real exchange rate volatility for countries with a higher openness of the economy. Indeed, Hau shows that this relationship is robust for the assumption of competitive as well as monopolistic markets for tradables. Empirical support for the inverse relationship support is then provided using a panel of 48 countries over a 19 year time period where openness explains up to 52% of exchange rate variation. Weaker evidence of an inverse relationship is provided by studies such as Stancik (2006) who analyzes the sources of exchange rate volatility in six Central Eastern Europe Countries using an ARCH-based modelling with emphasis on the asymmetric effects of news.

In a more recent contribution, Bleaney (2008) argues that the explanations offered by Hau (2002) are implausible. Since nominal exchange rate volatility is almost as strongly negatively correlated with openness as is real exchange rate volatility, Bleaney argues that the correlation of openness with real exchange rate volatility is unlikely to be determined purely by a price effect. Instead, Bleaney (2008) considers an alternative explanation based on standard procedures for assessing the sustainability of the current account balance. It is argued that economies that are more open to international trade are characterized by a narrower range of values of the real effective exchange rate for which the current account position is sustainable. Therefore, a given deviation of the real exchange rate from equilibrium should be associated with a stronger pull back towards equilibrium (i.e. a stronger mean-reverting tendency) in a more open economy. Using data for 19 countries across a 1980-2005 study period, Bleaney shows that the dynamics of the real effective exchange rate are such that there is less persistence and stronger mean-reversion under floating exchange rates. Indeed, Bleaney finds significant evidence of faster mean-reversion in more open economies, as predicted by current account sustainability analysis, and this effect is quantitatively much more important than the regime effect.

In this paper, we develop the theme that the solution to the puzzle lies in the speed of mean-reversion of the real exchange rate in more open economies. Under long-run PPP, arbitrage induces parity in prices in common currency terms for a sufficiently broad range of goods. Deviations form long-run PPP are corrected over time through adjustments in trade flows. To investigate the puzzle, we explore the possibility that openness of the economy can influence the reversion speed and therefore the persistence of PPP deviations. The absence of PPP is linked to a non-stationary real exchange rate characterized by an infinite variance; whereas as the presence of long-run PPP is associated with a stationary real exchange rate that has a finite variance. On this basis, low persistence, or a faster speed of mean-reversion, is associated with lower real exchange rate volatility.

To date, empirical evidence in support of an inverse relationship between openness and persistence is mixed. For example, Cheung and Lai (2000) employ univariate unit root testing and find that differences in openness explains little of the observed pattern of the persistence in PPP deviations across countries. However, panel data evidence from Alba and Papell (2007) indicates that PPP is more likely to feature in those countries that are more open to trade. In sharp contrast to the methodologies employed in papers such as these, we employ a Markov regime-switching approach where openness drives regime-switching real exchange rate behaviour between regimes characterised by differences in persistence and volatility.

For a given country *i*, let the real effective exchange rate be denoted by μ_t . Suppose μ_t is generated by the autoregressive process, $\mu_t = \varsigma + \varphi \mu_{t-1} + \nu_t$ where ν_t is a white noise residual. Following a transformation, the usual test for linear adjustment towards PPP is based assessing the unit root properties of μ_t through the OLS estimation of Augmented Dickey Fuller (ADF) regressions such as

$$\Delta \mu_t = \varsigma + \rho \mu_{t-1} + \sum_{i=1}^{k} \psi_i \Delta \mu_{t-i} + \nu_t \qquad (1)$$

where $\rho = (\varphi - 1)$. Here we find that $-2 < \rho < 0$ (consistent with $|\varphi| < 1$) indicates stationarity of the real exchange rate consistent with long-run PPP. This paper explores the possibility that this approach towards testing the non-stationarity of μ_t is too restrictive. This is because the dynamic behaviour of μ_t might be subject to regime shifts and if so, it is possible to improve on econometric approaches based on equation (1) that make no allowance for this. Indeed, this might be the reason why existing empirical studies often find evidence against PPP by accepting the non-stationary null.

Suppose a discrete random variable S_t takes two possible values $S_t=[0,1]$ and serves as an indicator for the state of the real exchange rate at time *t*. The expected component of $\Delta\mu_t$, conditional on the value of S_t, is given as follows:

$$\begin{aligned} E(\Delta\mu_t|S_t) &= [(1-S_t)\alpha_0+S_t\alpha_1]+(1-S_t)\lambda_0\mu_{t-1}+S_t\lambda_1\mu_{t-1} \\ &+(1-S_t)\sum_{i=1}^{l}\xi_i\Delta\mu_{t-i}+S_t\sum_{i=1}^{l}\tau_i\Delta\mu_{t-i}+\varepsilon_t \end{aligned} \quad (2)$$

where $\varepsilon_t \sim i.i.d.N(0,\sigma^2(S_t))$ characterised by a regime-dependent variance. Stationarity in both regimes is confirmed if $-2<\lambda_0,\lambda_1<0$. If $-1<\lambda_0,\lambda_1<0$, the half-life associated with a deviation from long-run equilibrium may be approximated as $HL_0=(\ln 0.5)/(1+\lambda_0)$ and $HL_1=(\ln 0.5)/(1+\lambda_1)$ for Regimes 0 and 1 respectively. If $-1<\lambda_0,\lambda_1<0$ where $\lambda_0\neq\lambda_1$, long-run PPP is confirmed across the in both regimes, but the autoregressive coefficients and speeds of adjustment towards long-run equilibrium are different. On the other hand, we may only be able to confirm that either λ_0 or λ_1 is significantly different from zero such that real exchange rate switches between regimes characterised by non-stationarity with an infinite variance and stationarity and a finite variance.

The unobserved indicator variable, S_t, can be modelled as evolving according to first-order Markov-switching process described in Hamilton (1989):

$$\begin{aligned} &P[S_t=0|S_{t-1}=0]=p=\Phi(\delta_0) \\ &P[S_t=1|S_{t-1}=0]=1-p \\ &P[S_t=1|S_{t-1}=1]=q=\Phi(\delta_1) \\ &P[S_t=0|S_{t-1}=1]=1-q \end{aligned}$$

where p and q are the fixed transition probabilities of being in Regime 0 or 1 respectively with $0<p,q<1$, and $\Phi()$ is the cumulative normal distribution function ensuring that the transition probabilities lie in the open interval $(0,1)$. However, our interest is whether or not the change of openness is responsible for switching the real exchange rate between Regime 0 and Regime 1. Extending the fixed two-state Markov-switching chain to allow for the possibility of time-varying transition probabilities enables us to specify:

$$P\left[S_t=0|S_{t-1}=0,\Omega_{t-1},\Omega_{t-2},\cdots\right]=p_t=\Phi\left(\delta_0+\sum_{i=1}^{m}\vartheta_i\Omega_{t-i}\right)$$

$$P\left[S_t=1|S_{t-1}=1,\Omega_{t-1},\Omega_{t-2},\cdots\right]=q_t=\Phi\left(\delta_1+\sum_{i=1}^{n}\kappa_i\Omega_{t-i}\right) \qquad (3)$$

where Ω denotes the change in openness.

3. Data and Results.

We employ the natural logarithm of the New Zealand real effective exchange rate obtained from the *OECD* database. Openness is measured as exports plus imports expressed as a proportion of GDP obtained from *Statistics New Zealand* where data availability dictates a study period of 1982Q3-2007Q1. For the New Zealand economy, this period includes the liberalization of trade barriers and capital controls combined with the floating of the New Zealand dollar in 1985. Figures 1 and 2 present the respective data series. There is a clear upward trend in openness over the study period, while the real exchange rate has been subject to wide swings. The standard ADF unit root tests reported in Table I indicate that both series are non-stationary in levels. In the case of the real exchange rate, non-stationarity implies that long-run PPP does not hold in the case of New Zealand.

We may now explore the possibility that the New Zealand real effective exchange rate may in fact be subject to different behavioural regimes- characterised by non-stationary or stationary behaviour and different volatilities- and that the process of regime-switching is itself affected by openness. An initial application of the LR-test proposed by Davies (1987) indicated that the time-varying transition probabilities Markov model represented by equations (2) and (3) is preferred to both the univariate ADF model represented by equation (1) and the fixed transition probabilities Markov model. Estimates based on equations (2) and (3) are reported in Table II. In contrast to the earlier univariate ADF unit root test, the New Zealand real exchange rate is characterised by two stationary regimes. Moreover, $-1<\lambda_0,\lambda_1<0$ suggests that real exchange rate stationarity prevails in both regimes. The null hypothesis $\lambda_0=\lambda_1$ is strongly rejected with $\chi^2(1)=12424$ enabling us to characterise Regime 0 by a relatively fast speed of adjustment with a half-life of 3.2 quarters. In contrast, Regime 1 is characterised by a relatively slow speed of adjustment with a half-life of 43.5 quarters. In the case of volatility, we find that $\sigma_1>\sigma_0$ indicating that volatility is greater in Regime 1 where persistence is higher.

On examining the time-varying transition probabilities, we find $\vartheta_1>0$ suggesting that larger increases (decreases) in openness lead to an increase (a decrease) in the probability of remaining in the low-volatility Regime 0. In the case of New Zealand, changes in openness do not mean the difference between long-run PPP holding or not holding. But rather, changes in openness affect the speed of adjustment towards long-run PPP. Larger increases in openness causes the New Zealand real exchange rate to remain longer in Regime 0 where volatility is lowest. Figure 3 plots the inferred probability of being in Regime 0 with the change in openness. The notable high probabilities of being in the fast speed of adjustment, low volatility Regime 0 include 1985Q3, 1986Q4-87Q3, 1989Q3-1990Q1, 1994Q4, 2002Q2 and 2004Q1-04Q3. These periods, particularly those from the initial liberalisation era of the mid to late 1980s, are associated with large increases in openness.

4. Concluding Comments

While the inverse correlation between openness and real exchange rate volatility is of great interest, surprisingly little is known about the fundamental determinants of this relationship. In this paper, we find evidence that the relationship can be explained by the regime-switching behaviour of the real exchange rate. Using New Zealand data, we find increases in openness affect the transition probabilities associated with regime shifting thereby facilitating a less volatile real exchange rate faster characterised by a faster speed of adjustment towards its long-run PPP value. Future avenues of research might consider methodologies that advocate smooth transition regime-switching against a background of threshold effects in the openness-volatility relationship.

Table I. Univariate ADF Unit Root Tests

	Level	First Difference
Real exchange rate	-2.004	-8.147***
Openness	-0.949	-14.858***

Lag lengths selected according to the SIC. The 5% critical value is -2.89. *** denotes rejection of the non-stationary null hypothesis at the 1% critical value based on a critical value of -3.500.

Table II. Regime-switching Analysis of the Real Exchange Rate

Regime 0		Regime 1	
α_0	0.934*** (0.007)	α_1	0.066*** (0.001)
λ_0	-0.192*** (0.002)	λ_1	-0.016*** (0.0003)
ξ_1	0.206 (0.235)	τ_1	0.204* (0.112)
δ_0	-25.913*** (0.002)	δ_1	245.959*** (0.048)
ϑ_1	1.094** (0.551)	κ_1	-0.459 (0.437)
σ_0	0.006	σ_1	0.070
HL_0	3.246	HL_1	43.491
$\lambda_0 = \lambda_1$	12424.413***		

Estimates are for the regime-switching model described by equations (2) and (3). Standard errors are given in parentheses where the superscripts ***, ** and * denote rejection of the zero null at the 1, 5 and 10% significance levels respectively. HL denotes half life and the p-value is reported for the hypothesis test $\lambda_0 = \lambda_1$ which is distributed as $\chi^2(1)$ on the null.

Figure 1. Real Effective Exchange Rate

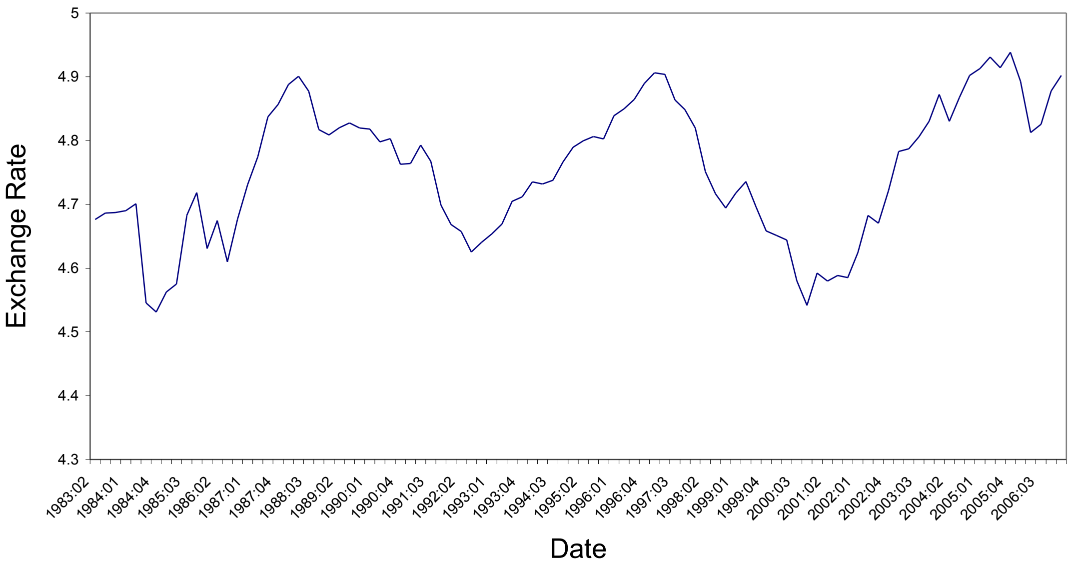


Figure 2. Openness

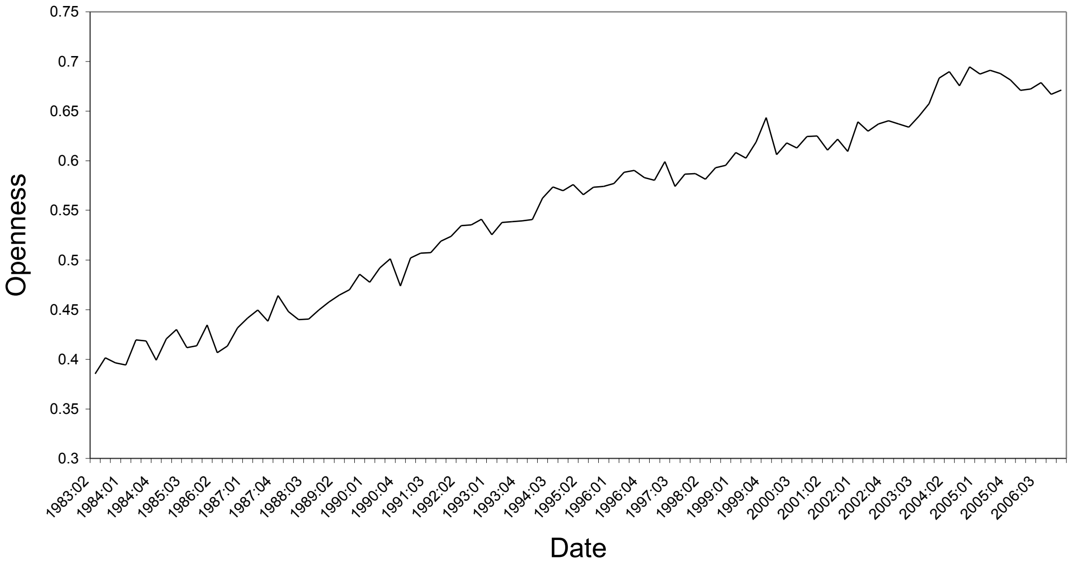
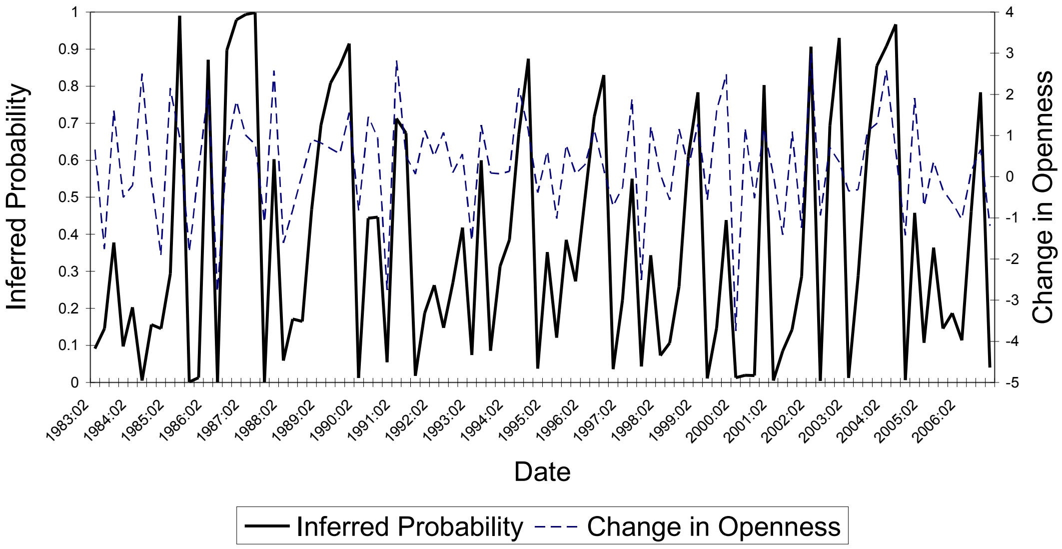


Figure 3. Change in Openness and the Inferred Probability of Regime 0



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