Issues in Political Economy, Vol 19, 2010, 51-68

The Suitability of Accession Countries in the Euro Area

Jordan Rhodes, Trinity College[1]

The euro is currently the common currency used among sixteen European nations. Since its onset in 1999, the euro area has evolved dramatically and continues to grow as additional countries seek euro area membership. The addition of post-communist countries into the euro area is constantly questioned, based on the fear that "as the common-currency area grows, the costs of a common currency rise and the benefits decline" (Yarbrough and Yarbrough 2006, 343). Since the fall of communism in 1989, ten additional countries have demonstrated interest in making the euro their national currency. In recent years, Slovakia and Slovenia fulfilled the necessary convergence criteria and became the first of the post-communist countries to gain euro area admission. The Maastricht Convergence Criteria is dependent on the evaluation of a country's performance in regards to price stability, government debt, public balance, long-term interest rates, and exchange rate stability. Of the eight European Union countries remaining outside of the euro area, only three participate in the mandatory Exchange Rate Mechanism II (ERM II); in accordance with the Maastricht convergence criteria, euro applicants must adjust their exchange rates to ERM II for at least two years prior to admission. Although five of the accession countries do not participate in ERM II, several of them have taken major steps towards sustaining exchange rate stability with the euro. For example, from 2001 to February 2008 Hungary "shadowed" ERM II, and voluntarily kept its exchange rate within the ± 15 nominal percent band; however, this was abolished in February 2008 and the exchange rate floated against the euro. Bulgaria holds a currency board with the euro, which has been critical for macroeconomic stabilization. The remaining three currencies operate on a floating exchange rate regime. This paper evaluates the accession countries' real convergence with the euro via a Generalized Purchasing Power Parity (GPPP) methodology. Developed in 1994 by Enders and Hurn, GPPP is a "method for testing groups of real exchange rates for reversion to a long-run stationary trend" (Bernstein 2000, 386). This analysis proves useful in that it goes beyond the conventional nominal evaluation, and measures the real economic convergence of these countries in their pursuit of euro membership. Following unit root and cointegration tests, an Error Correction Model (ECM) is applied to gauge the reaction of individual accession country exchange rates to a change in the euro exchange rate.

In conjunction with GPPP results, Ronald McKinnon's Optimum Currency Area (OCA) criterion is used to assess potential membership of the post-communist countries into the euro area. It is expected that the exchange rates of countries that participate in ERM II, as well as Hungary and Bulgaria, should exhibit a long-run trend in relation to the euro. This study provides an alternative method of assessing accession country progress than the conventional Maastricht Convergence Criteria. In performing the study, it becomes evident that the ERM II component of the Maastricht Convergence Criteria does not by itself help us determine whether these post-communist countries are ready for euro area admission. Based on the reported results, even the countries that participate in the mandatory ERM II may not be fully ready for euro admission, not only because of the potential detrimental effects to the euro area as a whole, but also to their individual economies.

I. Literature Review

David Bernstein (2000) used real exchange rates from then prospective euro area members, and evaluated if EMU had been effective in constructing a successful currency area. As Bernstein notes, "For a successful currency area, multicountry PPP implies that shocks to any one of the currencies within the union will also affect the other countries within the currency area when they are denominated by the same nonmember's currency" (386). Bernstein obtained mixed results: while many of the countries combined with Germany and the United Kingdom to form a cointegrated currency union, it was also found that the reaction by many country exchange rates was slow at best, measured by the speed of adjustment to deviations from GPPP. This study evaluates the relationship between accession country exchange rates and the euro exchange rate using GPPP.

II. Theory

A. Unit Root Analysis

Stationary vs. Non-Stationary Time Series

In order to determine whether the exchange rates of the accession countries are affected by shocks to the euro exchange rate, it is first necessary to determine if they are stationary in level form. Basically, when testing a time series for stationarity you are attempting to determine if the properties of the series are constant over time (time-invariant). A stationary time series is defined as one in which the effects of shocks to the variable dissipate over time, and the series' will "revert to their long-run mean values" (Asteriou and Hall 2007, 288; see also Dickey and Fuller, 1979). A non-stationary time series, on the other hand, has at least one basic attribute that does not change in the long-run, and the series "will necessarily contain permanent components" (Asteriou and Hall, 2007, 288). The following three conditions must be met for a time series to be considered stationary: the mean of X_t does not change over time, the variance of X_t does not change over time, or the simple correlation coefficient between X_t and X_{t-k} depends on lag length k but on no other variable (for all k). As illustrated in Figures 1 and 2, the real exchange rates appear to be increasing with time. If the variance and/or mean of the real exchange rates also increase, then these series will provide inaccurate values for future exchange rate data. Thus, if these statistical properties change over time and the series do not return to their long-run mean values, then the series are non-stationary and regression analysis will yield spurious results (Studenmund 2006, 433-434).

Non-stationarity is the major cause of spurious regressions, or regressions in which "there is a strong relationship between two or more variables that it not caused by a real underlying causal relationship" (Studenmund 2006, 433). This becomes problematic in regression analysis because t-scores and R^2 values, (performance statistics for individual variables and the regression as a whole, respectively), are much higher than they should be, thus giving the misleading impression that the dependent and independent variables are significantly related to one another. Thus, when using GPPP methodology it is essential that the exchange rates of all currencies involved are stationary or the results will be inaccurate. If any of the exchange rates are non-stationary they cannot be used.

Time Trends

In some cases, spurious regressions are rendered stationary by including a time trend in the time-series variable. Testing for a time trend confirms that the series will revert to long-run mean values in the event of a disturbance. Essentially, it demonstrates that the above mentioned statistical properties are constant, and not affected by time, despite the increasing or decreasing trend exhibited in the data, (as evidenced in Figures 1 and 2). When this is not the case, and a time-series variable remains non-stationary even with the inclusion of a time trend, it is deemed a random walk with a drift. A random walk occurs when "next period's value equals this period's value plus a stochastic error term" (Studenmund 2006, 343). In regression analysis, when a time series follows a random walk it poses problems because in the event of a shock or disturbance, the shock will not necessarily go away and the series will not return to its long-run value. Consider the following autogressive equation, comprised of only past values and a classical error term:

(1) $Y_t = \lambda Y_{t-1} + \varepsilon_t$

This equation is stationary if Y_t approaches 0; in other words, if the expected value of Y_t does not converge on any value, it is non-stationary. This is dependent on the value of $\lambda = (\sigma - 1)$. If $\sigma < 1$, than the expected value of Y_t approaches 0 as the sample size increases. On the other hand, if $\sigma > 1$ than the expected value of Y_t approaches ∞ and Y_t is considered non-stationary because it is explosive. Subtracting Y_{t-1} from both sides of the equation provides the following equation:

(2) $\Delta Y = \varepsilon_t$

By differencing equation Y_t, (subtracting Y_{t-1} from both sides of the equation), the series is now rendered stationary. The expected error term ε_t is not of concern because "it is a white-noise process" (Asteriou and Hall 2007, 290). Thus, if a series is non-stationary in level form and upon differencing it becomes stationary, the series is integrated of order 1. This is practically the case for all of the real exchange rate variables in this study, viz., they must be differenced once in order to render them stationary.

Unit Roots

The final and most important cause for concern in the above autoregressive equation occurs when $\sigma = 1$. Once again, the expected value of Y_t does not approach a value, and the time-series is rendered non-stationary. In the event that $\sigma = 1$, the equation is labeled a unit root and follows a random walk. Recall that a random walk signifies the opposite of reversion to a long-run trend, and is a major problem in regression analysis. Before moving on to the next step in GPPP methodology, cointegration between accession country exchange rates and that of the euro area, it is essential that the exchange rates of all countries involved (and that of the euro area) do not contain unit roots. However, in the event that series Y_t contains a unit root, this does not necessarily mean that the data cannot be used. Consider the following equation, in the event that $\lambda = 1$ it necessarily contains a unit root:

$$Y_t = \sigma Y_{t-1} + \varepsilon_t$$

$$Y_t - Y_{t-1} = \lambda Y_t \ \sigma Y_{t-1} - Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = (\sigma - 1) Y_{t-1} + \varepsilon_t$$

(3) $$\Delta Y_t = \lambda Y_{t-1} + \varepsilon_t$$

This is considered a random walk. Because the dependent variable ΔY_t is a function of its value in level form in the previous period; i.e., a time-series that is labeled a random walk means that each new value of ΔY_t has no relation to the previous period (Y_{t-1})- it is random, and not autocorrelated. A random walk with drift (or constant) can lead to spurious regressions because the statistical components of the data, such as mean and variance, change over time. It takes on the following form:

(4) $$\Delta Y_t = \delta + \lambda Y_{t-1} + \varepsilon_t$$

Finally, a random walk with a drift and a deterministic trend, (which appears to be the most likely case based on the graphs of the exchange rates) is problematic because statistical properties of the time series are dependent on a deterministic (stable) trend as well as a drift component. It has the following general form:

(5) $$\Delta Y_t = \delta + \beta_t + \lambda Y_{t-1} + \varepsilon_t$$

Another problem that arises when using macroeconomic data is that these "series typically have an underlying rate of growth" (Asteriou and Hall 2007, 291). As noted above, in order for a series to be stationary, the mean must be constant over time. It cannot be integrated either, because differencing cannot render them stationary.

B. Cointegration

Unit root analysis is used to determine whether individual country real exchange rates are stationary, while cointegration analysis is employed to assess whether there truly exists a stable long-term relationship between two (or more) variables. Cointegration is defined as the existence of a long-run equilibrium between two or more variables: "although the variables will rise over time (trended), there will be a common trend that links them together" (Asteriou and Hall 2007, 307; see also, Engle and Granger, 1987). In the case of the accession country real exchange rates, cointegration verifies that the error process does not create problems in running the regression between them and the euro real exchange rate. It shows that if accession country exchange rates and the euro are truly interrelated, "we would expect them to move together and so the two stochastic trends would be very similar to each other and when we combine them together it should be possible to find a combination of them which eliminates non-stationarity" (Asteriou and Hall 2007, 207). Cointegration analysis confirms that there is a relationship between individual accession country exchange rates and the euro exchange rate, and it is the final step in determining that the relationship between accession country exchange rates and the euro are not spurious. Testing for cointegration involves testing for unit roots in the residuals. If unit roots are not found in the residuals of the estimated regression, then the OLS estimates are accurate.

C. Error Correction Model

Following unit root and cointegration analysis, the impact of the euro real exchange rate on the accession country real exchange rates can be examined. When the variables are cointegrated, the OLS results are expected to be super-consistent. The following equation emerges between Hungary and the euro, in first difference form:

(6) $$\Delta Hun_{For_t} = B_1 + B_2 \Delta Euro_t + \epsilon_t$$

Despite the absence of spurious variables, this equation is not complete because it only reflects the short-run relationship between the Hungarian Forint and the euro. However, because the Hungarian Forint and the euro are cointegrated using both CPI and PPI analysis, the long-run equation:

(7) $$Hun_{For_t} = B_1 + B_2 Euro_t + u_t$$

Is no longer considered spurious, and also provides the following equation:

(8) $$\hat{u}_t = Hun_{For_t} - \hat{B}_1 - \hat{B}_2 Euro_t .$$

From cointegration analysis we know that because $\hat{u}_t$ is stationary there is a long-run relationship between the two exchange rates. Given that the Hungarian Forint and the euro are cointegrated, an error correction model can be generated which combines both the short-term and long-run properties of the relevant variables. The following error correction equation emerges:

(9) $$\Delta Hun_{For_t} = a_0 + b_1 \Delta Euro_t - \pi \hat{u}_{t-1} + v_t$$

III. Data

The data used is from the International Monetary Fund statistics website: the International Financial Statistics (IFS). A problem that emerged in collecting the bilateral exchange rates between accession countries and the United States was that only market rates were available for some countries (the Czech Republic and the euro area), and the only bilateral exchange rate available for Romania was the principal rate. For the rest of the countries, the official rate was used. Although the bilateral exchange rates for the various countries may differ, converting them into real exchange rates should compensate for these differences. Overall, the nine currencies included are the Bulgarian Lev, the Czech Koruna, the Estonian Kroon, the Hungarian Forint, the Latvian Lat, the Lithuanian Litas, the Polish Zloty, the Romanian Leu, and of course the euro. The data are quarterly, beginning in 1999:1, and ending in 2008:3(PPI) and 2008:4(CPI). The data used are the most recent, and should provide an ample number of observations to obtain accurate results.

Although Bernstein used the Consumer Price Index (CPI) in calculating real exchange rates, this paper also makes use of the Producer Price Index (PPI). The inclusion of both indices is likely to provide a more complete assessment of whether the accession countries are experiencing real convergence, particularly in view of the fact that the PPI may provide more accurate data on real exchange rates because, as opposed to the CPI, it only includes tradable goods which are more likely to be subject to the law of one price. The real exchange rates were calculated as follows:

(10) CPI Real Exchange Rate- € x $$\frac{CPI_{accession\ country.euro}}{CPI_{United\ States}}$$

(11) PPI Real Exchange Rate- € x $$\frac{PPI_{accession\ country.euro}}{PPI_{United\ States}}$$

Where € is the bilateral exchange rate between the accession country/euro area currency and the United States dollar. The logarithms of the real exchange rates are taken for graphical purposes, and the results were normalized using an additive function so that they equaled zero in 1999:1. The results are presented in the following graphs.

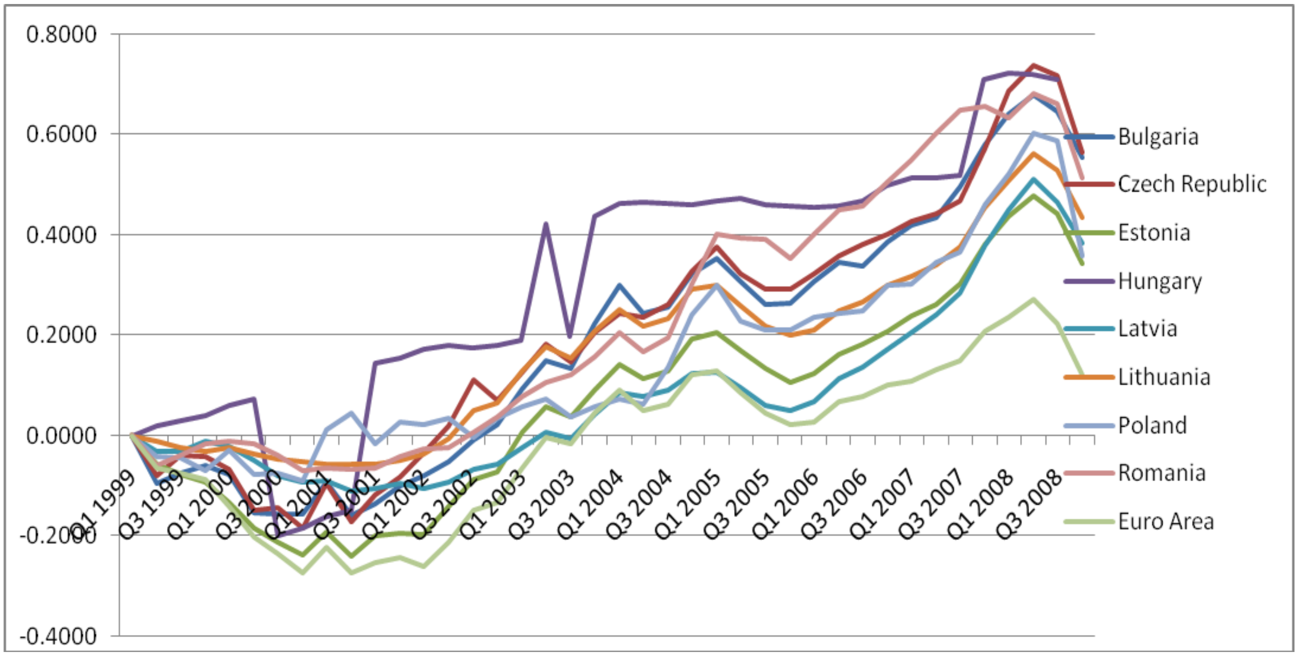

Figure 1: Logarithms of the Real Exchange Rates (CPI)

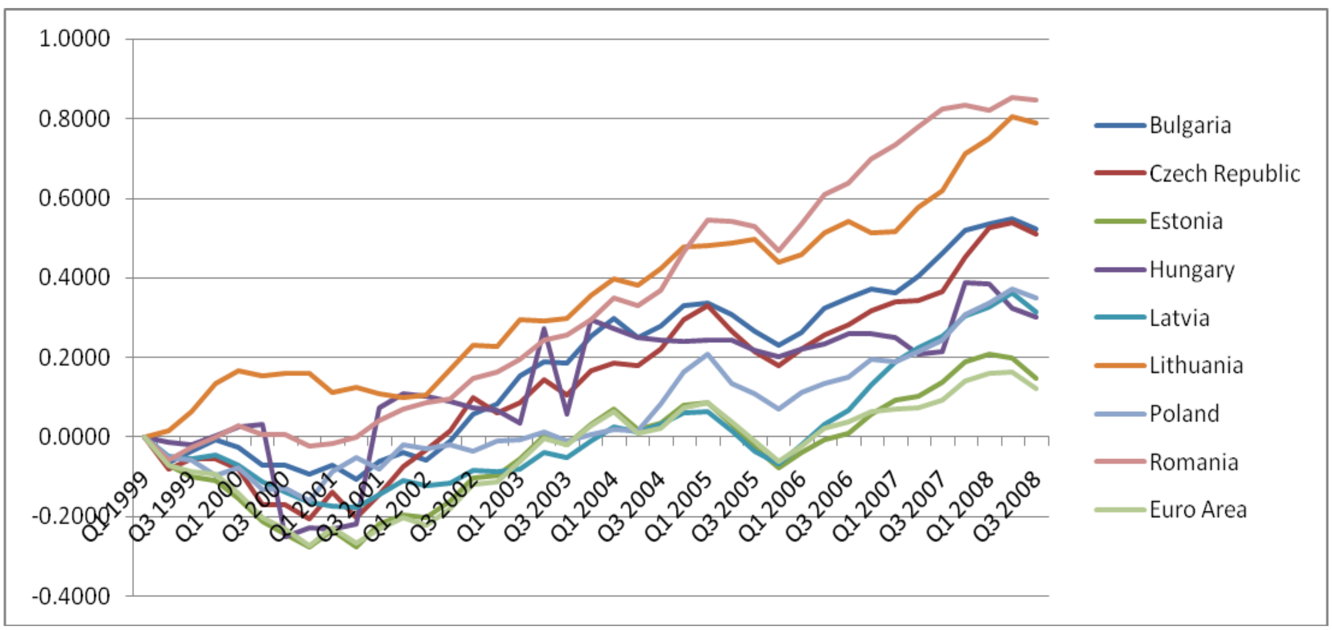

Figure 2: Logarithms of the Real Exchange Rates (PPI)

The eight exchange rates demonstrate a definite pattern among them, including an upwards drift. Both graphs seem to demonstrate that country CPIs and PPIs are either non-stationary with an upward drift or non-stationary with an upward drift that includes a deterministic time trend, (or a random walk). The former is most likely, but testing for an intercept and an intercept with a deterministic trend will be applied, to fully evaluate the existence of a unit root within the exchange rates. In the event that the exchange rates do contain unit roots, this suggests that the variables are non-stationary, and that regressing them against each other would produce a spurious regression. In order to establish whether there exists a meaningful relationship between the euro and the eight accession exchange rates, unit root testing is applied.

IV. Empirical Methodology and Results

A. Unit Root Analysis

<u>ADF Tests</u>

An augmented Dickey-Fuller (ADF) test is used to test for unit roots with real exchange rate data (see Dickey and Fuller, 1981). The ADF test contains the elements of a simple Dickey-Fuller test, as well as "extra lagged terms of the dependent variable in order to eliminate autocorrelation" (Asteriou and Hall 2007, 297). It is crucial that there is no autocorrelation in the series, as "the variance of the error terms will tend to become infinitely large as t increases" (Asteriou and Hall 2007, 295). Therefore, the ADF test provides the number of lags on the dependent variable necessary for the elimination of autocorrelation. Because country exchange rates will be considered the dependent variable, and the euro exchange rate the independent variable, the following equation is used:

(12) $$lnY_{accession\ exchange\ rate_t} = \beta lnX_{euro_t} + \varepsilon_t$$

Both lnY and lnX must be integrated of the same order before they are tested for cointegration. The ADF test examines the hypothesis that the time series contains a unit root. In the previous equation:

(13) $$\Delta Y_t = \lambda Y_{t-1} + \varepsilon_t$$

The null hypothesis of the Dickey-Fuller test is: $H_0 : \lambda = 0$, under the assumption that $\lambda = (\sigma - 1)$. The alternative hypothesis confirms that there is no unit root, stating that: $H_0 : \lambda < 0$. The Schwarz Information Criterion (SIC) is used to determine this. The SIC "penalizes the addition of right-hand-side variables more heavily than does the corrected R^2," and is useful when performing ADF tests (Pindyck & Rubinfeld, 1998, 239). The results of the ADF tests, as well as the number of lags necessary to eliminate autocorrelation can be found in the appendix (Tables A1 and A2). The results are broken up into two groups: level form and differenced, as well as without a deterministic trend and with a deterministic trend.

ADF Results

In the case of the logarithms of the real exchange rates in CPI values, none of the exchange rates are stationary in level form; however, when first differenced the ADF test reveals that all nine exchange rates are stationary. When using PPI real exchange rates, Bulgaria is stationary with a trend in level form whereas all eight other real exchange rates are stationary after differenced. Thus, the Bulgarian exchange rate cannot be tested for cointegration with the euro exchange rate. Additionally, the Phillips-Perron test, (a non-parametric test), was used to confirm the results of the ADF tests (Phillips & Perron, 1988). The same results were obtained, verifying the accuracy of the ADF tests.

B. Cointegration

Engle- Granger Approach

As indicated above, testing for cointegration between two variables involves checking for unit roots in the residuals. The Engle-Granger approach is used to undertake this test (see Engle & Granger, 1987). At this point, taking the log of a series converts it from one of average growth rate into a linear trend that is integrated (Asteriou and Hall 2007, 291). Consider the relationship between the Bulgarian Lev and the euro:

(14) $$lnBul_{Lev_t} = B_1 + B_2 lnEuro_t + u_t$$

After taking the residuals, the following is obtained:

(15) $$\hat{u}_t = lnBul_{Lev_t} - \widehat{B}_1 - \widehat{B}_2 lnEuro_t$$

Recall also that the individual exchange rates of the Bulgarian Lev and the euro have been tested to determine if they are stationary under unit root analysis. Thus, if $\hat{u}_t$ (the residual) is found to be stationary in level form, then the exchange rates of the Bulgarian Lev and the Euro are said to be cointegrated and there is a long-run relationship between the two currencies. This is because $\hat{u}_t$ is "the series of the estimated residuals of the long-run relationship. If these deviations from long-run equilibrium are found to be stationary," than $lnBul_{Lev_t}$ and $lnEuro_t$ are cointegrated (Asteriou and Hall 2007, 316). The OLS estimates will therefore not be spurious and will provide a clear indication of the impact of the effects of changes in the euro exchange rate on Bulgaria's exchange rate.

Engle- Granger Results

Testing for cointegration using CPI and PPI yields similar results, which can be found in the appendix of this paper. In both cases, cointegration between the euro real exchange rate and the Czech, Hungarian, Lithuanian, and Romanian real exchange rates exists. The PPI also reveals that cointegration between the Estonian and euro real exchange rate exists. Both CPI and PPI results can be found in the appendix (Table B1). The above countries can therefore be used to determine the effect of a shock to the euro real exchange rate on their exchange rates.

C. Error Correction Model (ECM)

The following (ECM) equation is estimated:

(16) $$\Delta Hun_{For_t} = a_0 + b_1 \Delta Euro_t - \pi \hat{u}_{t-1} + v_t$$

In the above equation, v_t is a random error term and b_1 is "the impact multiplier (the short-run effect) that measures the immediate impact that a change" in $Euro_t$ has on Hun_{For_t} (Asteriou and Hall 2007, 310). π is the adjustment effect and "shows how much of the disequilibrium is being corrected, i.e. the extent to which any disequilibrium in the previous period effects any adjustment" in Hun_{For_t} (Asteriou and Hall 2007, 310). Thus, a negative sign on the coefficient of $\hat{u}_{t-1}$ is indicative that the series will revert back to its long-run equilibrium after a shock to the euro exchange rate. Using the error correction model, a percentage change in the real exchange rate of the Hungarian forint is a function of a percentage change in the real exchange rate of the euro and the residuals lagged one period from the equation when in level form. The error correction model provides us with the necessary information to assess whether short-run shocks to the underlying relationship between the euro real exchange rate and accession country real exchange rates are corrected in subsequent time periods.

Error Correction Model Results

The results of the ECM are found in the appendix of this chapter (Tables C1 and C2). Using CPI analysis Hungary, Lithuania, and Romania have significant values in the short-run. Using PPI analysis, only Hungary and Lithuania have significant values in the short-run. They are presented in Table 1. As predicted, the error correction term lagged one period is negative in all five cases. This is interpreted as follows: if a shock to the euro real exchange rate causes it to deviate from its long-run equilibrium by 10 percent in the current quarter, the (CPI) Hungarian real exchange rate will return to its equilibrium by 3.9 percent in the next quarter.

V. Discussion of the Results

The results presented are not particularly promising for the accession countries. While Hungary "shadowed" ERM II for the majority of the decade, Lithuania has been a participant in ERM II and Bulgaria has held a currency board with the Deutschmark and euro in the past. Under PPI analysis, Hungary's exchange rate is most affected by the euro; yet it will only return to its equilibrium by 5.9 percent in the event of a 10 percent deviation from equilibrium in the previous period. This suggests that over the course of a year, Hungary's real exchange rate will revert back to equilibrium by 24 percent; only after 4 years will it return to its equilibrium level. The other results were even smaller in magnitude; for example, under CPI analysis, Lithuania and Romania will return to their equilibrium levels by less than 1 percent in the event of a ten percent deviation from equilibrium. For Lithuania this is especially discouraging given that the country participates in ERM II.

Table 1

CPI	**Coefficient**	**T-Statistic**
res_hungary(-1)	-0.395204	-3.195395
res_lithuania(-1)	-0.096984	-1.879595
res_romania(-1)	-0.082081	-1.829221
PPI		
res_hungary(-1)	-0.597152	-4.076687
res_lithuania-1)	-0.124791	-2.851558

Using both CPI and PPI analysis, cointegration between accession country real exchange rates and the euro real exchange rate occurred only for three countries, collectively. This is discouraging because it was expected that the real exchange rates of most of these countries would have an underlying relationship to changes in the euro real exchange rate. Moreover, a more robust relationship was expected in view of the currency board arrangements and participation in the ERM II of many of the aforementioned countries. GPPP analysis revealed that this was not the case, and that perhaps the economies of the accession countries are not as integrated with the euro as they appear. Furthermore, PPI analysis was even more disappointing: it was included under the assumption that it does not factor in non-tradables to the extent that the CPI does, and is a more accurate representation of the real exchange rate. However, only two countries are cointegrated with the euro using PPI analysis, with Lithuania presenting slightly over a 1 percent return to equilibrium in the current quarter following a 10 percent deviation from equilibrium in the previous quarter. This shows that although Lithuania participates in ERM II and its nominal exchange rate is dependent on that of the euro, its real exchange rate is not significantly affected by that of the euro- indicating that further integration between Lithuania and the euro area is needed.

In 1963 Ronald McKinnon’s expanded the groundbreaking Optimum Currency Area theory in his paper “Optimum Currency Areas.” Through hypothetical analysis, McKinnon comes to the conclusion that small “open” economies are most suited to fix their exchange rates, and are appropriate candidates in the formation of optimum currency regions. An open economy is defined as one in which “the ratio of tradable to non-tradable goods” is large (McKinnon 1963, 717). The benefits of joining a single currency regime are seen in the decreased transaction costs in trade with other nations using the same currency. Furthermore, the benefits of more open economies joining a single currency area are evident in the event of an asymmetric shock. Nominal exchange rate devaluation becomes less effective in smaller, more open economies for this reason.

There is no question that the accession countries are small, open economies. Six of the eight accession countries trade at levels greater than their total GDP. (The accuracy of this calculation is questionable because exports and imports consist of fixed sales, while GDP is computed through value added). On the surface it may seem as though McKinnon's OCA criteria is fulfilled by the accession countries; however, GPPP suggests this may not be the case, and that perhaps the ECB should consider alternative approaches in evaluating potential euro countries.

Table 2

Exports and Imports as a Percent of GDP (2006)	
Bulgaria	146.1909
Czech Republic	148.3329
Estonia	167.2996
Hungary	155.0998
Latvia	109.517
Lithuania	129.7724
Poland	81.23945
Romania	78.46255
Germany	84.68927
France	55.14155
Source: World Bank (2008)	

VI. Conclusions

This paper examined the relationship between accession country exchange rates and that of the euro using GPPP methodology. This was intended to shed light on post-communist country integration into the euro area, and to evaluate the credibility of the ERM II criteria required in the Maastricht Convergence Criteria. Utilizing both CPI and PPI indices, this study tested all nine bilateral exchange rates for unit roots using the Augmented Dickey-Fuller test. With the exception of the Bulgarian Lev under PPI analysis, all of the exchange rates were stationary in first difference form. Cointegration tests were then performed by regressing the effect of the log of the euro exchange rate on that of the logs of individual accession country exchange rates, and then testing the residuals for unit roots (Engle-Granger Approach). Nine of the seventeen tests passed at the 5 percent level- however, only five accession country exchange rates could be modeled within an Error Correction framework. Furthermore, the results obtained via ECM were even more disappointing in regards to the accession countries' integration into the euro area. It was found that a change in the euro real exchange rate will only minimally impact the exchange rates of three (collective) exchange rates using CPI and PPI analysis.

On the basis of GPPP methodology, the accession countries do not fulfill Ronald McKinnon's OCA criteria and would not necessarily benefit from euro admission at this time. McKinnon argues that in smaller more open economies, because of the heavy trade that occurs between these countries and others, the nominal exchange rate is not an effective instrument "because depreciation will augment the demand for 'tradable' output, draw labor away from 'non-tradable' out-put, and cause a general increase in wages and prices" (Kenen, 1969, 42). It was expected that countries tied nominally to the euro exchange rate would reflect this relationship in their real exchange rates; however, because this was not the case, further integration (particularly when it comes to their labor markets) is necessary before these countries become members of the EMU. While joining the euro area may initially appear to benefit these countries in the form of price stability and protection from external detrimental factors, GPPP methodology reveals that the benefits are likely to be small and uncertain.

VII. APPENDIX

Table A1

ADF Test: PPI	**Level**				**First**			
Variables	Without Trend	Lags	With Trend	Lags	Without Trend	Lags	With Trend	Lags
Bulgarian Lev	0.351314	0	-	6	-	0	-	0
Czech Koruna	0.335738	0	-2.51445	1	-	0	-	0
Estonian Kroon	-0.42347	0	-	0	-	0	-	0
Hungarian Forint	-1.3355	1	-	0	-	0	-	0
Latvian Lat	-	1	-2.24088	1	-	0	-	0
Lithuanian Litas	0.29603	0	-	0	-	0	-	0
Polish Zloty	0.470692	0	-	0	-	0	-	9
Romanian Leu	0.76231	0	-	1	-	0	-	0
Euro	-	0	-	0	-	0	-	0
At 5% Critical Value =	-2.94		-3.53		-2.94		-3.53	

Table A2

ADF Test: CPI	**Level**				**First**			
Variables	Without Trend	Lags	With Trend	Lags	Without Trend	Lags	With Trend	Lags
Bulgarian Lev	0.105964	0	-	1	-4.030766	1	-	1
Czech Koruna	-0.156866	0	-	1	-4.959525	0	-	0
Estonian Kroon	-0.943698	1	-	1	-3.621788	0	-	0
Hungarian Forint	-0.474451	1	-3.18181	0	-8.062603	0	-	0
Latvian Lat	-1.655582	1	-	1	-3.039929	1	-	1
Lithuanian Litas	-1.164155	1	-	1	-3.112094	0	-	0
Polish Zloty	-0.782887	0	-	1	-3.763407	0	-	0
Romanian Leu	-0.301338	0	-	1	-3.294955	1	-	0
Euro	-1.190967	1	-	1	-3.958839	0	-	0
At 5% Critical	-2.94		-3.53		-2.94		-3.53	

Table B1

Engle-Granger Approach: CPI		**Engle-Granger Approach: PPI**	
Bulgarian Lev	-1.923471		
Czech Koruna	-2.040789	**Czech Koruna**	-2.3862
Estonian Kroon	-0.896178	**Estonian Kroon**	-2.257278
Hungarian Forint	-3.720635	**Hungarian Forint**	-4.129543
Latvian Lat	-1.849196	**Latvian Lat**	-0.786623
Lithuanian Litas	-2.938666	**Lithuanian Litas**	-3.523651
Polish Zloty	-1.944682	**Polish Zloty**	-1.352307
Romanian Leu	-2.209837	**Romanian Leu**	-2.687711
5 % Critical Values	-1.949609	5 % Critical Values	-1.949609

Table C1

CPI: ECM Regressions			
Dependent Variable:	Δln(czech_republic)		
Adjusted Sample:	1999Q2-2008Q4		
Adjusted R-Squared:	0.745729		
Durbin-Watson Statistic:	1.856604		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	1.161049	10.50828	0
res_czech(-1)	-0.067381	-1.235778	0.2245
constant	0.010571	2.31669	0.0263
Dependent Variable:	Δln(hungary)		
Adjusted Sample:	1999Q2-2008Q3		
Adjusted R-Squared:	0.295429		
Durbin-Watson Statistic:	2.262754		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	1.379177	3.775529	0.0006
res_hungary(-1)	-0.395204	-3.195395	0.003
constant	0.010073	0.750886	0.4577
Dependent Variable:	Δln(lithuania)		
Adjusted Sample:	1999Q2-2008Q4		
Adjusted R-Squared:	0.75383		
Durbin-Watson Statistic:	1.93869		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	0.747584	10.78318	0
res_lithuania(-1)	-0.096984	-1.879595	0.0683
constant	0.008513	2.995417	0.0049
Dependent Variable:	Δln(romania)		
Adjusted Sample:	1999Q2-2008Q4		
Adjusted R-Squared:	0.489463		
Durbin-Watson Statistic:	1.409858		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	0.738209	6.168946	0
res_romania(-1)	-0.082081	-1.829221	0.0757
constant	0.010655	2.117977	0.0411

Table C2

PPI: ECM Regressions

Dependent Variable:	Δln(czech_republic)		
Adjusted Sample:	1999Q2-2008Q3		
Adjusted R-Squared:	0.746998		
Durbin-Watson Statistic:	1.639803		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	1.100139	9.844506	0
res_czech(-1)	-0.05152	-0.840671	0.4062
constant	0.009795	2.495614	0.0174
Dependent Variable:	Δln(estonia)		
Adjusted Sample:	1999Q2-2008Q3		
Adjusted R-Squared:	0.946737		
Durbin-Watson Statistic:	1.35725		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	1.030678	24.97719	0
res_estonia(-1)	-0.123753	-1.347384	0.1865
constant	0.000552	0.359186	0.7216
Dependent Variable:	Δln(hungary)		
Adjusted Sample:	1999Q2-2008Q3		
Adjusted R-Squared:	0.391348		
Durbin-Watson Statistic:	2.122802		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	1.342792	3.990929	0.0003
res_hungary(-1)	-0.597152	-4.076687	0.0002
constant	0.003871	0.307247	0.7605
Dependent Variable:	Δln(lithuania)		
Adjusted Sample:	1999Q2-2008Q3		
Adjusted R-Squared:	0.284091		
Durbin-Watson Statistic:	1.858963		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	0.486911	3.708102	0.0007
res_lithuania(-1)	-0.124791	-2.851558	0.0073
constant	0.018569	3.855634	0.0005
Dependent Variable:	Δln(romania)		
Adjusted Sample:	1999Q2-2008Q3		

Adjusted R-Squared:	0.494346		
Durbin-Watson Statistic:	1.580627		
Independent Variable	Coefficient	T-Statistic	Probability
Δln(euro_area)	0.683448	6.082489	0
res_czech(-1)	-0.033563	-1.215048	0.2325
constant	0.019977	4.914695	0

VIII. References

Asteriou, Dimitrios and Hall, Stephen G. 2007. *Applied Econometrics: A Modern Approach Using Eviews and Microfit*. New York: Palgrave MacMillan.

Bernstein, David J. 2000. Generalized Purchasing Power Parity and the Case of the European Union as a Successful Currency Area. *Atlantic Economic Journal* 28: 385-395.

Dickey, D., and Fuller W.A. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74: 427-31.

---. The Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica* 49: 1057-72.

Engle, R., and Granger, C.W.J. 1987. Cointegration and Error Correction: Representation, Estimation, and Testing. *Econometrica* 55: 251-76.

International Monetary Fund. 2009. *International Financial Statistics*. http://www.imfstatistics.org/imf/ (accessed February 10, 2009)

McKinnon, Ronald I. 1963. Optimum Currency Areas. *The American Economic Association* 53: 717-725. http://www.jstor.org/ (accessed December 1, 2008).

Phillips, P.C.B., and Perron, P. 1988. Testing for Unit Roots in Time Series Regression. *Biometrika* 75: 335-46.

Pindyck, Robert S. and Rubinfeld, Daniel L. 1998. *Econometric Models and Economic Forecasts*. United States: The McGraw Hill Companies, Inc.

Studenmund, A. H. 2006. *Using Econometrics: A Practical Guide*. Boston: Pearson Education, Inc.

Yarbrough, Beth V. and Yarbrough, Robert M. 2006. *The World Economy: Open-Economy Macroeconomics and Finance*. Mason, OH: Thomson-Southwestern Publishers.

Notes

[1]Special thanks to Professor Miguel Ramirez of Trinity College for his help and support in writing this paper.