NOTTINGHAM TRENT UNIVERSITY

DISCUSSION PAPERS IN ECONOMICS

No. 2010/1 ISSN 1478-9396

NONLINEARITIES IN STOCK RETURNS FOR SOME RECENT ENTRANTS TO THE EU

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April 2010

DISCUSSION PAPERS IN ECONOMICS

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Nonlinearities in Stock Returns for Some Recent Entrants to the EU[1]

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[1] We thank Juan Carlos Cuestas for helpful comments on an earlier draft of this paper.

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Abstract

In this paper we use nonlinear tests to investigate the mean reverting properties of stock returns in a group of CEE markets. We also test whether returns in our target group of countries demonstrate characteristics of persistence and cross sectional dependence. Our results indicate that all series' are stationary, but we find some ambiguity in the results of our tests for cross sectional dependence.

Keywords: Nonlinearities; Stock Markets; Central and Eastern European Countries

1. Introduction

In recent years, many studies have challenged the use of linear models in the time series analysis of financial data and it now seems clear that time series data on stock market returns commonly exhibit nonlinear serial dependence (see for example, Sarantis, 2001; Bradley and Jensen, 2004; Kim et al, 2008). These findings have important implications for financial theory since stock returns that exhibit nonlinearity, as well as serial dependence, could imply that securities that appear to follow a completely random process when tested using a linear framework, might, in reality, be predictable.

In this investigation, we focus on stock market returns in those Central and East European (CEE) countries that have recently joined the EU[2]. Several studies have confirmed that these markets offer opportunities for portfolio diversification to investors in Western economies (see, for example, Harrison and Moore, 2009). Furthermore, studies have generally shown that stock markets in CEE countries are efficient (see for example Harrison and Paton 2005, and Rockinger and Urga 2001) and the recent enlargement of the EU implies that many foreign investors from both Europe and further abroad will be considering investments in these countries. Few investigations into these markets have tested for nonlinearities in the returns and, as well as testing this, we also test whether returns in our sample demonstrate characteristics of persistence and cross sectional dependence.

The rest of this paper is structured as follows. In section 2, we outline our methodology and the data used in our investigation. In Section 3, we discuss our results and in Section 4 we provide a summary and conclusions.

[22] Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

2. Empirical Approach and Data

The study uses data on the stock market indices for ten CEE countries. The data were obtained from DataStream and Table 1 provides summary statistics for the daily returns between 1993 and 2010.

The panel data structure of the database can be exploited to undertake panel unit root tests since it has been shown that the power of unit root tests improves when the extra information derived from the additional observations is used. (see Baltagi, 2005). The results from four panel unit root tests are presented: Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) and the Fisher-type ADF test attributed to Maddala and Wu (1999) and Choi (2001). The Levin, Lin and Chu and Breitung (2000) tests both assume that there common unit root process, while the Im, Pesaran and Shin and Fisher ADF tests allow the unit root process to vary across countries. All tests include an intercept with the lag length chosen using the Modified Akaike Information Criterion (AIC) as proposed by Ng and Perron (2001).

There are potential problems with these tests since they all assume that the individual time series in the panel are cross-sectional independently distributed. However, Harrison and Moore (2009) find that CEE stock exchanges tend to exhibit some comovement with the developed markets of Western Europe. Another potential problem with these tests is that is that stock market returns might, as noted in our introduction, be non-linear. $I(0)$ W_0 $I(1)$ W_1

To deal with cross-sectional dependence, Pesaran (2007) proposes an alternative unit root test of the form:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_{t-1} + e_{it} \qquad (1)$$

where y_{it} is the stock price index in country i and period t , a_i is the country-specific effect, b_i, c_i and d_i are slope coefficients on various transformations of the stock price index and e_{it} is error an term assumed to have normal properties.

Kapetanios et al. (2003) show that in the presence of nonstationarity, standard unit root tests have very low power and fail to reject the null of a unit root. To deal with this, Cerrato et al. (2009) consider the case of stock prices being generated by the dynamic nonlinear heterogeneous panel ESTAR model:

$$\Delta y_{it} = v y_{it-1}\left[1 - \exp\left(-\theta_i y_{it-1}^2\right)\right] + \gamma_i f_t + e_{it} \qquad (2)$$

where f_t is the unobserved common effect. The null hypothesis, that stock prices in CEE countries are non-mean reverting, is tested against the alternative that a stationary ESTAR model generates some stock prices (denoted by NCADF). Assuming that the unobserved common factor component can be proxied by the cross-section average, Ceratao et al. (2009) recommend using the following Im, Pesaran and Shin (2003)-type statistic:

$$\bar{t}_{NT} = N^{-1} \sum_{i=1}^{N} t_i(N, T) \qquad (3)$$

where t_i is the t-statistic for b_i obtained from the following least squares regressions:

$$\Delta y_{it} = a_i + b_i y_{it-1}^3 + c_i \bar{y}_{t-1}^3 + d_i \bar{y}_t + e_{it} \qquad (4)$$

$$\Delta y_{it} = a_i + b_i y_{it-1}^3 + c_i \bar{y}_{t-1}^3 + \sum_{j=1}^{p} \left(b_{ij} y_{it-j}^3 + c_{ij} \bar{y}_{t-j}^3\right) + e_{it} \qquad (5)$$

for the serially uncorrelated and correlated error case, respectively.

3. Results

Table 2 reports our results from testing the null hypothesis that each of our series contains a unit root. The Levin, Lin and Chu (2002) test assumes a common unit root process, while the Im, Pesaran and Shin (2003), ADF-Fisher Chi-square and PP-Fisher Chi-square test assumes an individual unit root process. All four tests fail to reject the null hypothesis of a unit root, and therefore reject the notion of mean reverting stock prices in CEE countries.

When panel unit root tests that allow for cross sectional dependence and nonlinearity are used, the results are somewhat different. Table 3 reports the results of the CADF and NCADF tests on each of the ten stock price index series. Assuming serially uncorrelated or correlated errors gives similar results. Specifically, for the Czech Republic, Estonia, Hungary, Poland and Slovenia, the null hypothesis of the existence of unit roots was rejected. With the exception of Estonia, similar results were obtained if one assumes that the errors are serially correlated. The results therefore suggest stock prices are mean reverting in some CEE countries. In addition to cross-sectional dependence, we also allow for the existence of non-linearity using Ceratao's et al. (2009) approach. The results were again not definitive as the null hypothesis was rejected in some countries, but accepted in others.

To benefit from the size and power properties that the panel framework afforded, we use the Im, Pesaran and Shin (2003)-type statistic. Using this approach, the non-linear unit root tests strongly reject the null hypothesis. The implication is that stock prices from each of our target group of markets can be accurately used to model risk as they exhibit mean reversion. The stationarity ESTAR model provides information on the persistence properties of our data set and allows for cross sectional dependence between the CEE countries. The nonlinear mean reversion evidenced in our results suggests that the correct model specification is nonlinear.

4. Conclusions

Our results provide valuable insights into the mean reverting properties of stock returns in our target group of CEE markets. The linear panel unit root tests all reject the notion of mean reversion. However, allowing for cross sectional dependence significantly changes our results. The Ceratao et al. (2009) test and Im, Pesaran and Shin (2003)-type statistic both fail to reject the assumption of mean reversion in the stock price series for CEE countries over the review period. Our findings therefore have implications for the efficiency of markets in these countries and also for future modelling exercises since we show that ignoring non-linearity in the returns of CEE exchanges can result in inaccurate conclusions.

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Table 1: Summary Statistics of Daily Returns of CEE and European Stock Exchanges

	Country	Mean	Max	Min	Std. Dev.	Skew	Kurt.	Jarque-Bera	Obs.
LBULX	Bulgaria	6.079	7.577	4.256	0.916	-0.387	1.973	168.061	2440
LCZEHX	Czech Republic	6.777	7.568	5.769	0.527	-0.211	1.606	215.760	2440
LESX	Estonia	5.893	6.950	4.707	0.621	-0.186	1.795	161.542	2440
LHUNX	Hungary	9.522	10.313	8.643	0.489	-0.110	1.454	247.904	2440
LLATX	Latvia	5.835	6.639	4.970	0.491	0.020	1.655	184.061	2440
LLITX	Lithuania	5.388	6.383	4.146	0.690	-0.257	1.601	225.806	2440
LPOLX	Poland	10.202	11.121	9.356	0.492	0.040	1.776	152.927	2440
LROMX	Romania	8.034	9.289	6.217	0.887	-0.518	2.085	194.251	2440
LSLEX	Slovenia	8.379	9.413	7.540	0.462	0.269	2.773	34.630	2440
LSLVX	Slovakia	5.507	6.230	4.405	0.570	-0.434	1.631	266.981	2440

Table 3: Linear Panel Unit Root Statistics

	Levels	Returns
	3.280	-116.375
Levin, Lin and Chu	[0.999]	[0.000]
	6.026	-97.636
Im, Pesaran and Shin	[1.000]	[0.000]
	1.239	987.097
ADF – Fisher Chi-square	[1.000]	[0.000]
	1.153	184.207
PP – Fisher Chi-square	[1.000]	[0.000]

Note: p-values are provided in square brackets below test statistics.

Table 3: Individual Unit Root Tests for Non-Linear Mean Reversion and Cross-Section Dependence in CEE Stock Prices

	Serially Uncorrelated Errors		Serially Correlated Errors	
Country	CADF	NCADF	CADF	NCADF
Bulgaria	-1.391	-1.351	-0.908	-0.799
Czech Republic	-4.062***	-3.936***	-3.835***	-2.246
Estonia	-3.003*	-3.122*	-2.577	-2.754
Hungary	-3.974***	-3.879***	-2.874*	-4.723**
Latvia	-1.499	-1.422	-1.393	-1.014
Lithuania	-1.716	-2.200	-2.151	-2.362
Poland	-3.846***	-3..830***	-2.924*	-4.464***
Romania	-2.225	-2.185	-1.515	-3.495**
Slovenia	-4.129***	-4.133***	-3.319**	-5.093***
Slovak Republic	-0.961	-1.071	-0.901	-0.838

Note: The 1, 5 and 10 percent critical values for the CADF test are -3.81, -3.22, -2.91, while those for the NCADF test are -3.73, -3.12 and -2.82, respectively.

Table 4: Panel Unit Root Tests for Non-Linear Mean Reversion and Cross-Section Dependence in CEE Stock Prices

	CADF	NCADF
Serially Uncorrelated Errors	2.681***	2.713***
Serially Correlated Errors	2.240*	2.779***

Note: The 1, 5 and 10 percent critical value for the CADF test is -2.53, -2.32 and -2.21, while the values for the NCADF test are -2.50, -2.33 and -2.25.

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