Rational Bubbles in Emerging Stockmarkets

Mauricio Nunes[a], Sergio Da Silva[b*]

[a]*Department of Economics, Federal University of Rio Grande Do Sul, 90040000 Porto Alegre RS, Brazil*
[b]*Department of Economics, Federal University of Santa Catarina, 88049970 Florianopolis SC, Brazil*

Abstract

We detected rational bubbles in 22 emerging stockmarkets using both standard and threshold cointegration. Eighteen stockmarkets experienced explosive bubbles (and some of them periodically collapsing bubbles as well). The remaining four markets experienced periodically collapsing bubbles only.

JEL classification: E44, G12

Keywords: bubbles, stockmarkets, emerging markets

Acknowledgements. MN acknowledges financial support from the Brazilian agency CNPq, and SDS acknowledges financial support from CNPq and CAPES-Procad.

* Corresponding author.
E-mail: professorsergiodasilva@gmail.com (S. Da Silva)

1. Introduction

A stock's fundamental value is usually viewed as the present value of their expected payoff (dividends). In an efficient stockmarket, prices change only in situations where investors react to new information about changes in fundamentals, such as the sum of discounted future cash flows. Stock prices are then said to follow a martingale, in which case the difference between today's price and tomorrow's discounted price cannot be predicted. Systematic price deviations from fundamentals are considered as a bubble. Self-fulfilling expectations can give rise to rational bubbles as they push current prices toward expected prices regardless of fundamentals (Blanchard, 1979; Blanchard and Watson, 1982). Here rational reactions to asymmetric information may play a role (Selody and Wilkins, 2004). For instance, a large number of rational individuals reacting similarly to new information may create an overreaction in the aggregate (Bikhchandani and Sharma, 2000).

Standard cointegration tests can be employed to detect stock price bubbles. Absence of cointegration between stock prices and dividends may indicate the presence of a bubble. (Yet there are skeptics of this approach; e.g. Evans, 1991). The tests usually assume one unit root (as the null hypothesis) and one linear process as the alternative hypothesis. These tests also assume that the process adjusts symmetrically. However, financial variables usually adjust asymmetrically (Enders and Granger, 1998; Neftei, 1984; Potter, 1995; Balke and Fomby, 1996; Enders and Siklos 2001), a characteristic that can be tracked by threshold autoregressive cointegration models. In the threshold autoregressive (TAR) model (Tong, 1983) the degree of autoregressive decay depends on the variable state. The momentum threshold autoregressive (M-TAR) model (Enders and Granger, 1998; Enders and Siklos, 2001) further allows for positive and negative changes in the variable's autoregressive decay, thus capturing its possible asymmetric movement.

Standard (Johansen and Engle-Granger) cointegration detects explosive bubbles, whereas threshold cointegration tracks bubbles that begin, burst, and then return (periodically collapsing bubbles). For the latter, in the cointegration relationship between prices (P) and dividends (D)

$$P_t = \hat{\beta}_0 + \hat{\beta}_1 D_t + \hat{\mu}_t \tag{1}$$

the estimated residual $\hat{\mu}_t$ will reflect the sequence of price increases followed by a sudden drop, in which case there is a periodically collapsing bubble. In particular

$$\Delta\hat{\mu}_t = I_t\rho_1\hat{\mu}_{t-1} + (1-I_t)I_t\rho_2\hat{\mu}_{t-1} + \sum_{i=1}^{l}\gamma_i\Delta\hat{\mu}_{t-1} + \varepsilon_t \qquad (2)$$

where I_t is an indicator function defined as

$$I_t = \begin{cases} 1 \text{ if } \hat{\mu}_{t-1} \geq \tau \\ 0 \text{ if } \hat{\mu}_{t-1} < \tau \end{cases} \qquad (3)$$

and τ is the threshold value. In the TAR model, the null hypothesis is no-cointegration, i.e. $H_0 : \rho_1 = 0$, $H_0 : \rho_2 = 0$, and $H_0 : \rho_1 = \rho_2 = 0$. Enders and Siklos (2001, Tables 1 and 2) provide the critical values for the appropriate t and F tests. If the null of no-cointegration is rejected, the hypothesis of symmetric adjustment $H_0 : \rho_1 = \rho_2 = 0$ can be tested using the F statistic. If $H_0 : \rho_1 = \rho_2 = 0$ cannot be rejected, P and D cointegrate through a linear and symmetric adjustment.

Necessary and sufficient conditions for stationarity of sequence $\{\mu_t\}$ are $\rho_1, \rho_2 < 0$ and $(1+\rho_1)(1+\rho_2) < 1$, $\forall\tau$ (Petruccelli and Woolford, 1984). Convergence means $\mu = 0$ in the long run. If μ_{t-1} falls below this long run value, the adjustment implies $\rho_2\mu_{t-1}$. Since the adjustment is symmetric if $\rho_1 = \rho_2$, Engle-Granger cointegration becomes a particular case of the TAR cointegration. The TAR model can track sudden changes in the sequence because if $-1 < \rho_1 < \rho_2 < 0$ the negative phase of $\{\mu_t\}$ gets more persistent than the positive one (Enders and Granger, 1998). Thus periodically collapsing bubbles can be detected by the cumulative changes of $\hat{\mu}_{t-1}$ that fall above the threshold followed by sudden drop toward the threshold. (The same is not true of the cumulative changes of $\hat{\mu}_{t-1}$ that fall below the threshold.) If one finds no cointegration between stock prices and dividends, the hypothesis of periodically collapsing bubbles makes no sense. Andrews and

Ploberger (1994) and Hansen (1996) show that inference is not possible in that case because the nuisance parameters are not identified under the null hypothesis.

Rather than taking levels, Enders and Granger (1998) and Caner and Hansen (2001) consider changes in the previous period residuals $\{\Delta\mu_{t-1}\}$ in the indicator function, i.e.

$$I_t = \begin{cases} 1 \text{ if } \Delta\hat{\mu}_{t-1} \geq \tau \\ 0 \text{ if } \Delta\hat{\mu}_{t-1} < \tau \end{cases} \tag{4}$$

This is the M-TAR model, which tracks a series' momentum in one direction rather than the other (Enders and Siklos, 2001). Positive deviations from long run equilibrium are reverted faster in the M-TAR model if compared with the TAR model. Using Monte Carlo and bootstrap, Enders and Granger (1998) and Enders and Siklos (2001) provide critical values for the appropriate t and F statistics. The most significant of the t-statistic for the null of $\rho_1 = 0$ and $\rho_2 = 0$ is called $t_{\max}$, and the less significant one is the $t_{\min}$. The F-statistic for the null of $\rho_1 = \rho_2 = 0$ is dubbed ϕ, which has more power than $t_{\max}$ and $t_{\min}$ but can only be used in case of stationarity (because the ρs must be negative) and convergence.

As the assumption that the threshold coincides with the sequence's attractor is relaxed, τ has to be estimated along with ρ_1 and ρ_2. One way of doing that is as follows (Chan, 1993). The series of residuals are first ranked as $\mu_1^c < \mu_2^c < ... < \mu_T^c$ (for the TAR model, or as $\Delta\mu_1^c < \Delta\mu_2^c < ... < \Delta\mu_T^c$ for the M-TAR), where T is the number of observations. Then the 15 percent bigger and smaller values of $\{\mu_i^c\}$ are discarded. The possible attractor is supposed to lie in the 70 percent remaining values. For these, equations (1) and (2) are estimated. The estimated threshold with smaller sum of squared residuals is taken as the appropriate threshold. These are known as consistent TAR and M-TAR models, for which the appropriate statistics are now $t_{\max}^c$, $t_{\min}^c$, and ϕ^c.

Finding ρ_1 and ρ_2 along with constraint $\rho_1 = \rho_2$ is problematic if τ is unknown, because the property of asymptotically multivariate normality does not hold for sure in this case. Yet Chan and Tong (1989) think it may hold. Also, Enders and Falk (1999) find the usage of bootstrap distribution in the maximum likelihood statistic appropriate, at least for small samples.

The aim of this paper is thus to investigate the presence of rational bubbles in 22 emerging stockmarkets using standard cointegration and the models of threshold cointegration discussed above. The rest of this paper is organized as follows. Section 2 will present data. Section 3 will perform analysis. And Section 4 will conclude.

2. Data

We collected monthly data (from Datastream) of stock prices and dividends for the 22 countries in the Standard & Poors' Emerging Markets Data Base. Consumer price indices were taken from the IMF's International Financial Statistics. The countries were as follows. Argentina (ARG), Brazil (BRA), Chile (CHI), China (CHN), Colombia (COL), Czech Republic (CZE), Indonesia (IDN), India (IND), Israel (ISR), Korea (KOR), Malaysia (MAS), Mexico (MEX), Peru (PER), the Philippines (PHI), Poland (POL), South Africa (RSA), Russia (RUS), Sri Lanka (SRI), Thailand (THA), Taiwan (TPE), Turkey (TUR), and Venezuela (VEN). Table 1 presents the samples' time periods. Analysis was carried out with the variables' natural logs.

3. Analysis

We first performed augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for the variables in real terms (Tables 2 and 3). Though nonstationary in levels, the variables' series got stationary in first differences. Since both series were integrated of same order (one), cointegration between them could be evaluated.

We estimated six cointegration models for each of the 22 countries, namely Johansen's, Engle-Granger's, TAR, M-TAR, consistent TAR, and consistent M-TAR (Tables 4–25). All the emerging stockmarkets exhibited rational bubbles. Eighteen stockmarkets experienced explosive bubbles. The remained four experienced only periodically collapsing bubbles (Table 26).

For the markets that experienced explosive bubbles we could not reject the null of no-cointegration using standard cointegration. Thus stock prices behaved at odds with dividends. The four cases that showed no evidence of explosive bubbles were Chile (Table 6), Indonesia (Table 10), Korea (Table 13), and the Philippines (Table 17). Yet at least one of the nonlinear threshold cointegration models could not reject the hypothesis of periodically collapsing bubbles (and of asymmetry) for those four markets. For Chile and Indonesia, the null of $\rho_1 = 0$ was rejected at the one percent significance level, thus suggesting the stock prices to be in line with fundamentals. Yet the TAR and consistent TAR models detected periodically collapsing bubbles. Also, the residuals' changes adjusted faster from below the cointegration equation if compared with the adjustment from above the long run equation, i.e. $|\rho_2| > |\rho_1|$. The findings for Korea gave support to Enders and Granger (1998) and Enders and Siklos (2001), who pointed that the deviations from long run equilibrium revert faster in the M-TAR if compared with the TAR model. The stockmarket in the Philippines also showed nonlinearity and asymmetry (10 percent significant).

As for South Africa (Table 19), the positive coefficients ρ_1 also indicated explosive behavior (0.164 and 0.176 in the M-TAR and consistent M-TAR models respectively). At least one positive coefficient also emerged for Czech Republic, Malaysia, Sri Lanka (in all the models), Chile, Israel, Mexico, Poland, Russia, Taiwan, Turkey (in the M-TAR and consistent M-TAR models), Colombia (in the TAR model), and Venezuela (in the M-TAR model). Yet the null of $\rho_1 = \rho_2 = 0$ could not be rejected for those countries, and thus the rejection bias could not be assessed. For South Africa we relied on the $t^c_{\max}$ (and did not reject the null of no-cointegration) rather than on the values of ϕ and ϕ^c (6.22 and 5.37 respectively), which pointed to rejection of the null (10 percent significant). Considering ϕ and ϕ^c made no sense here because this would had lead to rejection of the null of $\rho_1 = \rho_2$ in the presence of lack of convergence (positive coefficient). Table 19 shows that the maximum *t*-statistics were the positive values 1.53 and 1.78 (in the M-TAR and consistent M-TAR model respectively), while the tabulated values are –1.76 and –1.66 respectively (Ender and Siklos, 2001, Tables 2 and 6).

Table 15 shows that the values of ϕ and ϕ^c (6.51 and 8.60 respectively) for Mexico felt above the critical values, and the consistent TAR model was best (AIC and BIC tests). Since the series cointegrated, the null of symmetric adjustment $\rho_1 = \rho_2$ could be evaluated by the standard *F*-statistic. The calculated *F*s of 12.96 and 17.15 felt above the critical values (one percent significant), and then the null of symmetric adjustment was rejected for the TAR and consistent TAR models. Moreover, since $|\rho_2| > |\rho_1|$ the residuals' adjustment from below the cointegration equation was faster than that related to the long run equation. This suggests short run stock price increases above the fundamentals followed by a crash. The latter result could be extended to Peru (Table 16).

Both the M-TAR and consistent M-TAR models detected periodically collapsing bubbles for Colombia (Table 8), i.e. the values of ϕ and ϕ^c (7.21 and 7.49 respectively) pointed to rejection of the null. Also, the hypothesis of symmetric adjustment ($\rho_1 = \rho_2$) was rejected at both five and one percent significance levels. Moreover, negative parameters along with $|\rho_2| < |\rho_1|$ suggested that positive deviations from long run equilibrium were reverted faster than the negative ones.

Periodically collapsing bubbles were also detected for Brazil (Table 5) and Venezuela (Table 25) by the TAR and consistent M-TAR models (threshold values of 0.663 and –0.437 for Brazil). There was absence of mean reversion and also persistence for the values ranging from τ to the zero attractor. While there was no symmetric adjustment for Brazil, symmetry could not be dismissed for Venezuela. The deviations from above long run equilibrium in Brazil were more persistent than the deviations from below the cointegration equation. This finding is consistent with asset price bubbles followed by crashes. And also with stock prices in line with dividends in the long run.

The consistent M-TAR model rejected the null of no-cointegration and favored the hypothesis of periodically collapsing bubbles in the Chinese data ($\phi^c = 6.51$, Table 7). For India (Table 11) the best model was the M-TAR, and the null of symmetric adjustment ($\rho_1 = \rho_2$) could not be rejected. There was evidence of cointegration of stock prices and dividends in Poland (Table 18). Periodically collapsing bubbles were present, short run adjustments were asymmetric, and the deviations above the long run equation converged faster toward the attractor.

4. Conclusion

We investigated the presence of rational bubbles in 22 emerging stockmarkets using standard cointegration along with threshold cointegration. The six models considered were Johansen's, Engle-Granger's, TAR, M-TAR, consistent TAR, and consistent M-TAR. All the emerging stockmarkets exhibited rational bubbles. Eighteen stockmarkets experienced explosive bubbles (and some of them periodically collapsing bubbles as well). The four cases that showed no evidence of explosive bubbles were Chile, Indonesia, Korea, and Philippines. Yet at least one of the nonlinear threshold cointegration models still detected periodically collapsing bubbles in those markets.

Table 1. Sample

Country	Time Period
ARG	Jul 1993 – Dec 2006
BRA	Jul 1994 – Dec 2006
CHI	Jan 1990 - Dec 2006
CHN	May 1994 – Dec 2006
COL	Apr 1992 – Dec 2006
CZE	Feb 1990 – Dec 2006
IDN	Apr 1990 – Dec 2006
IND	Jan 1990 – Dec 2006
ISR	Jan 1993 – Dec 2006
KOR	Jan 1990 – Dec 2006
MAS	Jan 1990 – Dec 2006
MEX	Jan 1990 – Dec 2006
PER	Jan 1994 – Dec 2006
PHI	Jan 1990 – Dec 2006
POL	Mar 1994 – Dec 2006
RSA	Jan 1990 – Dec 2006
RUS	Feb 1995 – Dec 2006
SRI	Jan 1990 – Dec 2006
THA	Jan 1990 – Dec 2006
TPE	Jan 1990 – Dec 2006
TUR	Jan 1990 – Dec 2006
VEN	Jan 1990 – Dec 2006

Table 2. Unit Root Tests for the Stock Prices

Country	Levels				First Differences			
	ADF(l)	τ_{crit}	PP	τ_{crit}	ADF(l)	τ_{crit}	PP	τ_{crit}
ARG	–2.43*	–2.88	–2.53*	–2.87	–12.54	–1.94	–12.79	–1.94
BRA	–1.98**	–3.44	–2.14	–3.44	–11.00	–1.94	–11.00	–1.94
CHI	–2.89**	–3.43	–2.90	–3.43	–12.08	–1.94	–12.09	–1.94
CHN	–2.28*	–2.88	–2.17	–2.88	–12.17	–1.94	–12.33	–1.94
COL	–0.62(1)*	–2.88	–0.59*	–2.88	–10.06	–1.94	–10.06*	–2.88
CZE	–2.77**	–3.44	–2.77**	–3.44	–9.73**	–3.44	–9.63**	–3.44
IDN	–1.98*	–2.88	–2.03*	–2.88	–12.07	–2.88	–12.02	–1.94
IND	–2.16(1)*	–2.88	–1.72*	–2.88	–11.77	–1.94	–11.66	–1.94
ISR	–2.59**	–3.44	–2.68**	–3.44	–11.52	–1.94	–11.50*	–2.88
KOR	–2.96(1)**	–3.43	–2.33(1)*	–2.88	–12.06	–1.94	–12.03*	–2.88
MAS	–2.29(1)*	–2.88	–2.22*	–2.88	–11.92	–1.94	–11.90	–1.94
MEX	–1.59(1)*	–2.88	–1.79**	–3.44	–12.44*	–2.88	–12.40*	–2.88
PER	–0.69(2)**	–3.43	–0.79*	–2.88	–10.18(1)	–1.94	–11.29	–1.94
PHI	–1.65(3)*	–2.88	–1.66*	–2.88	–12.68	–1.94	–12.66*	–2.88
POL	–0.54	–1.94	–0.53	–1.94	–12.66	–1.94	–12.70	–1.94
RSA	–2.51(1)**	–3.43	–0.109(1)*	–2.87	–13.55**	–3.43	–13.48*	–2.88
RUS	–1.05*	–2.88	–1.61	–2.88	–9.93	–1.94	–10.14	–1.94
SRI	–2.15(1)*	–2.88	–2.11*	–2.88	–11.57	–1.94	–11.60	–1.94
THA	–1.60*	–2.88	–1.51*	–2.88	–14.11	–1.94	–14.19	–1.94
TPE	–2.64**	–3.43	–2.89**	–3.43	–11.96	–1.94	–11.95	–1.94
TUR	–2.42*	–2.88	–2.51*	–2.88	–14.04	–1.94	–14.06	–1.94
VEN	–3.28**	–3.44	–3.12**	–3.44	–12.60	–1.94	–12.40	–1.94

Notes

ADF(·) is the augmented Dickey-Fuller test with the optimal lag length in brackets (Akaike-Schwarz criterion)

PP is the Philips-Perron test

τ_{crit} stands for critical values at the five percent significance level

* test with a constant

** test with both constant and trend

Table 3. Unit Root Tests for the Dividends

Country	Levels				First Differences			
	ADF(·)	τ_{crit}	PP	τ_{crit}	ADF(·)	τ_{crit}	PP	τ_{crit}
ARG	–1.92(1)**	–3.44	–1.33*	–2.88	–10.33	–1.94	–10.49	–1.94
BRA	–1.62*	–2.88	–1.67*	–2.88	–9.39	–1.94	–9.54	–1.94
CHI	–2.58(1)**	–3.43	–2.83**	–3.43	–13.30*	–2.88	–13.31*	–1.94
CHN	–2.22*	–2.88	–2.20*	–2.88	–7.47(2)	–1.94	–12.07	–1.94
COL	–1.59(1)	–1.94	–1.54	–1.94	–10.10	–1.94	–10.11	–1.94
CZE	–3.13**	–3.44	–2.55*	–2.88	–12.04	–1.94	–12.10	–1.94
IDN	–3.15**	–3.44	–3.10**	–3.44	–16.70	–2.88	–16.51	–1.94
IND	–2.35*	–2.88	–2.40*	–2.88	–14.14	–1.94	–14.13	–1.94
ISR	–1.76*	–2.88	–1.75*	–2.88	–13.09	–1.94	–13.10	–1.94
KOR	–2.88(5)**	–3.43	–2.71**	–3.44	–5.56(4)	–1.94	–11.99	–1.94
MAS	–2.48*	–2.88	–2.53*	–2.88	–11.79	–1.94	–11.95	–1.94
MEX	–2.44**	–3.44	–2.22**	–3.44	–13.43*	–2.88	–14.32*	–2.88
PER	–1.82*	–2.88	–1.77*	–2.88	–13.59	–1.94	–13.58	–1.94
PHI	–2.57*	–2.88	–2.53*	–2.88	–11.62	–1.94	–11.69	–1.94
POL	–2.52(2)*	–2.88	–2.14*	–2.88	–6.60(2)	–1.94	–11.78	–1.94
RSA	–2.63**	–3.44	–2.55**	–3.44	–14.39*	–2.88	–14.90*	–2.88
RUS	–2.56*	–2.88	–2.48*	–2.88	–12.25	–1.94	–12.62	–1.94
SRI	–1.31**	–3.44	–1.58**	–3.44	–13.88	–1.94	–14.00	–1.94
THA	–1.93*	–2.88	–2.12*	–2.88	–14.08	–1.94	–14.12	–1.94
TPE	–2.36(1)*	–2.88	–1.70*	–2.88	–11.71	–1.94	–11.69	–1.94
TUR	–1.02**	–3.44	–1.13**	–3.44	–13.24*	–1.94	–13.23*	–2.88
VEN	–2.03*	–2.88	–2.15*	–2.88	–12.47	–1.94	–12.48	–1.94

Notes
ADF(·) is the augmented Dickey-Fuller test with the optimal lag length in brackets (Akaike-Schwarz criterion)
PP is the Philips-Perron test
τ_{crit} stands for critical values at the five percent significance level
* test with a constant
** test with both constant and trend

Table 4. Argentina

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	16.39(C,4)	–	–	–	–	–
ρ_1	–	–0.088	–0.095(1)	0.084(2)	–0.042(C,1)	0.178(C,1)
t-statistic		(–2.66)*	(–1.78)	(0.72)	(–0.81)	(1.52)
ρ_2	–	–	–0.083	–0.048	–0.128	–0.183
t-statistic			(–2.02)	(–0.42)	(–2.61)	(–1.39)
AIC	–	43.40	45.40	49.91	46.17	48.88
BIC	–	49.51	54.51	59.00	58.31	61.00
τ	–	–	–	–	–0.277	–0.083
ϕ, ϕ^c	–	–	3.55	0.35	4.16	1.84
$\rho_1 = \rho_2$	–	–	0.03	0.66	0.42	2.38
p-value			(0.857)	(0.415)	(0.513)	(0.124)

Notes

λ_{trace} is trace statistic

ρ_1 and ρ_2 are the lagged residuals coefficients (μ_{t-1})

AIC is Akaike information criterion

BIC is Schwarz information criterion

τ is the consistent threshold value

ϕ and ϕ^c are the F-statistic values for rejecting the null of no-cointegration in the TAR (M-TAR) and consistent TAR (M-TAR) models respectively

$\rho_1 = \rho_2$ is the F-statistic for rejecting the null of symmetric adjustment

Values in brackets are for first differences of the lagged residuals for both $\Delta\mu_{t-i}$ and the deterministic component

Number of observations: 156

Critical values: $\lambda_{\text{trace (1\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 4.99$, $\phi_{\text{M-TAR (10\%)}} = 5.47$, $\phi^c_{\text{TAR (10\%)}} = 6.02$, $\phi^c_{\text{M-TAR (10\%)}} = 5.76$

Table 5. Brazil

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	6.89(C,2)	–	–	–	–	–
ρ_1	–	–0.022(1)	–0.018	–0.068	–0.026(2)	–0.016(1)
t-statistic		(–1.51)*	(–1.15)	(–0.05)	(–1.65)	(–0.88)
ρ_2	–	–	–0.142	–0.359	–0.166	–0.450
t-statistic			(–2.11)	(–3.48)	(–3.42)	(–0.00)
AIC	–	546.84	532.51	545.87	520.43	540.33
BIC	–	552.83	550.37	551.87	544.23	549.30
τ	–	–	–	–	0.663	–0.437
ϕ, ϕ^c	–	–	4.64	5.22	6.88	7.96
$\rho_1 = \rho_2$	–	–	5.97	3.27	7.98	7.12
p-value			(0.016)	(0.072)	(0.005)	(0.008)

Notes

Number of observations: 152

Critical values: $\lambda_{\text{trace (1\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 4.92$, $\phi_{\text{M-TAR (10\%)}} = 5.45$, $\phi^c_{\text{TAR (10\%)}} = 6.02$, $\phi^c_{\text{M-TAR (5\%)}} = 6.86$

Table 6. Chile

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	22.62(4)	–	–	–	–	–
ρ_1	–	–0.043(C,4)	–0.004(4)	0.272(2)	–0.028(C,4)	0.282(4)
t-statistic		(–4.14)*	(–0.36)	(2.96)	(–2.29)	(3.12)
ρ_2	–	–	–0.054	0.032	–0.034	0.015
t-statistic			(–3.76)	(0.34)	(–2.08)	(0.162)
AIC	–	675.45	681.64	692.80	667.00	692.02
BIC	–	695.24	701.43	712.59	700.09	711.81
τ	–	–	–	–	0.634	–0.174
ϕ, ϕ^c	–	–	7.19	4.52	8.79	4.92
$\rho_1 = \rho_2$	–	–	6.60	3.10	6.14	3.87
p-value			(0.010)	(0.08)	(0.014)	(0.06)

Notes

Number of observations: 205

Critical values: $\lambda_{\text{trace (1\%)}} = 16.31$, $\tau_{(1\%)} = -4.07$, $\phi_{\text{TAR (5\%)}} = 6.35$, $\phi_{\text{M-TAR (10\%)}} = 5.36$, $\phi^c_{\text{TAR (5\%)}} = 7.56$, $\phi^c_{\text{M-TAR (10\%)}} = 5.32$

Table 7. China

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	4.59(4)	–	–	–	–	–
ρ_1	–	–0.042	–0.016(2)	–0.091(2)	–0.007(2)	–0.105(2)
t-statistic		(–2.17)*	(–0.53)	(–0.88)	(–0.24)	(–0.24)
ρ_2	–	–	–0.070	–0.373	–0.083	–0.406
t-statistic			(–2.75)	(–2.95)	(–3.14)	(–3.19)
AIC	–	–46.75	–52.32	–52.30	–54.32	–55.88
BIC	–	–40.73	–40.31	–40.28	–42.30	–43.86
τ	–	–	–	–	–0.229	–0.026
ϕ, ϕ^c	–	–	3.92	4.68	4.98	6.51
$\rho_1 = \rho_2$	–	–	1.85	7.87	3.83	9.52
p-value			(0.175)	(0.005)	(0.052)	(0.002)

Notes

Number of observations: 152

Critical values: $\lambda_{\text{trace (5\%)}} = 12.53$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 4.99$, $\phi_{\text{M-TAR (10\%)}} = 5.47$, $\phi^c_{\text{TAR (10\%)}} = 6.02$, $\phi^c_{\text{M-TAR (10\%)}} = 5.76$

Table 8. Colombia

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	7.36(C,4)	–	–	–	–	–
ρ_1	–	–0.010(4)	–0.006(1)	–0.289(C)	–0.006(1)	–0.337(C)
t-statistic		(–0.90)*	(–0.38)	(–2.41)	(0.35)	(–3.05)
ρ_2	–	–	–0.015	–0.263	–0.028	–0.218
t-statistic			(–0.90)	(–1.79)	(–1.64)	(–1.97)
AIC	–	18.40	18.26	18.77	18.25	18.26
BIC	–	27.58	27.76	28.26	25.74	25.75
τ	–	–	–	–	–0.345	0.080
ϕ, ϕ^c	–	–	0.48	7.21	1.48	7.49
$\rho_1 = \rho_2$	–	–	0.12	5.18	3.83	8.75
p-value			(0.723)	(0.023)	(0.147)	(0.003)

Notes

Number of observations: 177

Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 4.99$, $\phi_{\text{M-TAR (5\%)}} = 5.98$, $\phi^c_{\text{TAR (10\%)}} = 6.02$, $\phi^c_{\text{M-TAR (5\%)}} = 6.78$

Table 9. Czech Republic

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	17.84(C,4)	–	–	–	–	–
ρ_1	–	0.006(4)	0.070(C,2)	0.076(C)	0.003	0.054(C)
t-statistic		(0.40)*	(–2.68)	(0.52)	(0.20)	(0.40)
ρ_2	–	–	0.164	0.301	–0.087	0.301
t-statistic			(–3.27)	(2.34)	(–2.24)	(2.74)
AIC	–	–67.67	–73.10	–36.46	–30.81	–37.23
BIC	–	–52.62	–57.98	–27.37	–21.70	–28.14
τ	–	–	–	–	–0.263	–0.045
ϕ, ϕ^c	–	–	4.62	3.70	2.53	4.10
$\rho_1 = \rho_2$	–	–	11.17	0.21	0.30	1.78
p-value			(0.001)	(0.645)	(0.587)	(0.184)

Notes

Number of observations: 155

Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 4.99$, $\phi_{\text{M-TAR (10\%)}} = 5.47$, $\phi^c_{\text{TAR (10\%)}} = 5.95$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 10. Indonesia

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	19.69(2)	–	–	–	–	–
ρ_1	–	–0.095(C,4)	–0.116(C,4)	–0.117(C)	–0.095(C,4)	–0.006(C,1)
t-statistic		(–3.71)*	(–3.43)	(–0.87)	(–3.11)	(–0.05)
ρ_2	–	–	–0.034	–0.156	–0.098	–0.214
t-statistic			(–0.49)	(–1.53)	(–1.79)	(–2.19)
AIC	–	861.62	862.70	885.55	853.62	878.93
BIC	–	881.29	885.65	895.43	876.56	892.08
τ	–	–	–	–	1.042	–0.456
ϕ, ϕ^c	–	–	7.33	2.01	6.86	2.43
$\rho_1 = \rho_2$	–	–	4.88	0.26	3.59	0.08
p-value			(0.028)	(0.612)	(0.059)	(0.772)

Notes

Number of observations: 201

Critical values: $\lambda_{\text{trace (5\%)}} = 12.53$, $\tau_{(5\%)} = -3.37$, $\phi_{\text{TAR (5\%)}} = 6.35$, $\phi_{\text{M-TAR (10\%)}} = 5.36$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.57$

Table 11. India

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	8.74(4)	–	–	–	–	–
ρ_1	–	–0.032(2)	–0.003	0.057(C,4)	–0.005(C,6)	–0.070(C,6)
t-statistic		(–1.66)*	(–0.12)	(0.49)	(–0.17)	(0.50)
ρ_2	–	–	–0.380	–0.219	–0.076	–0.377
t-statistic			(–3.15)	(–1.58)	(–2.23)	(–3.26)
AIC	–	–21.71	–22.03	–35.32	–27.97	–33.31
BIC	–	11.80	15.40	10.20	30.18	9.09
τ	–	–	–	–	0.135	–0.034
ϕ, ϕ^c	–	–	4.98	5.96	2.58	5.36
$\rho_1 = \rho_2$	–	–	0.28	1.83	3.26	0.48
p-value			(0.591)	(0.176)	(0.007)	(0.490)

Notes

Number of observations: 204

Critical values: $\lambda_{\text{trace (5\%)}} = 12.53$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 6.35$, $\phi_{\text{M-TAR (10\%)}} = 5.36$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.32$

Table 12. Israel

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	6.36(C,4)	–	–	–	–	–
ρ_1	–	–0.020	–0.002	0.083	–0.006	0.021
t-statistic		(–1.10)*	(–0.09)	(0.75)	(0.25)	(0.17)
ρ_2	–	–	–0.042	0.089	–0.045	0.131
t-statistic			(–1.57)	(0.89)	(–1.65)	(1.33)
AIC	–	–15.17	–14.46	–13.94	–15.55	–15.22
BIC	–	–8.95	–5.12	–7.72	–9.31	–5.90
τ	–	–	–	–	0.120	0.068
ϕ, ϕ^c	–	–	1.24	0.62	1.39	0.90
$\rho_1 = \rho_2$	–	–	1.26	0.01	1.96	0.47
p-value			(0.262)	(0.974)	(0.162)	(0.492)

Notes

Number of observations: 168

Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(5\%)} = -3.37$, $\phi_{\text{TAR (10\%)}} = 4.94$, $\phi_{\text{M-TAR (10\%)}} = 5.86$, $\phi^c_{\text{TAR (10\%)}} = 5.95$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 13. Korea

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	47.13(4)	–	–	–	–	–
ρ_1	–	–0.007(C,6)	–0.003(C,6)	–0.299(C,4)	–0.003(C,9)	–0.343(C)
t-statistic		(–3.07)*	(–0.70)	(–3.09)	(–0.61)	(–3.65)
ρ_2	–	–	–0.009	–0.164	–0.012	–0.127
t-statistic			(–1.89)	(–0.33)	(–1.47)	(–0.74)
AIC	–	–986.03	–995.92	–998.93	–978.85	–1003.69
BIC	–	–953.25	–996.13	–979.14	–939.57	–973.76
τ	–	–	–	–	–0.006	5.15 e^{-4}
ϕ, ϕ^c	–	–	3.93	6.84	5.94	9.05
$\rho_1 = \rho_2$	–	–	1.84	9.22	1.98	13.07
p-value			(0.175)	(0.002)	(0.161)	(0.000)

Notes

Number of observations: 205

Critical values: $\lambda_{\text{trace (1\%)}} = 16.31$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 5.23$, $\phi_{\text{M-TAR (5\%)}} = 6.12$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (1\%)}} = 8.47$

Table 14. Malaysia

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	7.69(C,4)	–	–	–	–	–
ρ_1	–	–0.011(4)	0.004(C,4)	0.115(C,4)	0.005(C,6)	0.018(C,8)
t-statistic		(–0.78)*	(–0.20)	(1.18)	(0.24)	(0.87)
ρ_2	–	–	–0.024	0.142	–0.114	0.250
t-statistic			(–1.25)	(1.36)	(–3.51)	(2.33)
AIC	–	–308.83	–309.50	–308.24	–298.83	–305.36
BIC	–	–292.34	–302.86	–291.75	–231.09	–259.75
τ	–	–	–	–	–0.206	0.023
ϕ, ϕ^c	–	–	1.81	1.62	6.25	2.83
$\rho_1 = \rho_2$	–	–	0.99	0.04	0.20	0.016
p-value			(0.320)	(0.849)	(0.657)	(0.900)

Notes

Number of observations: 205

Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(5\%)} = -3.37$, $\phi_{\text{TAR (10\%)}} = 5.23$, $\phi_{\text{M-TAR (10\%)}} = 5.13$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 15. Mexico

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	14.66(C,4)	–	–	–	–	–
ρ_1	–	–0.020(C,2)	–0.008(4)	0.237(4)	–0.009(5)	0.244(5)
t-statistic		(–2.17)*	(–1.04)	(2.35)	(–1,16)	(2.15)
ρ_2	–	–	–0.085	–0.075	–0.098	–0.026
t-statistic			(–3.49)	(–0.76)	(–4.01)	(–0.29)
AIC	–	842.56	825.47	821.80	821.45	823.05
BIC	–	855.79	848.53	844.81	844.50	846.07
τ	–	–	–	–	–1.722	0.498
ϕ, ϕ^c	–	–	6.51	2.97	8.60	2.39
$\rho_1 = \rho_2$	–	–	12.96	4.69	17.15	3.46
p-value			(0.000)	(0.031)	(0.000)	(0.064)

Notes
Number of observations: 205
Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 5.23$, $\phi_{\text{M-TAR (10\%)}} = 5.13$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 16. Peru

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	6.88(C,4)	–	–	–	–	–
ρ_1	–	–0.007(2)	–0.035(4)	–0.116(C,8)	–0.040(6)	–0.080(C,6)
t-statistic		(–0.36)*	(–1.29)	(–0.70)	(–1.51)	(–0.60)
ρ_2	–	–	–0.086	0.447	–0.101	0.284
t-statistic			(–2.51)	(2.69)	(–2.91)	(2.54)
AIC	–	–119.05	–120.78	–118.16	–123.75	–121.22
BIC	–	–109.96	–96.75	–85.34	–99.72	–99.24
τ	–	–	–	–	–0.097	0.052
ϕ, ϕ^c	–	–	5.26	3.72	6.77	3.33
$\rho_1 = \rho_2$	–	–	8.30	0.60	11.30	0.45
p-value			(0.004)	(0.440)	(0.000)	(0.502)

Notes
Number of observations: 156
Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 5.20$, $\phi_{\text{M-TAR (10\%)}} = 5.20$, $\phi^c_{\text{TAR (10\%)}} = 6.35$, $\phi^c_{\text{M-TAR (10\%)}} = 5.52$

Table 17. The Philippines

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	27.13(C,4)	–	–	–	–	–
ρ_1	–	–0.058(C,4)	–0.054(C,6)	–0.271(C,4)	–0.050(C,3)	–0.316(C,3)
t-statistic		(–3.25)*	(–2.16)	(–2.27)	(–2.15)	(–2.90)
ρ_2	–	–	–0.128	–0.219	–0.109	–0.137
t-statistic			(–2.78)	(–1.58)	(–2.88)	(–1.54)
AIC	–	994.09	957.14	986.92	982.11	1,003.27
BIC	–	1,013.88	996.41	1,016.42	1,011.71	1,023.06
τ	–	–	–	–	1.376	0.607
ϕ, ϕ^c	–	–	7.84	5.96	7.25	6.17
$\rho_1 = \rho_2$	–	–	3.20	1.83	3.39	3.55
p-value			(0.075)	(0.176)	(0.067)	(0.064)

Notes
Number of observations: 205
Critical values: $\lambda_{\text{trace (1\%)}} = 24.60$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 6.35$, $\phi_{\text{M-TAR (10\%)}} = 5.13$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.32$

Table 18. Poland

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	11.96(4)	–	–	–	–	–
ρ_1	–	–0.067	–0.155(C)	–0.116(1)	–0.141	–0.219(C)
t-statistic		(–2.26)*	(–2.96)	(–0.70)	(–3.46)	(–1.57)
ρ_2	–	–	–0.032	0.447	–0.006	0.177
t-statistic			(–0.53)	(2.69)	(–1.40)	(1.81)
AIC	–	21.53	25.80	21.62	23.45	23.80
BIC	–	27.58	34.89	30.67	29.51	32.88
τ	–	–	–	–	0.175	0.072
ϕ, ϕ^c	–	–	6.69	0.11	6.97	2.55
$\rho_1 = \rho_2$	–	–	7.27	0.086	4.15	2.51
p-value			(0.007)	(0.769)	(0.044)	(0.141)

Notes
Number of observations: 154
Critical values: $\lambda_{\text{trace (5\%)}} = 12.53$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 5.98$, $\phi_{\text{M-TAR (10\%)}} = 5.47$, $\phi^c_{\text{TAR (5\%)}} = 6.95$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 19. South Africa

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	22.64(C,4)	–	–	–	–	–
ρ_1	–	–0.040(4)	–0.070(1)	0.164(6)	–0.058(6)	0.173
t-statistic		(–2.40)*	(–2.18)	(1.53)	(–1.74)	(1.78)
ρ_2	–	–	–0.008	–0.124	–0.020	–0.171
t-statistic			(–0.27)	(–1.22)	(–0.57)	(–1.71)
AIC	–	708.28	711.75	545.87	709.85	756.93
BIC	–	753.81	754.03	551.87	758.63	763.55
τ	–	–	–	–	1.392	–0.449
ϕ, ϕ^c	–	–	1.90	6.22	3.06	5.37
$\rho_1 = \rho_2$	–	–	5.20	3.79	3.97	6.13
p-value			(0.023)	(0.0053)	(0.047)	(0.014)

Notes
Number of observations: 204
Critical values: $\lambda_{\text{trace (1\%)}} = 24.60$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (5\%)}} = 4.92$, $\phi_{\text{M-TAR (10\%)}} = 5.13$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.32$

Table 20. Russia

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	8.89(C,2)	–	–	–	–	–
ρ_1	–	–0.045(4)	–0.027	–0.037	–0.041(6)	–0.207(C)
t-statistic		(–1.68)*	(–0.76)	(–0.295)	(–1.24)	(–1.39)
ρ_2	–	–	–0.045	0.195	–0.118	0.261
t-statistic			(–1.27)	(1.79)	(–2.41)	(2.46)
AIC	–	221.67	233.04	225.95	199.82	223.79
BIC	–	236.30	238.96	231.85	234.41	232.64
τ	–	–	–	–	–0.662	0.138
ϕ, ϕ^c	–	–	1.09	1.66	3.14	3.66
$\rho_1 = \rho_2$	–	–	0.12	1.93	2.13	2.22
p-value			(0.722)	(0.166)	(0.146)	(0.138)

Notes
Number of observations: 143
Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 5.01$, $\phi_{\text{M-TAR (10\%)}} = 5.47$, $\phi^c_{\text{TAR (10\%)}} = 6.35$, $\phi^c_{\text{M-TAR (10\%)}} = 5.73$

Table 21. Sri Lanka

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	5.29(2)	–	–	–	–	–
ρ_1	–	–0.020(4)	0.009	0.154	0.004(C,6)	0.010(4)
t-statistic		(–1.55)*	(0.38)	(1.60)	(0.19)	(0.11)
ρ_2	–	–	–0.067	0.241	–0.062	0.269
t-statistic			(–2.04)	(2.43)	(–2.36)	(2.99)
AIC	–	–62.60	–70.33	–42.55	–65.46	–63.97
BIC	–	–46.11	–57.22	–35.92	–35.86	–47.47
τ	–	–	–	–	0.273	0.044
ϕ, ϕ^c	–	–	2.47	4.25	3.06	4.66
$\rho_1 = \rho_2$	–	–	0.59	0.39	0.31	3.73
p-value			(0.445)	(0.532)	(0.581)	(0.054)

Notes
Number of observations: 205
Critical values: $\lambda_{trace\,(5\%)} = 12.53$, $\tau_{(10\%)} = -3.03$, $\phi_{TAR\,(10\%)} = 4.94$, $\phi_{M\text{-}TAR\,(10\%)} = 5.38$, $\phi^c_{TAR\,(10\%)} = 6.44$, $\phi^c_{M\text{-}TAR\,(10\%)} = 5.32$

Table 22. Thailand

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	8.37(C,2)	–	–	–	–	–
ρ_1	–	–0.032(2)	0.011(C,1)	–0.132(C)	–0.002(C,6)	–0.148(C)
t-statistic		(–1.83)*	(0.38)	(–1.17)	(–0.09)	(–1.43)
ρ_2	–	–	–0.092	0.186	–0.089	0.161
t-statistic			(–2.44)	(1.32)	(–2.65)	(1.49)
AIC	–	205.94	208.20	210.41	188.65	208.94
BIC	–	215.87	221.45	220.35	250.15	218.88
τ	–	–	–	–	0.463	0.104
ϕ, ϕ^c	–	–	3.25	1.15	3.65	1.88
$\rho_1 = \rho_2$	–	–	0.59	1.49	0.01	2.13
p-value			(0.442)	(0.224)	(0.753)	(0.145)

Notes
Number of observations: 205
Critical values: $\lambda_{trace\,(5\%)} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{TAR\,(10\%)} = 4.92$, $\phi_{M\text{-}TAR\,(10\%)} = 5.38$, $\phi^c_{TAR\,(10\%)} = 6.44$, $\phi^c_{M\text{-}TAR\,(10\%)} = 5.58$

Table 23. Taiwan

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	13.94(C,2)	–	–	–	–	–
ρ_1	–	–0.028(2)	–0.059(C,2)	0.163(C,2)	–0.012(C,8)	0.254(9)
t-statistic		(–1.71)*	(–0.15)	(1.40)	(–0.50)	(2.95)
ρ_2	–	–	–0.044	0.142	–0.040	0.032
t-statistic			(–1.48)	(1.11)	(–1.60)	(0.30)
AIC	–	44.35	47.93	51.27	3.24	3.14
BIC	–	54.28	64.47	67.82	45.72	39.14
τ	–	–	–	–	0.417	–0.053
ϕ, ϕ^c	–	–	1.65	2.41	1.53	4.38
$\rho_1 = \rho_2$	–	–	0.00	1.81	0.33	2.53
p-value			(0.997)	(0.179)	(0.564)	(0.113)

Notes
Number of observations: 205
Critical values: $\lambda_{trace\,(5\%)} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{TAR\,(10\%)} = 4.92$, $\phi_{M\text{-}TAR\,(10\%)} = 5.36$, $\phi^c_{TAR\,(10\%)} = 6.44$, $\phi^c_{M\text{-}TAR\,(10\%)} = 5.32$

Table 24. Turkey

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	17.02(C,T,4)	–	–	–	–	–
ρ_1	–	–0.084(6)	–0.117(8)	–0.001	–0.095(2)	–0.079(2)
t-statistic		(–3.06)*	(–2.77)	(–0.01)	(–2.62)	(–0.91)
ρ_2	–	–	–0.084	0.072	–0.049	0.111
t-statistic			(–2.37)	(0.69)	(–1.57)	(1.00)
AIC	–	261.36	258.81	281.84	266.21	273.45
BIC	–	290.86	298.02	288.47	279.44	286.68
τ	–	–	–	–	0.309	–0.107
ϕ, ϕ^c	–	–	4.84	0.24	4.55	0.92
$\rho_1 = \rho_2$	–	–	0.40	0.28	0.92	1.82
p-value			(0.526)	(0.599)	(0.338)	(0.179)

Notes
Number of observations: 205
Critical values: $\lambda_{\text{trace (5\%)}} = 25.32$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 5.23$, $\phi_{\text{M-TAR (10\%)}} = 5.38$, $\phi^c_{\text{TAR (10\%)}} = 5.92$, $\phi^c_{\text{M-TAR (10\%)}} = 5.57$

Table 25. Venezuela

	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
λ_{trace}	14.38(C,2)	–	–	–	–	–
ρ_1	–	–0.003(4)	–0.037(4)	0.155	–0.102(C,4)	–0.184(1)
t-statistic		(–1.98)*	(–2.77)	(1.68)	(–3.83)	(–2.06)
ρ_2	–	–	–0.019	0.103	–0.011	–0.057
t-statistic			(–0.90)	(0.97)	(–0.61)	(0.498)
AIC	–	274.92	276.52	297.27	268.23	297.08
BIC	–	291.36	296.25	303.88	291.25	306.98
τ	–	–	–	–	0.706	–0.115
ϕ, ϕ^c	–	–	2.14	1.88	7.32	6.22
$\rho_1 = \rho_2$	–	–	0.38	0.14	10.57	0.74
p-value			(0.536)	(0.707)	(0.338)	(0.389)

Notes
Number of observations: 203
Critical values: $\lambda_{\text{trace (5\%)}} = 19.96$, $\tau_{(10\%)} = -3.03$, $\phi_{\text{TAR (10\%)}} = 5.23$, $\phi_{\text{M-TAR (10\%)}} = 5.38$, $\phi^c_{\text{TAR (10\%)}} = 6.44$, $\phi^c_{\text{M-TAR (10\%)}} = 5.57$

Table 26. Summary of Results

Country	Explosive Bubbles		Periodically Collapsing Bubbles			
	Johansen	Engle-Granger	TAR	M-TAR	Consistent TAR	Consistent M-TAR
ARG	yes	yes	–	–	–	–
BRA	yes	yes	–	–	yes	yes
CHI	no	no	yes	–	yes	yes
CHN	yes	yes	–	–	–	yes
COL	yes	yes	yes	–	yes	–
CZE	yes	yes	–	–	–	–
IDN	no	no	yes	–	yes	–
IND	yes	yes	–	yes	–	yes
ISR	yes	yes	–	–	–	–
KOR	no	no	–	yes	–	yes
MAS	yes	yes	–	–	–	–
MEX	yes	yes	yes	–	yes	–
PER	yes	yes	yes	–	yes	–
PHI	no	no	yes	yes	yes	yes
POL	yes	yes	yes	–	yes	–
RSA	yes	yes	–	–	–	–
RUS	yes	yes	–	–	–	–
SRI	yes	yes	–	–	–	–
THA	yes	yes	–	–	–	–
TPE	yes	yes	–	–	–	–
TUR	yes	yes	–	–	–	–
VEN	yes	yes	–	–	yes	yes

References

Andrews D., and W. Ploberger (1994) Optimal tests when a nuisance parameter is present only under the alternative, *Econometrica* 62, 1383–1414.

Balke, N. S., and T. B. Fomby (1997) Threshold cointegration, *International Economic Review* 38, 627–643.

Bikhchandani, S., and S. Sharma (2000) Herd behavior in financial markets: a review, *IMF Working Papers* No. 48.

Blanchard, O. (1979) Speculative bubbles, crashes, and rational expectations, *Economics Letters* 3, 387–389.

Blanchard, O., and M. W. Watson (1982) Bubbles, rational expectations, and financial markets, *NBER Working Papers* No. 945.

Caner, M., and B. E. Hansen (2001) Threshold autoregression with a unit root, *Econometrica* 69, 1555–1596.

Chan, K. S. (1993) Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model, *The Annals of Statistics* 21, 520–533.

Chan, K. S., and H. Tong (1989) A survey of the statistical analysis of a univariate threshold autoregressive model, in R. Mariano (Ed.), *Advances in Statistical Analysis and Statistical Computing: Theory and Applications, Vol. 2*, Greenwich, Conn: JAI Press Inc., pp. 1–42.

Enders, W., and C. W. J. Granger (1998) Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates, *Journal of Business & Economic Statistics* 16, 304–311.

Enders, W., and B. Falk (1998) Threshold-autoregressive, median-unbiased, and cointegration tests of purchasing power parity, *International Journal of Forecasting* 14, 171–186.

Enders, W., and P. Siklos (2001) Cointegration and threshold adjustment, *Journal of Business & Economic Statistics* 19, 166–176.

Engle, R., and C. L. W. Granger (1987) Cointegration and error-correction: representation, estimation, and testing, *Econometrica* 55, 251–276.

Evans, G. (1991) Pitfalls in testing for explosive bubbles in asset prices, *American Economic Review* 81, 922–930.

Hansen, B. (1996) Inference when a nuisance parameter is not identified under the null hypothesis, *Econometrica* 64, 413–430.

Neftei, S. N. (1984) Are economic time series asymmetric over the business cycle? *Journal of Political Economy* 92, 307–328.

Petruccelli, J. D., and S. W. Woolford (1984) A threshold AR(1) model, *Journal of Applied Probability* 21, 270–286.

Potter, S. (1995) A nonlinear approach to U.S. GNP, *Journal of Applied Econometrics* 10, 109–125.

Selody, J., and C. Wilkins (2004) Asset prices and monetary policy: a Canadian perspective on the issues, *Bank of Canada Review* 127, 3–14.

Tong, H. (1983) Threshold Models in Non-Linear Time Series Analysis, New York: Springer-Verlag.