How does the Regional Monetary Unit work as a surveillance tool?

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Contents

Backgrounds

* Needs for Exchange rates stability in East Asia
  * Further economic growth in the region
  * A threat of ‘beggar-thy-neighbor’ policy: competitive devaluation
    * Einchengreen and Sachs (1985): individual devaluation vs. coordinated international devaluation
    * A country who adopt rigid exchange rate regime may impose trade restrictions.

ASEAN+3 Finance Ministers agree to move Cooperation at Higher Level in response to the global financial crisis

* The multilateral currency swap facility – the USD 120 million Chiang Mai Initiative Multilateralisation (CMIM) – came into effect in 2010.
* The ASEAN+3 Macroeconomic Research Office (AMRO)
  * was established in Singapore,
  * plays an important role in securing the region's stability, and
  * conducts comprehensive surveillance of regional economies.

Backgrounds (cont.1)

* Needs for Exchange rates monitoring among CMIM members' currency as a conditionality of liquidity support by CMIM,
  * To capture possibilities of future crisis and its potential risk
  * To analyze the determinants of regional economic trend and policy action
* Exchange rates monitoring contributes to
  * Assuring the soundness of financial system, banking sector, or capital flows, and
  * Creating Asian regionalisms

Backgrounds (cont.2)

* AMRO is now playing an important role of
  * in securing the region's stability through the conduct of comprehensive surveillance of regional economies to support decision-making process for CMIM.
* How could the AMRO monitor the members' exchange rate monitoring?
  * Nominal exchange rates: USD, EUR, or JPY
  * Effective exchange rates: NEER, REER, or ULC-REER, or
  * Basket currencies: ACU, AMU

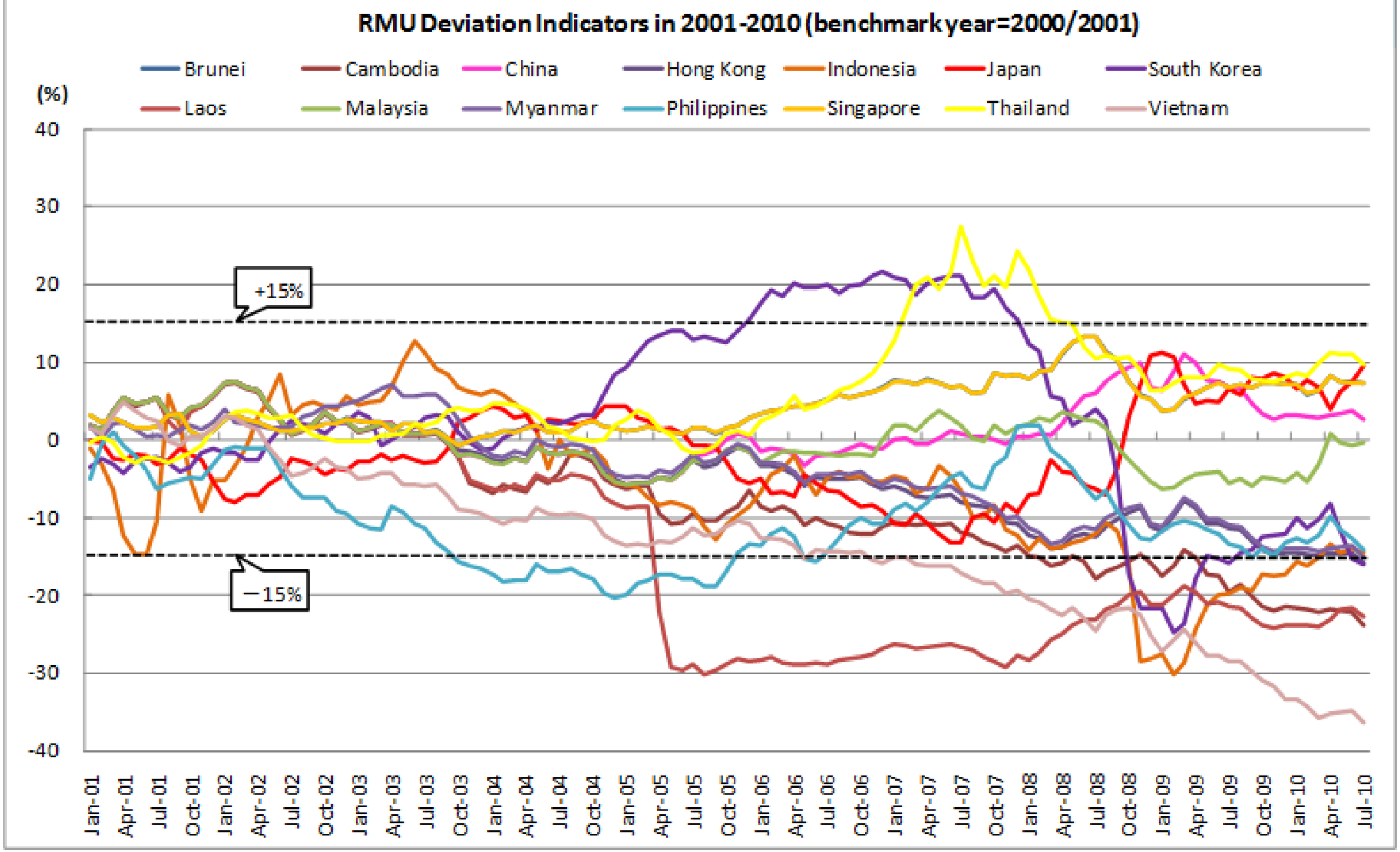
Motivations

* Bilateral vs. Multilateral Real EXR
  * Whether dose there exist significant differences in the movement of the real Regional Monetary Unit Deviation Indicator (RMU DI) and the bilateral real exchange rate?

Motivations

* Improving the performance of monitoring exchange rate in employing the regional monetary unit such as AMU
  * AMU DI: ad hoc assumption in choosing benchmark year
  * Concerning economic growth, inter-relations, and mean-reversions toward equilibrium exchange rates
  * Introducing the concept of "OCA" as an equilibrium : Kawasaki (2012a), Kawasaki and Ogawa (2006), & Ogawa and Kawasaki (2008)
* How would the inter-relations among member's currencies dominate the exchange rates movements?

http://www.rieti.go.jp/users/amu/cmi.html



Contributions

* Decompose of Exchange rates movements;
  * Employing the Permanent-Transitory decomposition (P-T decomposition) proposed by Gonzalo and Granger (1995)
  * Eliminating the effect from permanent movements and **focusing on transitory movements for the short-term monitoring**
* Imposing the condition of equilibrium on the exchange rates among member states' exchange rates movements
  * Concept of G-PPP approach: cointegration among exchange rates' movement

3. Advantages of Employing RMU Deviation Indicators in Macroeconomic Surveillance

Examining the properties of fluctuations in the exchange rates

1. **a stationary convergence process,** where the real exchange rates possesses the long-term mean and its reverting process when the exchange rates deviate from it (mean-reversion),
2. **a stationary divergent process,** where the real exchange rates exhibit tendencies to increase deviations (real deviation),
3. **a non-stationary random walk process,** where the changes in the real exchange rates are completely random (that is, the movement is unpredictable).

Non-linear model of the UR test : the Momentum TAR (M-TAR) model by Enders and Granger (1998)

$$\Delta g_t = I_t \rho_1 (g_{t-1} - \tau) + (1 - I_t) \rho_2 (g_{t-1} - \tau) + \sum_{i=1}^{p} \alpha_i \Delta g_{t-1} + \varepsilon_i$$

$$\rho_1 < 0, \rho_2 < 0$$

$$I_t = \begin{cases} 1 \; if \; \Delta g_{t-1} \geq 0 \\ 0 \; if \; \Delta g_{t-1} < 0 \end{cases}$$

$$z(+) = I_t \rho_1$$

$$z(-) = (1 - I_t) \rho_2$$

$$H_0 : \rho_1 = \rho_2 = 0, H_1 : \text{ no unit root}$$

$$H_0 : \rho_1 = \rho_2, \; H_1 : \text{asymmetric adjstment}$$

Examining the properties of fluctuations in the exchange rates

* The coefficient of zeta-plus: Z(+) is regarded as the **appreciation-correcting** coefficient:
* The coefficient of zeta-minus: Z(-) is regarded as the **depreciation-correcting** coefficient
  * Z(+) = Z(-)<0 : Symmetric convergent
  * Z(+) = Z(-)>0 : Symmetric divergent
  * Z(+) = Z(-)=0 : Symmetric Unit root
  * Z(+)≥0, Z(0)<0 or Z(+)<0, Z(-)≥0 : Asymmetric convergent
  * Z(+)>0, Z(0)=0 or Z(+)=0, Z(-)>0: Asymmetric divergent

Examining the properties of fluctuations in the exchange rates

* **Data**
  * Sample Period: January 3, 2000 -December 31, 2009.
  * The data on the exchange rate and the AMU are obtained from *Datastream* and RIETI.
  * The price data is obtained from IMF-*IFS* as monthly consumer price indices.
  * The "Daily" real exchange rates and the real RMU DI are calculated from the daily nominal exchange rates, the AMU, and the monthly CPI which is converted to daily data.

The Empirical results of the M-TAR unit root test for each currency of 'ASEAN plus three' exchange rate vis-à-vis the U.S. dollars

* **Random walk process** (unforeseeable: Z(+)=Z(-)=0):
  * **China (CNY), Hong Kong (HKD), Indonesia (IDR), Japan (JPY), Korea (KRW), Lao (LAK), Singapore (SGD)** and **Thailand (THB)**,
* **Asymmetric stationary process**
  * one-side mean reversion and one-side divergent
    * **Cambodia:** Z(+)<0, Z(-)>0
  * one-side mean reversion
    * **Brunei*** : Z(+)<0, Z(-)=0 (*10%)
    * **Malaysia**: Z(+)=0, Z(-)<0
  * one-side divergent
    * **Philippines**, and **Vietnam**: Z(+)>0, Z(-)=0
* **Symmetric stationary divergent process**
  * **Myanmar:** Z(+) = Z(-)>0

The Empirical results of the M-TAR unit root test for each currency of 'ASEAN plus three' exchange rate vis-à-vis the RMU DI

- **Random walk process** (unforeseeable: Z(+)=Z(-)=0):
  - **Japan (JPY), Lao (LAK), Philippines (PHP),** and **Thailand (THB),**
- **Asymmetric stationary process**
  - one-side mean reversion and one-side divergent
    - **Cambodia:** Z(+)<0, Z(-)>0
    - **Korea:** Z(+)<0, Z(-)>0* (10%)
  - one-side mean reversion
    - **Brunei**: Z(+)=0, Z(-)<0
    - **China**: Z(+)<0, Z(-)=0
  - one-side divergent
    - **Hong Kong***(10%)**, Indonesia, Myanmar,** and **Vietnam:** Z(+)>0, Z(-)=0
- **Symmetric stationary convergent process**
  - **Singapore** and **Malaysia*(10%)** : Z(+)=Z(-)<0

The sequential M-TAR unit root for KRW, SGD, and THB

* Sequential M-TAR unit root test,
  * the short-term model: 250 samples
  * the medium-term model: 500 samples.
* The rolling regressions (from January 3, 2000 + 250/500 samples)
  * The 1st short-term model: Jan. 3, 2000 - Dec. 18, 2000,
  * The 1st medium-term model: Jan. 3, 2000 - Dec. 3, 2001,
  * The final short-term model: Dec. 25, 2008 - Dec. 10, 2009,
  * The final medium-term model: Jan. 10, 2008 – Dec. 10, 2009.

Figure 1a: M-TAR Unit Root Test for Indices of the SGD Real Exchange Rate vis-à-vis the USD

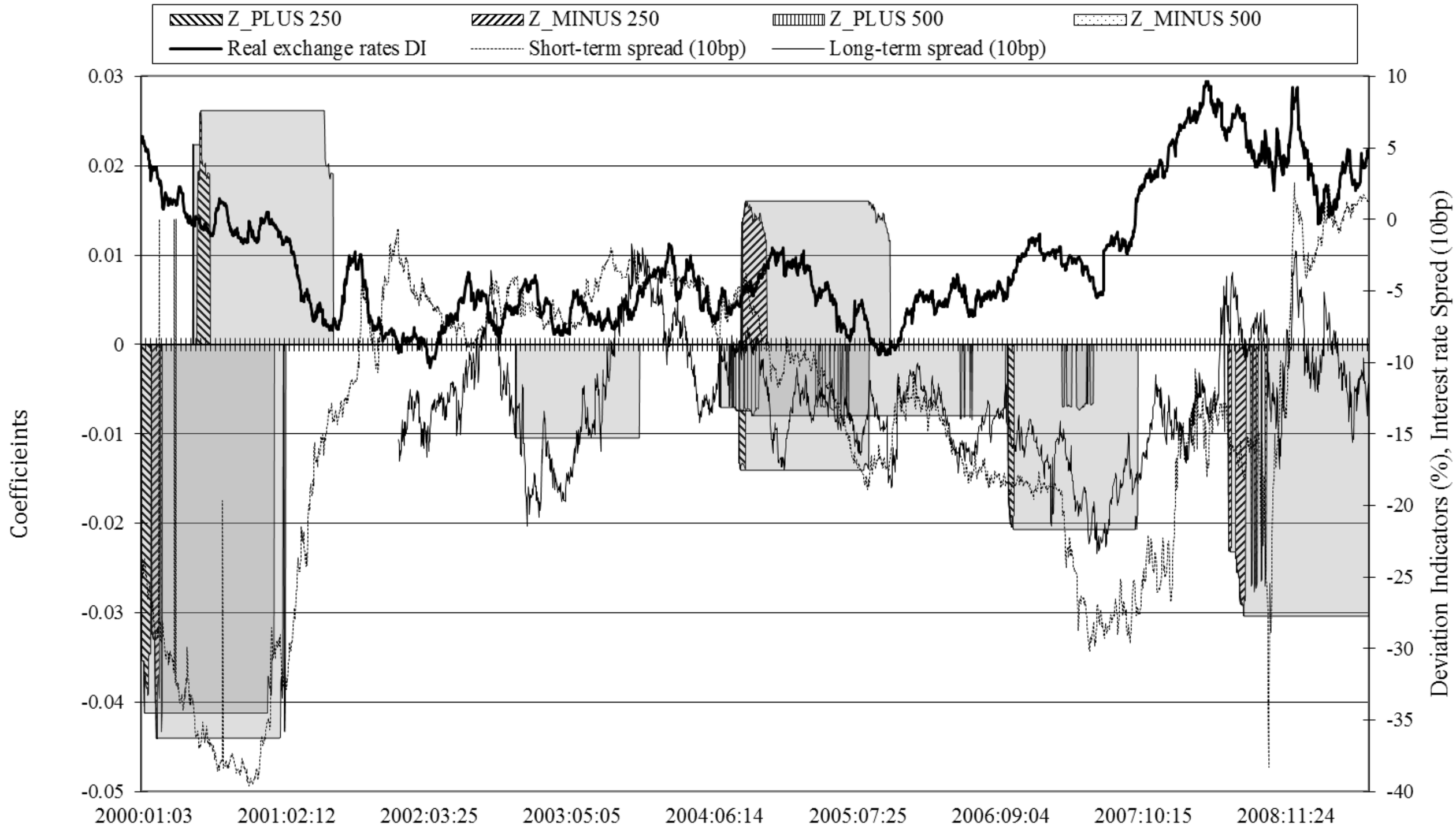


Figure 1b: M-TAR Unit Root Test for the Real RMU DI of the Singapore Dollar

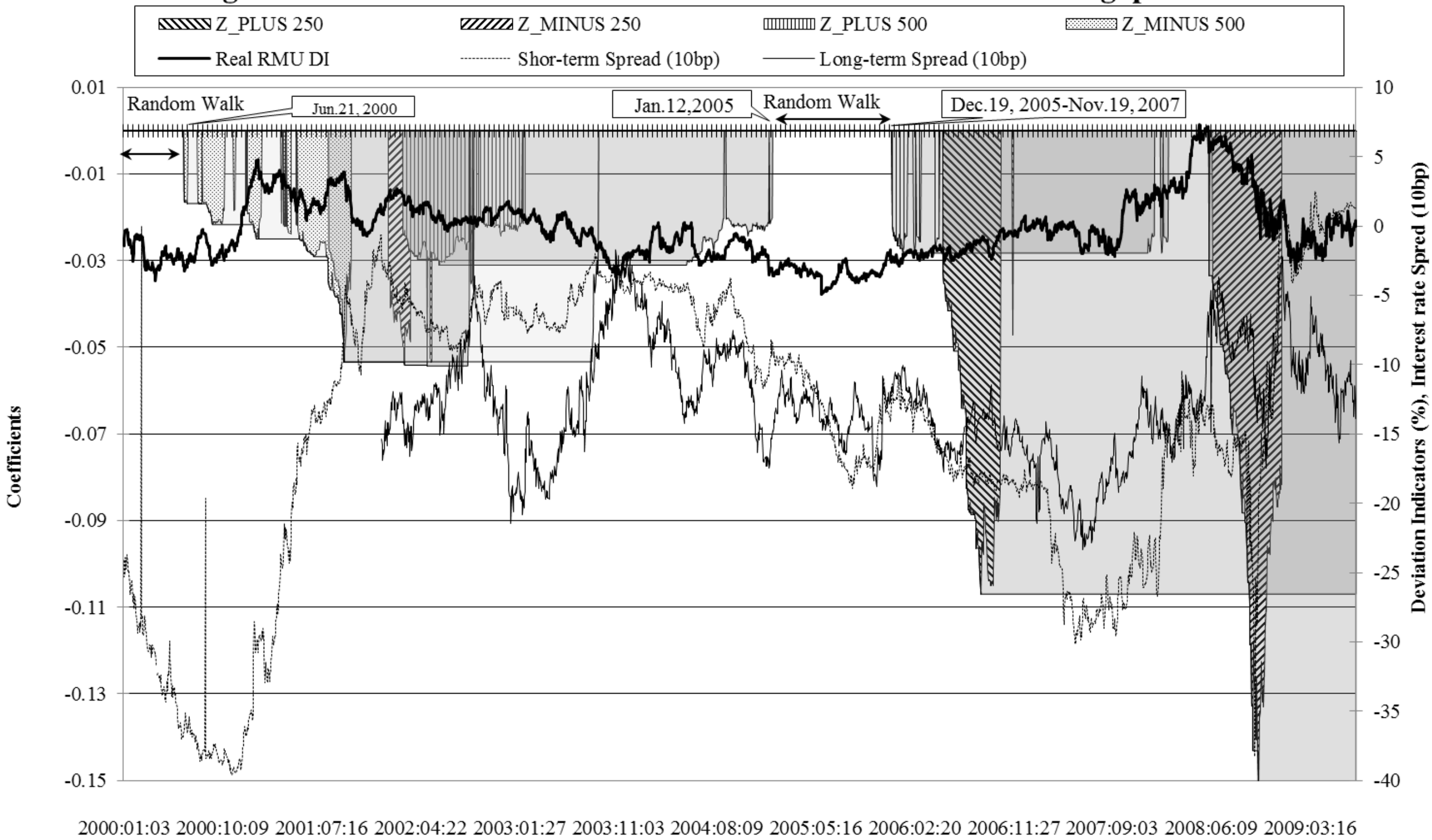


Figure 2a: M-TAR Unit Root Test for Indices of the KRW Real Exchange Rate vis-à-vis the USD

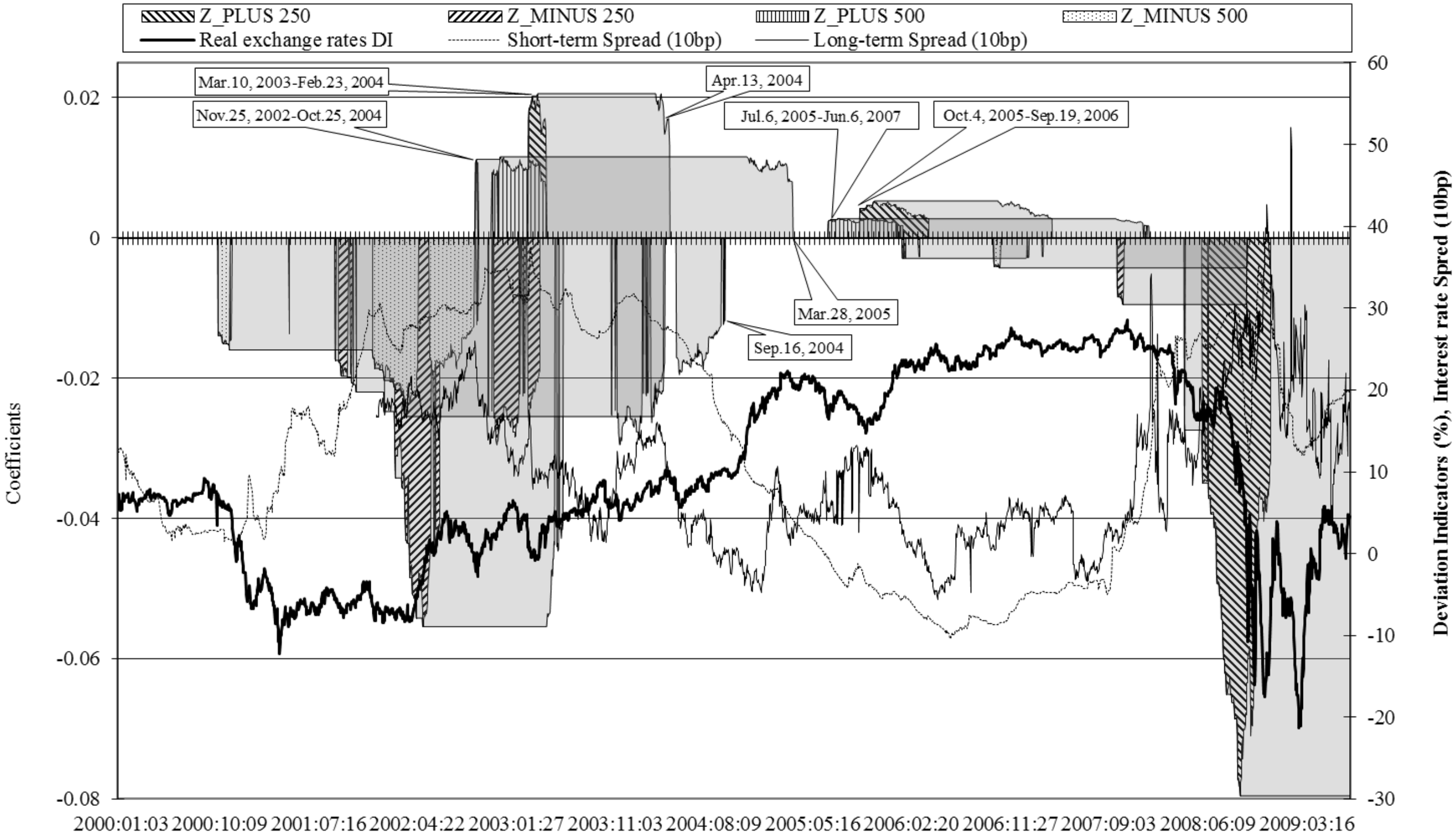


Figure 2b: M-TAR Unit Root Test for Real RMU DI of the Korean Won

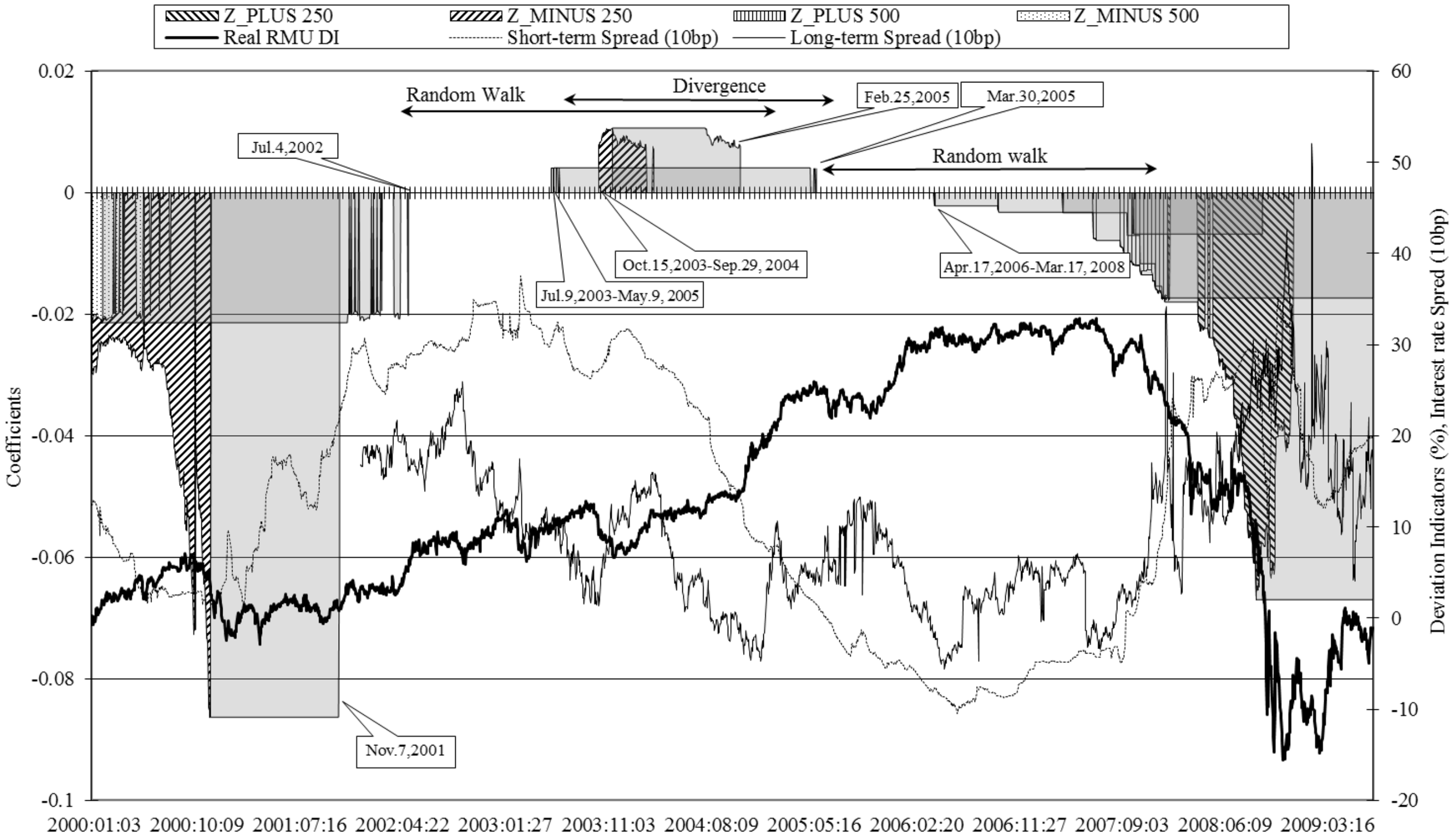


Figure 3a: M-TAR Unit Root Test for Indices of the THB Real Exchange Rate vis-à-vis the USD

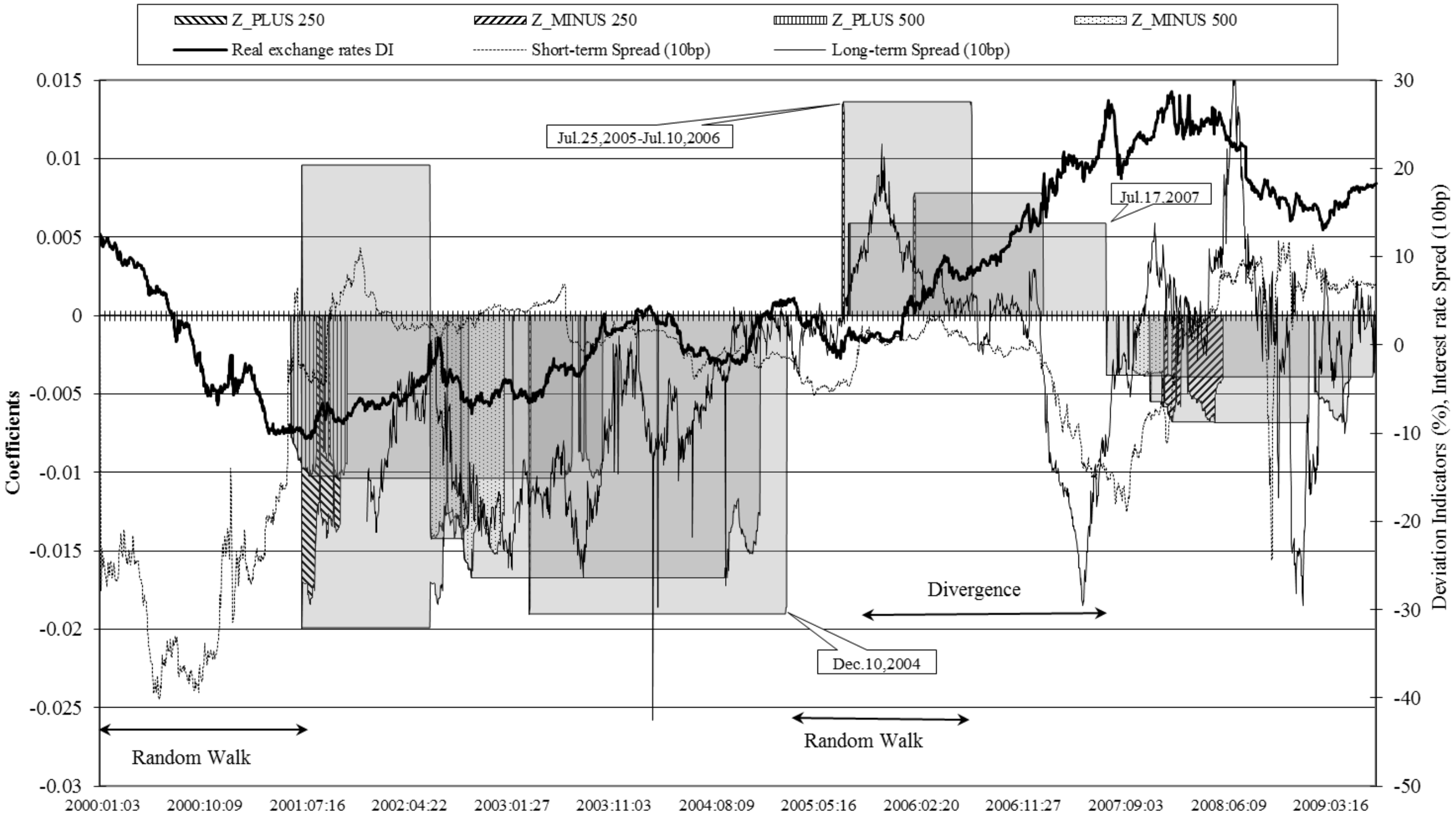
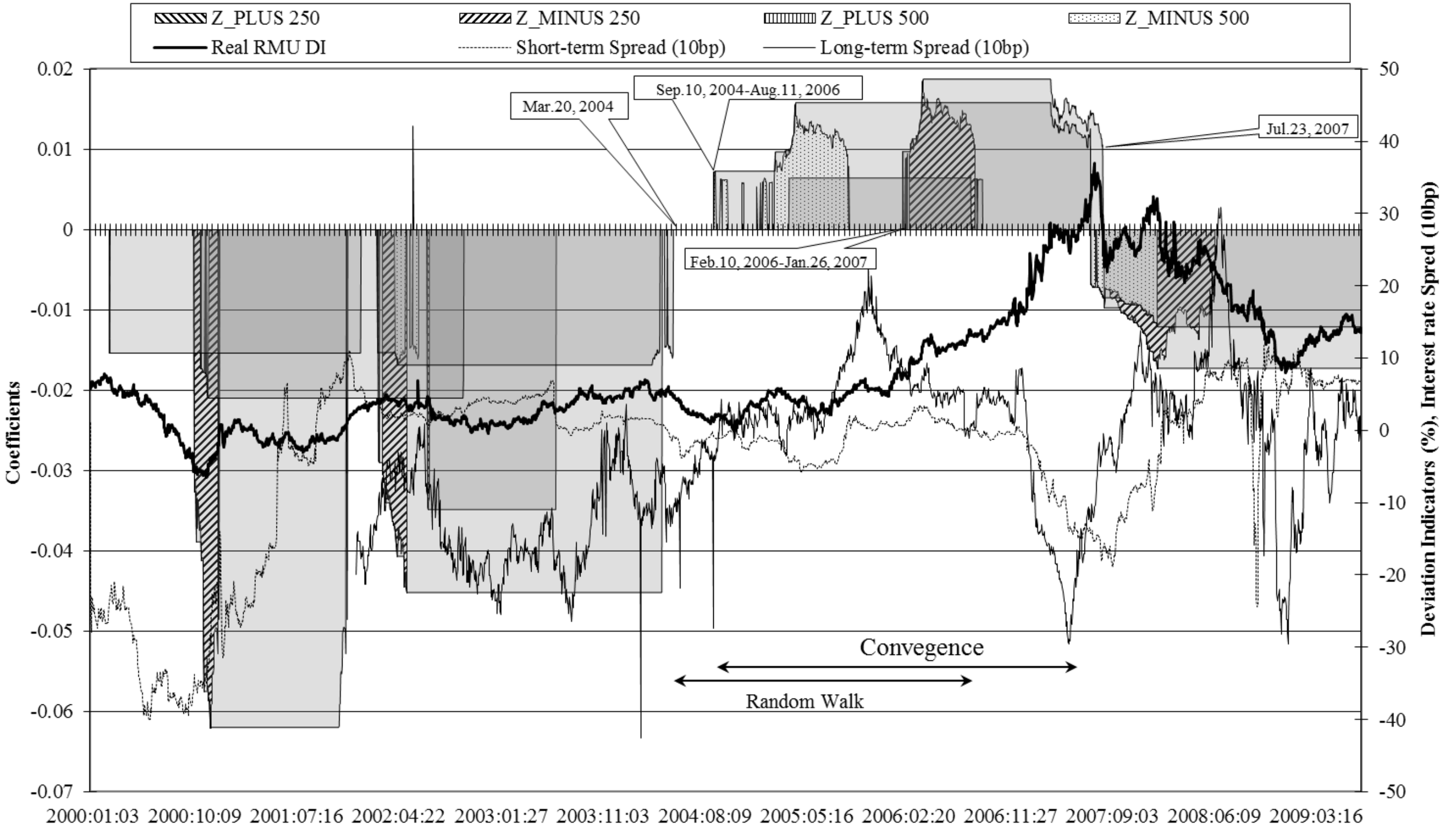


Figure 3b: M-TAR Unit Root Test for the Real RMU DI of the Thai Baht



Summary of Empirical Results

1. **the magnitudes of convergence speeds in the real RMU DI deviation are larger** than those of the bilateral real exchange rates vis-à-vis the USD,
2. the unit root test for the RMU DI is **able to detect the possibility of exchange rates' deviation earlier** than the test for the bilateral real exchange rates,
3. the time series property of the exchange rate movement changes time to time, and
4. the unit root test for the RMU DI has the **ability to capture the possibility of structural switches more clearly** than the test for the bilateral rates.

4. Decompose of Exchange rates movements

Empirics: Definition of RMU

* Definition of RMU, (us$/AMU)

14

$$NEX_{US\$/RMU} = \prod_{i=1}^{13} \omega_i \cdot NEX_{US\$/i} \quad \text{where} \quad \sum_{i=1}^{13} \omega_i = 1$$

13

* Logarithm of real exchange rates,

$$\begin{aligned} rex_{RMU/j,t} &= nex_{RMU/j,t} + p_{j,t} - p_{RMU,t} \\ &= nex_{US\$/RMU,t} - nex_{US\$/j,t} + p_{j,t} - \sum_{i=1}^{13} \omega_i \cdot p_{i,t} \\ &= \sum_{i=1, i\neq j}^{13} \omega_i \left(nex_{US\$/i,t} - p_{i,t} \right) - \left(nex_{US\$/j,t} - p_{j,t} \right) \\ &= \sum_{i=1, i\neq j}^{13} \omega_i \cdot x_{i,t} - x_{j,t} \end{aligned}$$

where $p_{RMU,t} = \sum_{i=1}^{13} \omega_i \cdot p_{i,t}$

Empirics: Definition of RMU

* Matrices form

$$rex_{RMU/j,t} = W' \cdot X_t$$

$$W' = \left[\omega_1, \ldots, -1, \ldots \omega_{13}\right] \qquad X'_t = \left[x_{1,t}, \ldots, x_{j,t}, \ldots x_{13,t}\right]$$

Concerning Equilibrium of G-PPP

* Partitioning into two groups: dominate currencies + dominated currencies

$$rex_{RMU/j,t} = \underbrace{W_1' \cdot X_{1,t}}_{\text{Cointegrated}} + \underbrace{W_2' \cdot X_{2,t}}_{\text{Not cointegrated}}$$

$$W_1' = [\omega_1, \ldots, -1, \ldots \omega_m], W_2' = [\omega_{m+1}, \ldots\ldots \omega_{13}]$$

$$X_{1,t}' = [x_{1,t}, \ldots, x_{j,t}, \ldots x_{m,t}], X_{2,t}' = [x_{m+1,t}, \ldots x_{13,t}]$$

Dominate currencies **Dominated currencies**

P-T Decomposition by Gonzalo and Granger (1995)

* Decompose the permanent and transitory components

$$X_{1,t} = X_t^P + X_t^T$$

1) Vector is X_t^P difference stationary and Vector X_t^P is covariance stationary,

2) $\mathrm{var}(\Delta X_t^P) > 0$ and $\mathrm{var}\left(X_t^T\right) > 0$, and

3) innovations: $u_{P,t}$ and $u_{T,t}$ for the autoregressive representation of ; $\left(\Delta X_t^P, X_t^T\right)$,,

$$\begin{bmatrix} H_{11}(L) & H_{12}(L) \\ H_{21}(L) & H_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta X_t^P \\ X_t^T \end{bmatrix} = \begin{bmatrix} u_{P,t} \\ u_{T,t} \end{bmatrix}$$

$$\lim_{h\to\infty} \frac{\partial E\left(X_{1,t+h}\right)}{\partial u_{P,t}} \neq 0 \qquad \lim_{h\to\infty} \frac{\partial E\left(X_{1,t+h}\right)}{\partial u_{T,t}} = 0 \qquad H_{12}(1) = 0$$

P-T Decomposition by Gonzalo and Granger (1995)

* VECM and MA representation;

$$\Delta X_{1,t} = \underset{m\times 1}{\alpha} \cdot \underset{1\times m}{\beta'} X_{1,t-1} + \sum_{i=1}^{p} \Gamma_i \Delta X_{1,t-i} + \Phi D_t + \varepsilon_t$$

$$X_{1,t} = C\sum_{i=1}^{t} \varepsilon_i + C\cdot\Phi D_t + C(L)\left(\varepsilon_t + \Phi D_t\right)$$

where $C = \beta_\perp \left(\alpha_\perp' \left(I - \sum_{i=1}^{p-1} \Gamma_i \right) \beta_\perp \right)^{-1} \alpha_\perp'$

* P-T decomposition of

$$X_{1,t} = A_1 \alpha_\perp' X_{1,t} + A_2 \beta' X_{1,t}$$

where $A_1 = \beta_\perp \left(\alpha_\perp' \beta_\perp\right)^{-1}$ and $A_2 = \alpha\left(\beta'\alpha\right)^{-1}$

Definition of Deviation Indicators

* Benchmark rates;

$$\overline{rex}_{RMU/j} = W' \cdot X = W_1' \cdot X_1 + W_2' \cdot X_2$$

$$X_{1,t}' = \left[x_{1,t}, \ldots, x_{j,t}, \ldots x_{m,t} \right], X_{2,t}' = \left[x_{m+1,t}, \ldots x_{13,t} \right]$$

* Deviation from benchmark rates

$$\begin{aligned} DI_{i,t} &= rex_{RMU/i,t} - \overline{rex}_{RMU/i} \\ &= W_1' \cdot \left(X_{1,t} - \bar{X}_1 \right) + W_2' \cdot \left(X_{2,t} - \bar{X}_2 \right) \\ &= W_1' \cdot \left(X_t^P + X_t^T - \bar{X}_1 \right) + W_2' \cdot \left(X_{2,t} - \bar{X}_2 \right) \end{aligned}$$

Current misalignment and its deviation indicator

* Current misalignment for dominate currencies

$$cm_{j.t} = rex_{RMU/j} - rex^{XP}_{RMU/j,t} = W_1' \cdot X_{1,t} - W_1' \cdot X_t^P$$
$$= W_1' \cdot \left(X_{1,t} - X_t^P \right)$$
$$= W_1' \cdot X_t^T$$

* its deviation indicator for **dominate currencies**

$$CDI_{i,t} = W_1' \cdot \left(X_t^T - \bar{X}^T \right)$$

Temporal deviation indicator for temporal misalignments

* Temporal deviation indicator for temporal misalignments of **dominated currencies**

$$TDI_{i,t} = W_1' \cdot \left(\bar{X}^P + X_t^T - \bar{X}_1 \right) + W_2' \cdot \left(X_{2,t} - \bar{X}_2 \right)$$

data

* Monthly exchange rates of 14 CMIM member's currencies vis-à-vis the USD and CPI from IMF-*IFS*
  * BND, KHR, CNY, HKD, IDR, JPY, KRW, LAK, MYR, MMK, PHP, SGD, THB, and VND
* Sample covers 2000:1-2011:12
* Dominate currencies' groups
  * ASEAN5+ JPY, ASEAN5+CNY+JPY, ASEAN5+KRW+JPY, and ASEAN5+CNY+KRW+JPY (checked cointegration relationship by Johansen methodology)
  * No cointegrated relationship in CNY+KRW+JPY

Figure 1: The Deviation Indicators of CMIM member currencies

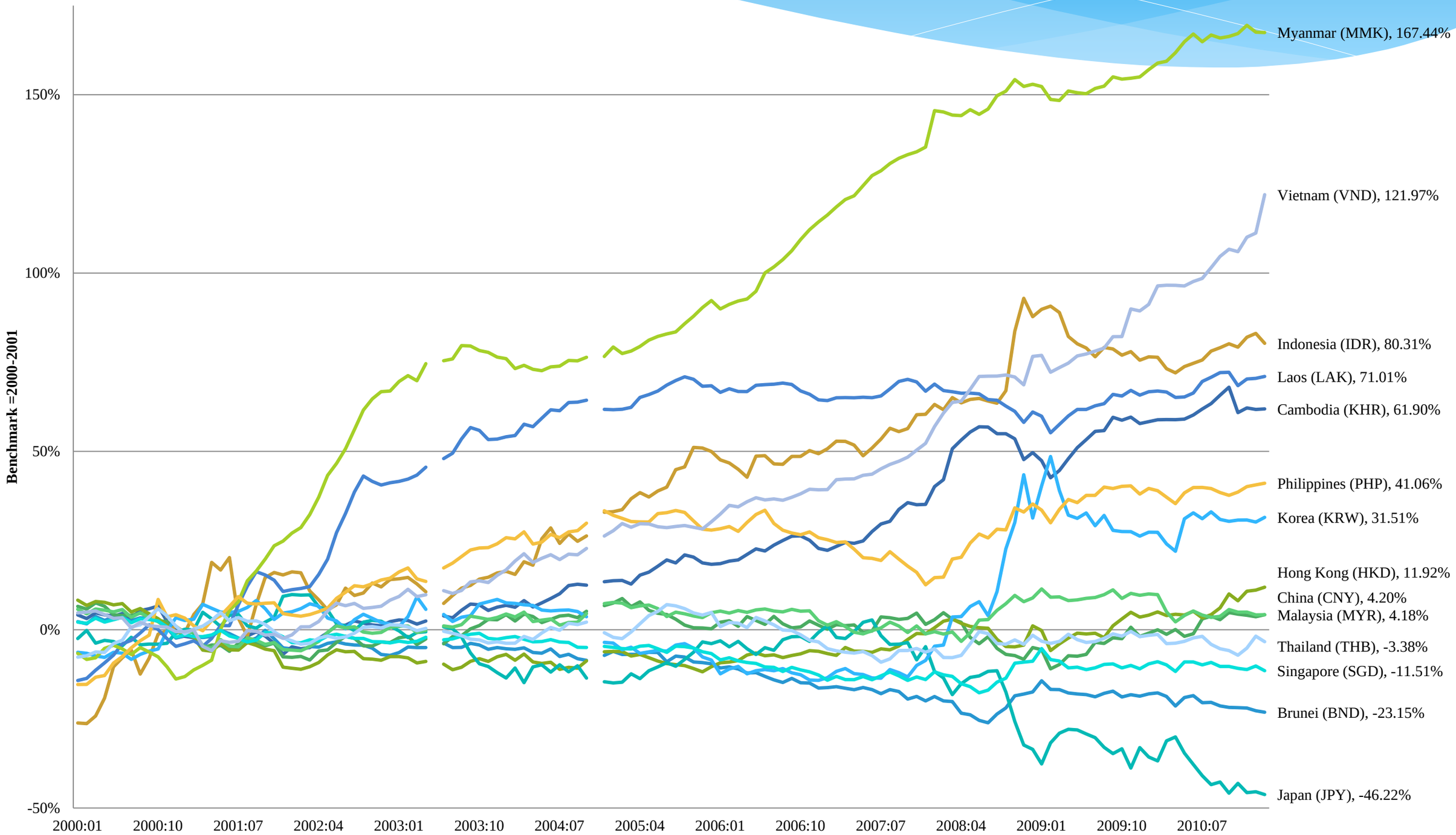


Figure 2a: Current Deviation Index for ASEAN5 + Korea

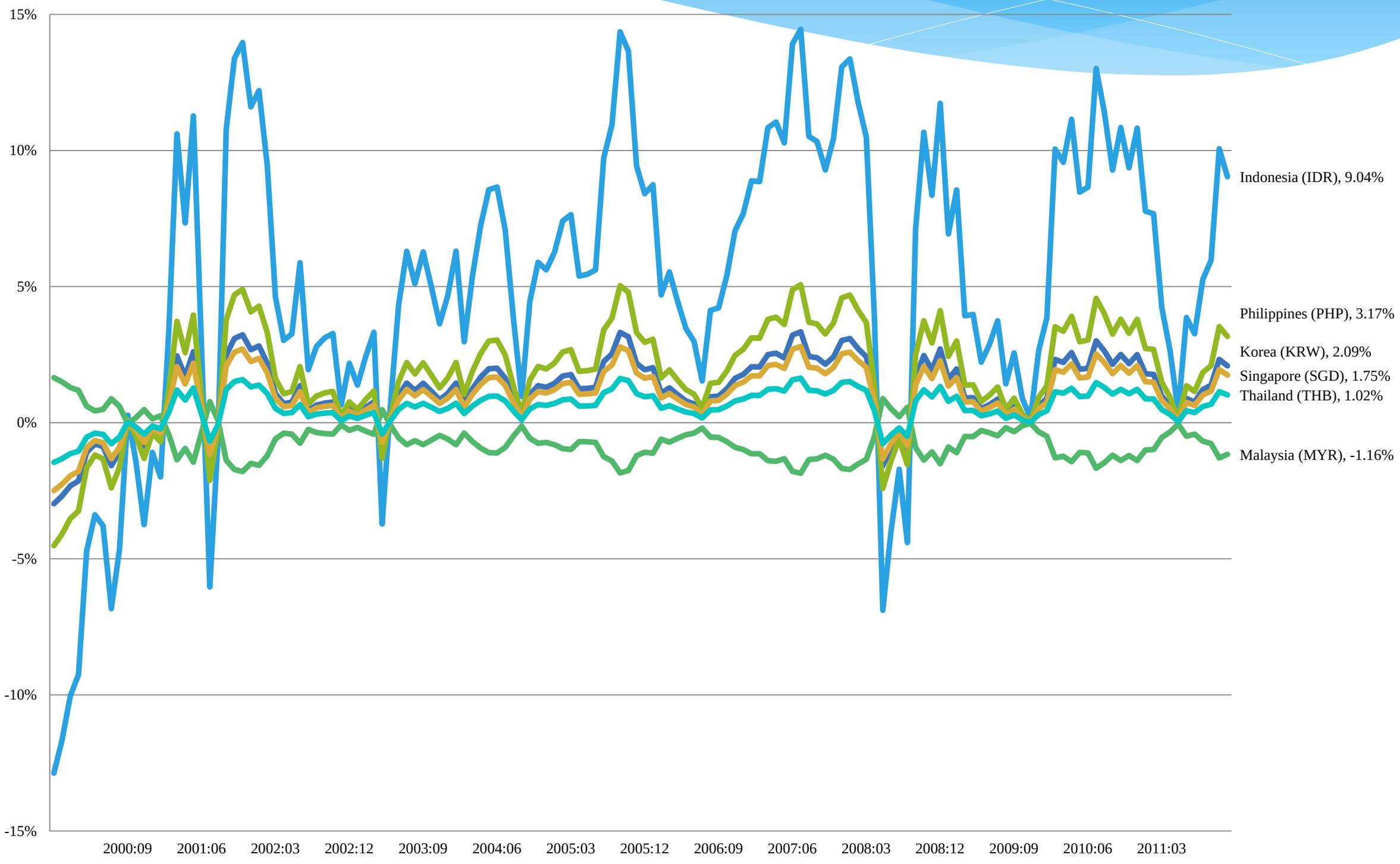


Figure 2b: Current Deviation Index for ASEAN5 + Japan

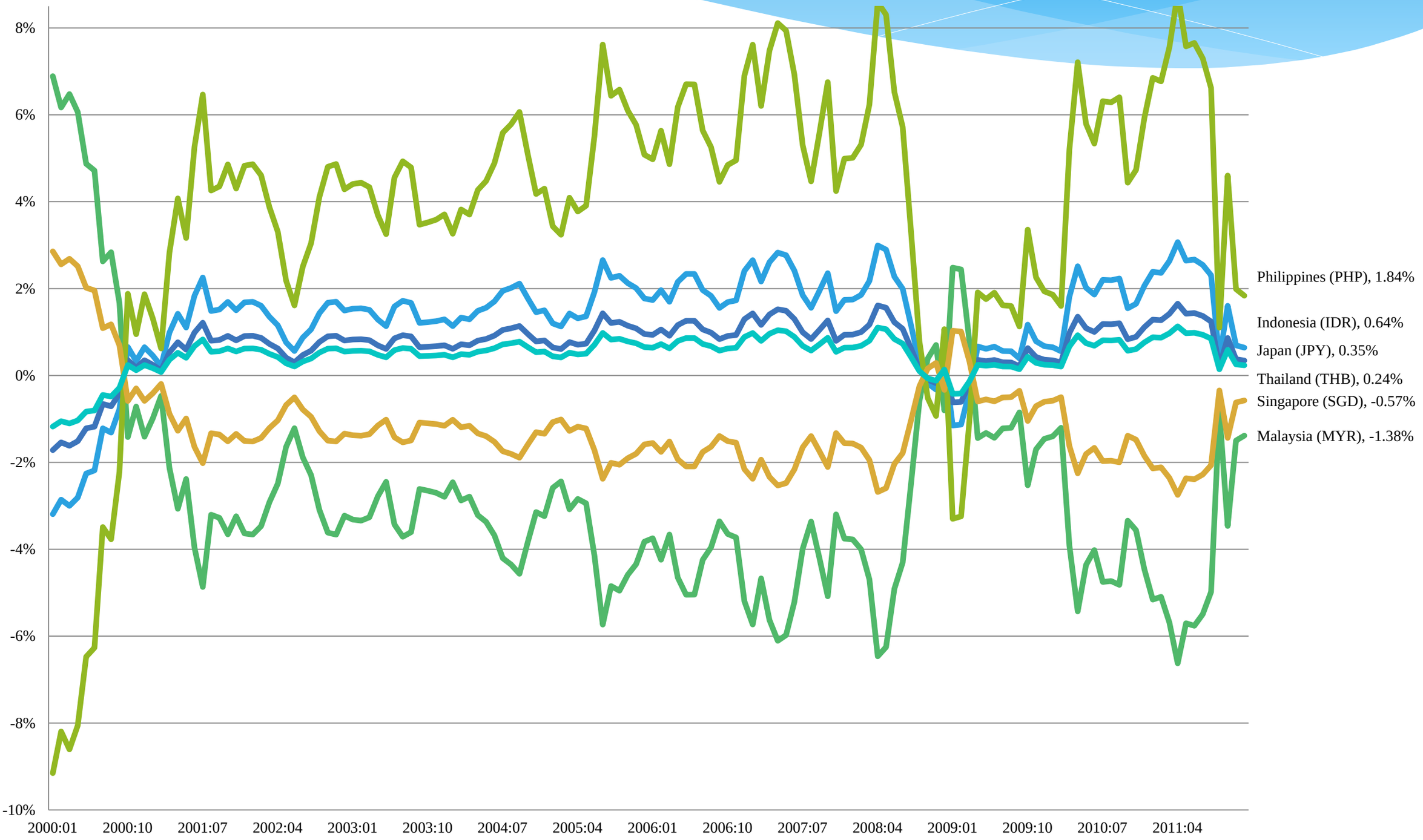


Figure 2c: Current Deviation Index for ASEAN5 + China + Korea

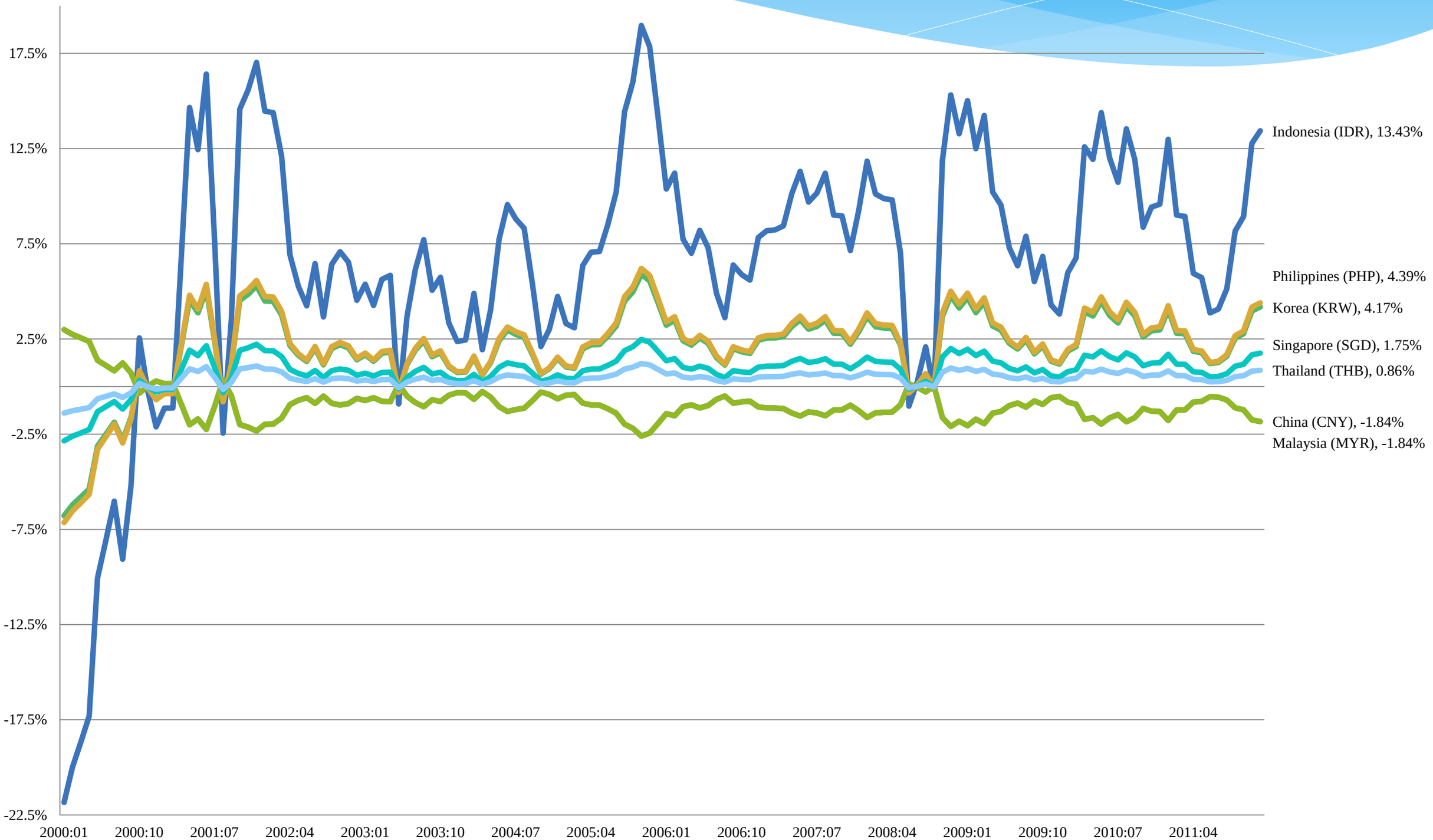


Figure 2d: Current Deviation Index for ASEAN5 + China + Japan

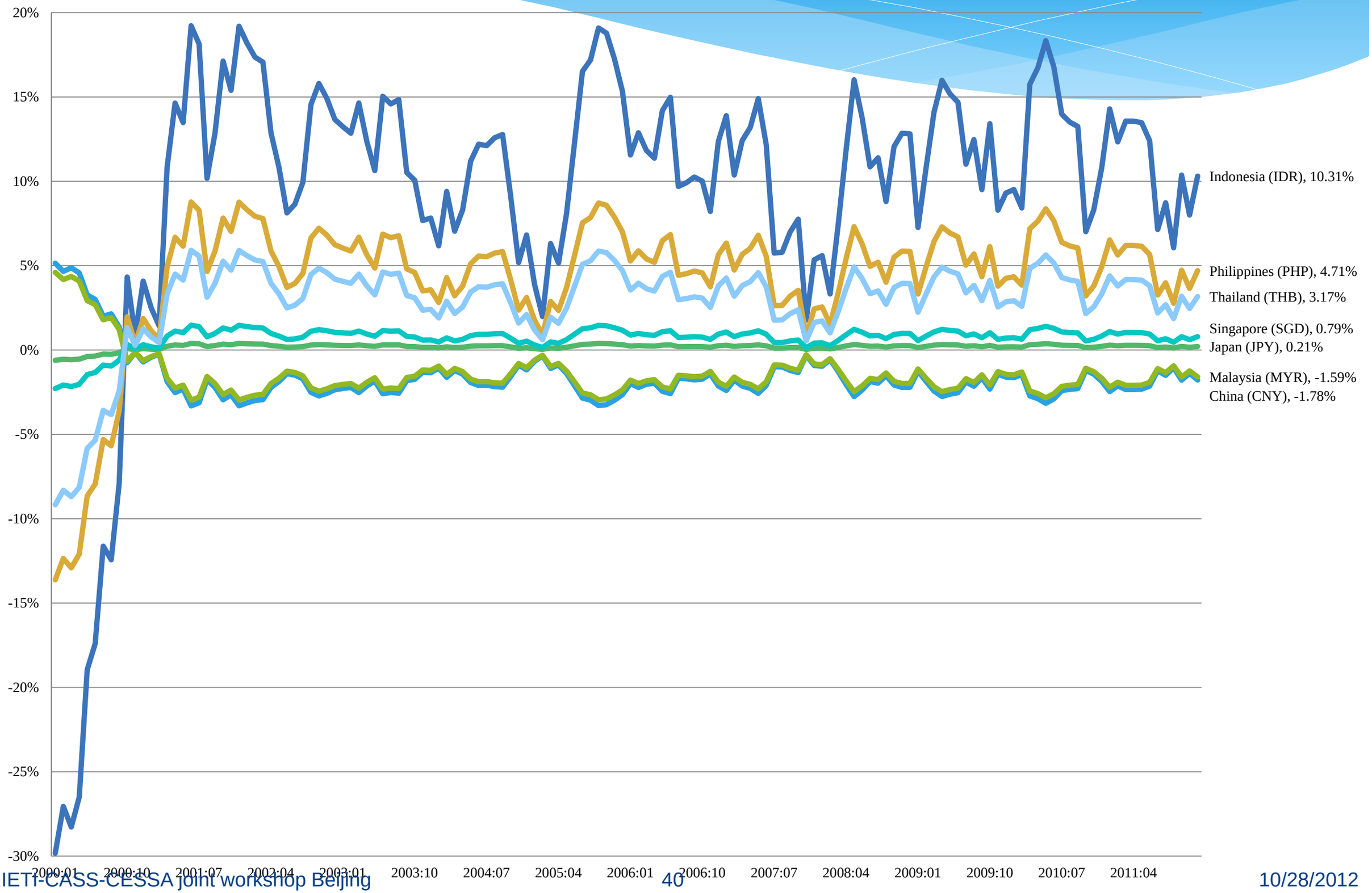


Figure 2e: Current Deviation Index for ASEAN5 + Korea + Japan

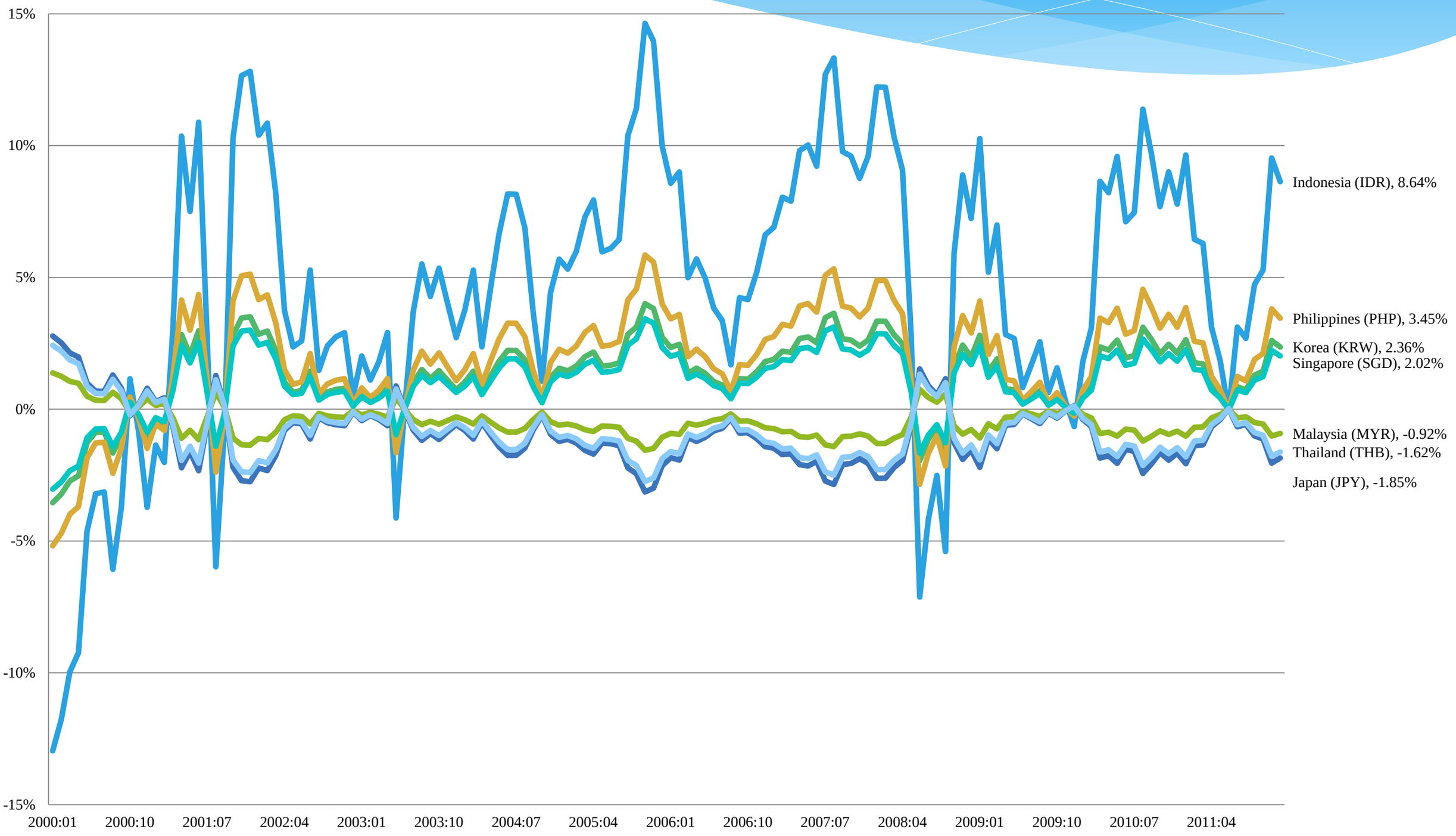
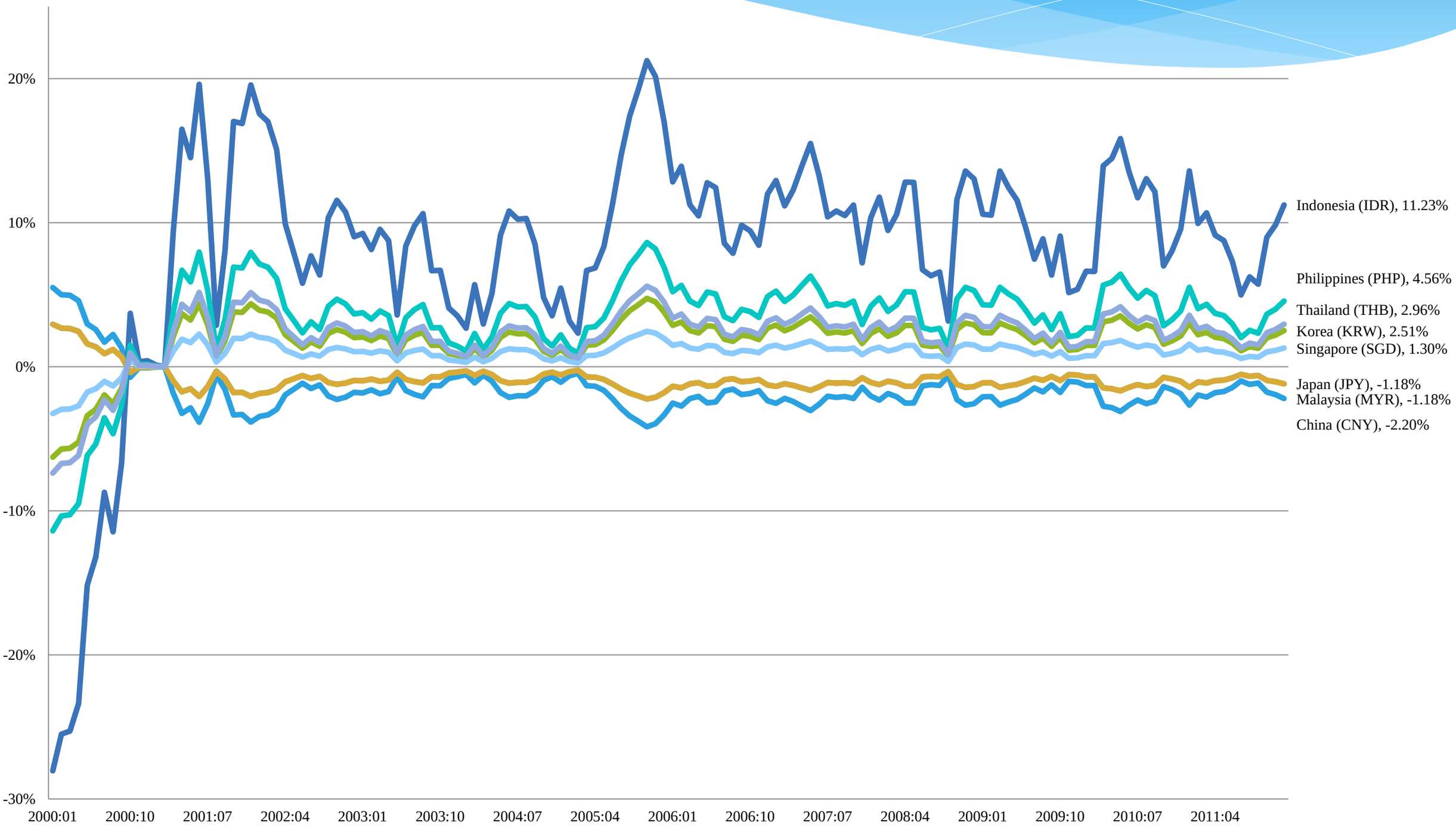


Figure 2f: Current Deviation Index for ASEAN5 + China + Korea + Japan



Summary of Figure 2s

* Temporal deviations calculated from Transitory components show that
  * Indonesian rupiah (IDR) tends to deviate temporally, not more than 20%,
  * Philippines peso (PHP) tends to deviate temporally, not more than 10%, and
  * Chinese yuan and Malaysian ringgit were very stable .
  * For IDR and PHP, temporal deviations continued for 4-6 years so often.
* The AMRO should focus on the issues why the correction of the deviation is slow.

Table 3a: Average of TDI and differences from DI (Case for the currencies of ASEAN5+Korea are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I	II	III	IV	2000:1-2011.2	I	II	III	IV
				2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2		2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2
Dominate	Indonesia	(IDR)	6.712%	0.902%	6.601%	6.960%	14.558%	32.174%	2.284%	19.779%	50.304%	64.665%
			(0.067173939)	(0.056400112)	(0.031053286)	(0.05546981)	(0.048337864)					
	Korea	(KRW)	2.741%	-0.239%	1.999%	1.647%	9.355%	3.020%	1.391%	-0.703%	-5.329%	21.701%
			(0.038880867)	(0.011451723)	(0.012804867)	(0.026245898)	(0.021922084)					
	Malaysia	(MYR)	0.884%	-0.773%	-0.154%	-0.839%	6.921%	2.105%	0.340%	3.730%	3.712%	0.197%
			(0.037661104)	(0.029493466)	(0.014308761)	(0.025883278)	(0.015685951)					
	Philippines	(PHP)	3.360%	-0.062%	2.716%	2.474%	10.166%	18.345%	2.878%	23.187%	22.383%	27.839%
			(0.041570255)	(0.01383795)	(0.014460298)	(0.029162197)	(0.025460383)					
	Singapore	(SGD)	2.549%	-0.295%	1.776%	1.389%	9.103%	-9.065%	-0.540%	-5.558%	-13.704%	-19.033%
			(0.038252125)	(0.011982288)	(0.012485686)	(0.025580314)	(0.02091628)					
	Thailand	(THB)	2.133%	-0.414%	1.293%	0.832%	8.558%	-3.686%	-0.091%	-0.793%	-4.274%	-11.634%
			(0.037270244)	(0.014871212)	(0.012172271)	(0.024606952)	(0.018952329)					
Dominated	Brunei	(BND)	-7.954%	-1.050%	-4.566%	-15.408%	-11.623%	-2.628%	-0.521%	-1.838%	-1.926%	-7.549%
			(0.079302957)	(0.079302957)	(0.079302957)	(0.079302957)	(0.079302957)					
	Cambodia	(KHR)	25.997%	0.436%	12.402%	36.220%	65.010%					
			(0.25243637)	(0.027607046)	(0.058905215)	(0.154725984)	(0.046815569)					
	China	(CNY)	2.689%	-1.012%	4.241%	2.412%	6.165%					
			(0.03742698)	(0.02979928)	(0.031622723)	(0.013737478)	(0.030735281)					
	Hong Kong	(HKD)	-0.873%	-2.113%	-7.031%	-2.311%	10.891%					
			(0.073136668)	(0.045856789)	(0.012967949)	(0.05142352)	(0.03300943)					
	Japan	(JPY)	-8.578%	1.884%	-6.804%	-6.077%	-28.849%					
			(0.122999024)	(0.057546731)	(0.051564683)	(0.065187323)	(0.073190476)					
	Lao	(LAK)	51.270%	9.664%	60.722%	68.071%	73.258%					
			(0.279387038)	(0.181225487)	(0.083318113)	(0.021702617)	(0.029411295)					
	Myanmmar	(MMK)	92.384%	16.151%	79.754%	127.127%	166.350%					
			(0.583949211)	(0.27865515)	(0.053166128)	(0.223225915)	(0.057244364)					
	Vietnam	(VND)	40.091%	2.178%	22.542%	51.760%	99.376%					
			(0.364207978)	(0.036777194)	(0.073511543)	(0.162705705)	(0.12238191)					

†: A value in the parenthesis indicates the standard value

Table 3b:Average of TDI and differences from DI (Case for the currencies of ASEAN5+Japan are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I	II	III	IV	2000:1-2011.2	I	II	III	IV
				2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2		2000:1-2002:12	2003:1-2005:!2	2006.1-2008.12	2009.1-20011.2
Dominate	Indonesia	(IDR)	-0.529%	0.101%	0.173%	0.767%	-4.116%	39.415%	3.085%	26.207%	56.497%	83.339%
			(0.023664477)	(0.006895175)	(0.00726503)	(0.024774925)	(0.015333331)					
	Japan	(JPY)	-1.107%	-0.073%	-0.576%	-0.092%	-4.639%	-10.099%	1.436%	-8.066%	-7.911%	-31.759%
			(0.022097681)	(0.007203823)	(0.006848026)	(0.021615112)	(0.011478681)					
	Malaysia	(MYR)	-4.483%	-1.088%	-4.953%	-5.111%	-7.700%	7.472%	0.655%	8.529%	7.984%	14.818%
			(0.036210798)	(0.048018406)	(0.011643581)	(0.011815349)	(0.021113294)					
	Philippines	(PHP)	1.808%	0.804%	3.204%	4.243%	-1.996%	19.897%	2.013%	22.698%	20.614%	40.001%
			(0.03852677)	(0.0341718)	(0.011808539)	(0.038434562)	(0.033498208)					
	Singapore	(SGD)	-2.902%	-0.613%	-2.903%	-2.760%	-6.266%	-3.614%	-0.222%	-0.879%	-9.555%	-3.664%
			(0.025722768)	(0.027859528)	(0.00823795)	(0.013436961)	(0.01017193)					
	Thailand	(THB)	-1.320%	-0.137%	-0.852%	-0.409%	-4.832%	-0.234%	-0.368%	1.352%	-3.034%	1.755%
			(0.021852511)	(0.009035319)	(0.006802775)	(0.020489166)	(0.010257517)					
Dominated	Brunei	(BND)	-10.949%	-0.652%	-6.289%	-16.153%	-24.094%	0.367%	-0.919%	-0.115%	-1.181%	4.921%
			(0.0947746)	(0.018025732)	(0.018402588)	(0.051978647)	(0.047870902)					
	Cambodia	(KHR)	23.002%	0.834%	10.678%	35.475%	52.539%					
			(0.210670366)	(0.0202986)	(0.065011131)	(0.120595056)	(0.03859221)					
	China	(CNY)	-0.306%	-0.614%	2.517%	1.667%	-6.305%					
			(0.042539046)	(0.018231108)	(0.025852664)	(0.041132218)	(0.019104497)					
	Hong Kong	(HKD)	-3.867%	-1.715%	-8.755%	-3.056%	-1.579%					
			(0.038136539)	(0.034976521)	(0.011953414)	(0.021899959)	(0.022214663)					
	Korea	(KRW)	5.394%	2.071%	1.412%	-2.501%	26.135%					
			(0.139282498)	(0.081144366)	(0.054221008)	(0.137306266)	(0.068555057)					
	Lao	(LAK)	48.276%	10.062%	58.999%	67.326%	60.787%					
			(0.26025015)	(0.186413841)	(0.086159837)	(0.034273124)	(0.018868954)					
	Myanmmar	(MMK)	89.390%	16.550%	78.030%	126.382%	153.880%					
			(0.550092597)	(0.285132147)	(0.063488239)	(0.194926959)	(0.046307416)					
	Vietnam	(VND)	37.096%	2.576%	20.819%	51.015%	86.905%					
			(0.32047917)	(0.039128805)	(0.076638916)	(0.126943703)	(0.11036543)					

A value in the parenthesis indicates the standard value

Table 3c: Average of TDI and differences from DI (Case for the currencies of ASEAN5+China+Korea are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I	II	III	IV	2000:1-2011.2	I	II	III	IV
				2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2		2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2
Dominate	China	CNY	1.053%	-0.939%	0.615%	-0.325%	6.293%	-0.993%	-0.594%	1.787%	0.810%	-7.677%
			(0.03594266)	(0.034373053)	(0.018508455)	(0.019272226)	(0.020410738)					
	Indonesia	(IDR)	8.483%	1.583%	8.712%	8.769%	17.342%	30.402%	1.602%	17.668%	48.495%	61.881%
			(0.079232593)	(0.09009536)	(0.040564665)	(0.045483206)	(0.037770856)					
	Korea	(KRW)	3.979%	0.054%	3.803%	3.256%	10.644%	1.782%	1.098%	-2.507%	-6.938%	20.412%
			(0.041655082)	(0.018652971)	(0.015462093)	(0.025121868)	(0.022102301)					
	Malaysia	(MYR)	1.053%	-0.939%	0.615%	-0.325%	6.293%	1.935%	0.506%	2.961%	3.198%	0.825%
			(0.03594266)	(0.034373053)	(0.018508455)	(0.019272226)	(0.020410738)					
	Philippines	(PHP)	4.086%	0.091%	3.920%	3.387%	10.803%	17.619%	2.726%	21.982%	21.470%	27.201%
			(0.042294535)	(0.020130924)	(0.015826578)	(0.025508499)	(0.022342097)					
	Singapore	(SGD)	2.802%	-0.346%	2.520%	1.815%	8.893%	-9.318%	-0.489%	-6.302%	-14.130%	-18.823%
			(0.036322802)	(0.011252962)	(0.013580291)	(0.021512207)	(0.020215858)					
	Thailand	(THB)	2.365%	-0.494%	2.044%	1.280%	8.243%	-3.918%	-0.011%	-1.544%	-4.723%	-11.320%
			(0.035304206)	(0.015340751)	(0.014040989)	(0.020546706)	(0.019912116)					
Dominated	Brunei	(BND)	-7.784%	-1.216%	-3.796%	-14.893%	-12.251%	-2.798%	-0.355%	-2.608%	-2.441%	-6.921%
			(0.064625424)	(0.022821519)	(0.013779408)	(0.03962477)	(0.031283576)					
	Cambodia	(KHR)	26.166%	0.270%	13.171%	36.735%	64.382%					
			(0.250003422)	(0.029538023)	(0.062402349)	(0.148622442)	(0.052158293)					
	Hong Kong	(HKD)	-0.703%	-2.279%	-6.262%	-1.797%	10.263%					
			(0.069870989)	(0.050918574)	(0.016747555)	(0.045485109)	(0.038016952)					
	Japan	(JPY)	-8.409%	1.718%	-6.034%	-5.562%	-29.477%					
			(0.124337239)	(0.053259802)	(0.045175344)	(0.070328817)	(0.067513438)					
	Lao	(LAK)	51.440%	9.498%	61.492%	68.585%	72.630%					
			(0.280340249)	(0.177026192)	(0.087573193)	(0.019117667)	(0.034960542)					
	Myanmmar	(MMK)	92.554%	15.985%	80.523%	127.641%	165.722%					
			(0.582598596)	(0.275049212)	(0.053947408)	(0.218560365)	(0.062905033)					
	Vietnam	(VND)	40.260%	2.012%	23.312%	52.274%	98.748%					
			(0.362044133)	(0.036098666)	(0.078403403)	(0.156327428)	(0.128091701)					

A value in the parenthesis indicates the standard value

Table 3d: Average of TDI and differences from DI (Case for the currencies of ASEAN5+China+Japan are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I	II	III	IV	2000:1-2011.2	I	II	III	IV
				2000:1-2002:12	2003:1-2005:12	2006.1-2008.12	2009.1-20011.2		2000:1-2002:12	2003:1-2005:!2	2006.1-2008.12	2009.1-20011.2
Dominate	China	CNY	-2.981%	-1.029%	-2.419%	-2.166%	-7.547%	3.042%	-0.504%	4.821%	2.651%	6.163%
			(0.034381426)	(0.039481889)	(0.011360788)	(0.024859432)	(0.010999199)					
	Indonesia	(IDR)	7.899%	3.734%	10.797%	10.027%	6.929%	30.987%	-0.548%	15.582%	47.237%	72.295%
			(0.0849551)	(0.1412935)	(0.042598463)	(0.037528499)	(0.033349594)					
	Japan	(JPY)	-1.192%	-0.246%	-0.246%	-0.161%	-5.166%	-10.015%	1.609%	-8.397%	-7.842%	-31.232%
			(0.024334202)	(0.01073794)	(0.007308733)	(0.022947825)	(0.009335778)					
	Malaysia	(MYR)	-2.812%	-0.955%	-2.214%	-1.977%	-7.323%	5.801%	0.522%	5.791%	4.850%	14.441%
			(0.033166013)	(0.036713661)	(0.010771425)	(0.024610407)	(0.010700204)					
	Philippines	(PHP)	2.857%	1.527%	4.672%	4.376%	0.220%	18.848%	1.290%	21.230%	20.481%	37.785%
			(0.039453062)	(0.057828687)	(0.019872451)	(0.025327033)	(0.017222295)					
	Singapore	(SGD)	-0.670%	-0.017%	0.388%	0.424%	-4.472%	-5.846%	-0.817%	-4.170%	-12.739%	-5.457%
			(0.023182485)	(0.005070475)	(0.007583413)	(0.022723646)	(0.009585456)					
	Thailand	(THB)	1.472%	0.920%	2.990%	2.824%	-1.622%	-3.026%	-1.426%	-2.490%	-6.267%	-1.455%
			(0.02945995)	(0.035017411)	(0.014075234)	(0.023494285)	(0.013429203)					
Dominated	Brunei	(BND)	-10.936%	-0.920%	-5.758%	-15.745%	-24.917%	0.354%	-0.651%	-0.646%	-1.589%	5.744%
			(0.096316782)	(0.019447506)	(0.012082112)	(0.05592103)	(0.041933515)					
	Cambodia	(KHR)	23.014%	0.566%	11.209%	35.883%	51.716%					
			(0.208807197)	(0.021349188)	(0.068560044)	(0.115541846)	(0.043566896)					
	Hong Kong	(HKD)	-3.855%	-1.983%	-8.224%	-2.649%	-2.402%					
			(0.038214115)	(0.0421943)	(0.012542358)	(0.022428176)	(0.026800805)					
	Korea	(KRW)	5.407%	1.803%	1.942%	-2.093%	25.312%					
			(0.132248832)	(0.074316785)	(0.050156324)	(0.130096099)	(0.06395662)					
	Lao	(LAK)	48.288%	9.794%	59.530%	67.733%	59.964%					
			(0.261599258)	(0.180545938)	(0.090631263)	(0.040939742)	(0.02414432)					
	Myanmmar	(MMK)	89.402%	16.282%	78.561%	126.789%	153.057%					
			(0.54863504)	(0.279760305)	(0.064125695)	(0.190876628)	(0.051597367)					
	Vietnam	(VND)	37.108%	2.308%	21.350%	51.422%	86.082%					
			(0.318578086)	(0.035948037)	(0.081786006)	(0.121236013)	(0.116169698)					

†: A value in the parenthesis indicates the standard value

Table 3e: Average of TDI and differences from DI (Case for the currencies of ASEAN5+Korea+Japan are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I 2000:1-2002:12	II 2003:1-2005:12	III 2006.1-2008.12	IV 2009.1-20011.2	2000:1-2011.2	I 2000:1-2002:12	II 2003:1-2005:!2	III 2006.1-2008.12	IV 2009.1-20011.2
Dominate	Indonesia	(IDR)	3.878% (0.051107171)	1.323% (0.069363268)	4.741% (0.031287922)	5.098% (0.047679173)	4.597% (0.034158621)	35.008%	1.863%	21.639%	52.166%	74.626%
	Japan	(JPY)	-1.737% (0.016266279)	-0.209% (0.015065411)	-2.226% (0.012509737)	-2.575% (0.012998941)	-2.054% (0.012048804)	-9.469%	1.572%	-6.416%	-5.429%	-34.344%
	Korea	(KRW)	0.518% (0.012969349)	0.407% (0.019084643)	0.573% (0.008021757)	0.507% (0.012303463)	0.618% (0.008448073)	5.243%	0.745%	0.724%	-4.189%	30.438%
	Malaysia	(MYR)	-1.238% (0.011087017)	-0.072% (0.007749994)	-1.606% (0.009336511)	-1.892% (0.008073151)	-1.462% (0.008530703)	4.226%	-0.360%	5.183%	4.765%	8.581%
	Philippines	(PHP)	1.103% (0.019257455)	0.566% (0.027803347)	1.298% (0.01153306)	1.306% (0.01832473)	1.310% (0.012581348)	20.602%	2.251%	24.605%	23.551%	36.695%
	Singapore	(SGD)	0.336% (0.011144965)	0.357% (0.01637835)	0.347% (0.007123042)	0.259% (0.010479046)	0.402% (0.007294278)	-6.853%	-1.192%	-4.129%	-12.574%	-10.332%
	Thailand	(THB)	-1.612% (0.014921995)	-0.175% (0.013213796)	-2.071% (0.011683758)	-2.404% (0.01173146)	-1.906% (0.011137244)	-12.569%	-1.161%	-5.987%	-16.184%	-31.970%
Dominated	Brunei	(BND)	-10.075% (0.086227874)	-0.349% (0.020181492)	-6.018% (0.023834691)	-16.461% (0.04396901)	-20.007% (0.054260957)	-0.507%	-1.222%	-0.386%	-0.874%	0.834%
	Cambodia	(KHR)	23.875% (0.222734363)	1.137% (0.02175688)	10.950% (0.057472805)	35.167% (0.138403712)	56.626% (0.032070823)					
	China	CNY	0.567% (0.024372929)	-0.311% (0.010428317)	2.789% (0.019515655)	1.359% (0.021024667)	-2.218% (0.012630985)					
	Hong Kong	(HKD)	-2.994% (0.045074081)	-1.413% (0.025532333)	-8.483% (0.012113215)	-3.364% (0.033930778)	2.508% (0.017368375)					
	Lao	(LAK)	49.149% (0.263586354)	10.365% (0.194033405)	59.270% (0.079232747)	67.018% (0.021878043)	64.874% (0.012714321)					
	Myanmmar	(MMK)	90.263% (0.560002144)	16.852% (0.291662083)	78.302% (0.057253475)	126.074% (0.209116633)	157.967% (0.041849219)					
	Vietnam	(VND)	37.969% (0.33310441)	2.878% (0.045092286)	21.090% (0.068189615)	50.707% (0.145560851)	90.992% (0.104679608)					

†: A value in the parenthesis indicates the standard value

Table 3f: Average of TDI and differences from DI (Case for the currencies of ASEAN5+China+Korea+Japan are cointegrated)

Currencies			Average of the TDI †					Differences from DI				
			2000:1-2011.2	I 2000:1-2002:12	II 2003:1-2005:12	III 2006.1-2008.12	IV 2009.1-20011.2	2000:1-2011.2	I 2000:1-2002:12	II 2003:1-2005:!2	III 2006.1-2008.12	IV 2009.1-20011.2
Dominate	China	CNY	-1.948%	-0.611%	-1.808%	-2.613%	-3.061%	2.009%	-0.922%	4.211%	3.099%	1.677%
			(0.017970091)	(0.026971149)	(0.010486653)	(0.004920417)	(0.006472813)					
	Indonesia	(IDR)	7.821%	3.166%	9.085%	10.276%	9.214%	31.065%	0.019%	17.295%	46.988%	70.009%
			(0.083224834)	(0.137890744)	(0.050183708)	(0.02698218)	(0.030411251)					
	Japan	(JPY)	-1.204%	-0.323%	-0.979%	-1.632%	-2.127%	-10.002%	1.686%	-7.663%	-6.371%	-34.271%
			(0.010681758)	(0.014422688)	(0.005887949)	(0.003000823)	(0.003840309)					
	Korea	(KRW)	1.481%	0.715%	2.015%	1.910%	1.247%	4.280%	0.437%	-0.718%	-5.592%	29.809%
			(0.018331189)	(0.030893257)	(0.010841715)	(0.006960663)	(0.006793709)					
	Malaysia	(MYR)	-1.204%	-0.323%	-0.979%	-1.632%	-2.127%	4.193%	-0.110%	4.555%	4.505%	9.245%
			(0.010681758)	(0.014422688)	(0.005887949)	(0.003000823)	(0.003840309)					
	Philippines	(PHP)	2.971%	1.291%	3.676%	3.876%	3.119%	18.734%	1.526%	22.226%	20.981%	34.885%
			(0.033445897)	(0.056037048)	(0.020080982)	(0.011579735)	(0.012289815)					
	Singapore	(SGD)	0.601%	0.375%	1.034%	0.749%	0.141%	-7.117%	-1.209%	-4.816%	-13.064%	-10.071%
			(0.009741128)	(0.016042103)	(0.005400299)	(0.004386663)	(0.003677894)					
	Thailand	(THB)	1.804%	0.840%	2.375%	2.337%	1.654%	-3.358%	-1.345%	-1.875%	-5.780%	-4.730%
			(0.021584153)	(0.036349674)	(0.012845507)	(0.007947963)	(0.007975745)					
Dominated	Brunei	(BND)	-10.042%	-0.600%	-5.391%	-16.201%	-20.671%	-0.540%	-0.971%	-1.013%	-1.134%	1.499%
			(0.086464393)	(0.017941924)	(0.016942509)	(0.045852135)	(0.049095409)					
	Cambodia	(KHR)	23.908%	0.886%	11.577%	35.427%	55.962%					
			(0.220206303)	(0.018402375)	(0.060526681)	(0.13242118)	(0.035597066)					
	Hong Kong	(HKD)	-2.961%	-1.663%	-7.856%	-3.104%	1.844%					
			(0.041529261)	(0.032451222)	(0.008460182)	(0.02859812)	(0.020457103)					
	Lao	(LAK)	49.182%	10.114%	59.897%	67.278%	64.210%					
			(0.264178797)	(0.187696927)	(0.083632805)	(0.024384066)	(0.016346959)					
	Myanmmar	(MMK)	90.296%	16.601%	78.929%	126.334%	157.303%					
			(0.558339726)	(0.286172684)	(0.05711748)	(0.204949867)	(0.046694131)					
	Vietnam	(VND)	38.002%	2.627%	21.717%	50.967%	90.328%					
			(0.330944962)	(0.040507854)	(0.073332682)	(0.139423074)	(0.109914062)					

†: A value in the parenthesis indicates the standard value

Summary of Table 3s

* Deviations of the Indonesia rupiah from the benchmark of the RMU DI tends to be over-estimated at more than 30% in the full sample period.
* Deviations of the Philippines peso from the benchmark of the RMU DI tends to be over-estimated at more than 17%,
* Deviations of the Singapore dollar and the Thai baht tend to be under-estimated about 3-11%,
* Deviations of the Japanese yen are also under-estimated if the Japanese yen is included as a dominate currency, and
* Deviations of dominated currencies are not suffered much from the temporal deviations of dominate currencies.

Conclusions

* For an empirical analysis, accumulation of historical data is required, and hence, it might be **impossible to forecast the beginning of an economic crisis** with timeliness and accuracy.
* However**, the sequential unit root test for the RMU DI employed here can detect the beginning of overvaluation**, which usually happens several years before the sudden rapid depreciation of the currency in a crisis. By applying econometric methodologies to the RMU DI, we can detect changes in the determinant of exchange rates, e.g., innovative changes in real economies or unexpected booms in the market as the beginning of a bubble.
* Monitoring of the RMU DI, as well as the nominal exchange rates against the USD, should be **helpful for raising an alert for a possible large correction in the future**, and hence, the RMU DI can be a useful surveillance tool.

Conclusions (cont.)

* The RMU DI such as the AMU DI is a better indicator for exploiting the information for deviation and mean reversion.
* Employing the RMU DI the surveillance unit such as the AMRO can detect an early-warning signal of deviation from the mean and the possibility of large corrections ahead.
* However, it is important to monitor and update the time-varying coefficients of exchange rate movement using higher frequency data of exchange rates and the policy/market variables,
* By employing the efficient tools for the economic surveillance to strengthen the soundness of economic structures, the governments of East Asian countries will be able to take further steps for regional financial cooperation from now onward.