# Stock Price and Industrial Production in Developing Countries: A Dynamic Heterogeneous Panel Analysis

Masih, Mansur and Majid, Hamdan Abdul

INCEIF, Malaysia, INCEIF, Malaysia

25 November 2013

# Stock Price and Industrial Production in Developing Countries: A Dynamic Heterogeneous Panel Analysis

**Mansur Masih**[1*]

**Hamdan Abdul Majid** [2]

**Abstract**

As an investor, we are interested in the relationship between economic and financial indicators. For this, for the investor, it is of utmost importance to identify the correct model for the long run and short run relationship, as this will determine the timing of entering and exiting the stock market. In this paper we investigate the correlation between the real stock price and the real industrial production index. The estimation of correlation coefficient would involve the panel data of nine (9) developing countries, including the four (4) BRIC countries, using data for the period 2008 to 2010. We employed the panel unit root test and panel cointegration tests using Eviews. We then proceed with the estimation of Fixed Effect (FE), Random Effect (RE), Pool Mean Group (PMG) and the Mean Group (MG) using Stata II command. The application of the heterogeneous panel model of Pool Mean Group (PMG) and the Mean Group (MG) – Im,Pesaran,Smith (IPS,1999) will allow for the heterogeneity effect among the different economies. Our findings proved that RE is superior to FE due to the inconsistency problem, which is the existence of correlation between missing cross sectional variables with the explanatory/regressor variables. The Hausman test performed supported this finding. We observed that the slope coefficients indicate a negative relationship between real industrial production and real stock price. Again, although both PMG and MG are consistent, Hausman test proved that MG is inefficient, and thus PMG is chosen for the final estimation. Finally, while we found out that in the short run the coefficient of industrial production varies with each country, they were the same in the long run.

**Keywords**: Stock price; industrial production; panel unit root test; panel co-integration test; long run model estimation; random effect; pool mean group

1. Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100, Kuala Lumpur, Malaysia,

*Corresponding Author: mansurmasih@inceif.org

2. Ph.D. student at INCEIF.

## Introduction

The relationship between stock price and economic growth has been debated immensely in financial and economic development fraternities. Asset prices are commonly known to react sensitively to economic news. Daily experience seems to support the view that individual asset price are influenced by a wide variety of unanticipated events and that some economic events have more pervasive effect on asset price than others. Innovations in macroeconomic variables are risks that are rewarded in the stock market. Financial theory suggests that the following macroeconomic variables should systematically affect stock market returns (Chen *et al*,1999);

1. The spread between long and short interest
2. Expected and unexpected inflation
3. Industrial production and
4. The spread between high and low grade bond

History has proven that economic growth is the exogenous factor that has pushed the financial revolutions. When the VoC (Dutch East India Company) ventured to the new world in 1609, they introduced joint-stock companies with non-redeemable capital. These financial innovations formed the basis of liquidity in equity market. As recently, the link between liquidity and economic development had arisen because of some high return projects that require a long run capital commitment. However, investors are not savers. They do not like to relinquish control of their savings for long periods, as this will expose them to unnecessary risks. Thus, if economic growth does not augment the liquidity of long term investment, less investment is likely to occur in the high return economic projects. Indeed industrial revolution in England facilitated the innovation in financial engineering whereby liquidity was made mobile to expand innovation further. However, through my readings, consensus with regard to econometric tests has been lacking regarding the long run as well as short term correlations involving panel data. We pose to ourselves these questions, which we will try to find the answers through this study:

1. **To determine the best model for the estimation of the long run and the short run relationship of the real industrial production and the real stock price of the of the panel data under study and**
2. **To determine the correlation between real industrial production and the real stock price of the group of countries and the individual country under study**

Thus, the main objective of our study here is to pool together cross sectional data that differs across nine individual countries (panel) of Malaysia, China, Egypt, India, Indonesia, South Korea, Philippines, Russia and Turkey. Our paper differs from previous studies by applying the new dynamic heterogeneous panel unit root and panel co-integration test to examine the relationship between financial development (stock price) and growth (Industrial production index) across the nine emerging/developing countries.

Our paper is organised as follows; Section 2 – Econometric Methodology - Data and Model Specification, Section 3 – Empirical Results and Section 4 – Conclusions

## 1. Econometric Methodology – Data and Model Specification

All good research work would involve the part of science (the mechanics) and the part of art (the interpretation). Science usually tries to decompose complicated interlaced interactions into simpler parts (elementary bricks), analyse them separately and finally to reconstruct the whole chain from these simple parts. Thus, we will follow the sequence and try to find a simplistic explanation to result obtained via the complex mechanics involved.
We obtained the monthly stock index (price) and industrial production index (growth) data of nine countries from the Datastream for the period of January 2008 to December 2010 for a total of 36 observations (36 months) . The countries chosen are from the emerging economies of MENA (Egypt and Turkey), Asian (China, South Korea and India), South-East Asia (Malaysia, Indonesia, Philippines) and Russia. As we will be using the real stock index and real industrial production index, we thus divide both, monthly stock price index and monthly industrial production index with the inflation rate (of each individual country).

| | | |
|---|---|---|
| ***rsp*** | real stock price | = (stock price / inflation) |
| ***rip*** | real industrial production | = (industrial production index/inflation) |

The first step in the empirical analysis is to investigate the stochastic properties of the time-series involved. Hence, we performed unit root tests on a per country basis. However, it is noted here that the power of the individual unit root tests can be severely distorted when the sample size is too small (or the span of data is too short), as in our case of panel data. For this reason, we need to combine the information across countries and perform the panel unit root tests. Then we use the Johansen co-integration tests to determine whether the relationships are spurious or structural. Again, the power of the Johansen panel unit root tests can be severely distorted in a multivariate systems with small samples sizes like ours. And for this reason, we will combine the information again and perform the panel co-integration tests. Finally, when we are satisfied that the relationships are structural by testing, we will proceed to estimate using fully modified OLS (Ordinary Least Squares). The reason of using modified OLS rather than ordinary OLS is to estimate the cointegration vector for the heterogeneous cointegrated panels, to correct the standard OLS for the **bias** induced by the endogeneity and serial correlation of the regressors. Finally, we specify and estimate an error correction model appropriate for the heterogeneous panels, which distinguishes between long-run and short-run .

**The Model Specifications**

Any panel data would involve *i=1,…..,N* and *t=1,…..,T*, where *i* represents the number of countries and *t* represents the period of data studied. In the estimation process of the panel data, there will be four critical assumptions of panel analysis with respect to the degree of homogeneity (same, without changing) across panels. They are;

i. **intercept**
ii. **error variances**
iii. **short run coefficients (elasticity) and**
iv. **the long run coefficients.**

By relaxing each assumption, it will increase the degree of accuracy nearer to the real world. This is especially true, since the allowance for the heterogeneity effects (in the estimation across panels} will accommodate the differences and uniqueness operations for each economy (the reality). Here, we will show how the relaxation for these assumptions, through the Fixed Effect (FE) model, Random Effect(RE), pool mean group PMG) and mean group (MG) estimator. The estimation for the FE and RE model will be estimated via ***Eviews*** statistical package, while PMG and MG model will be estimated through special command of ***Stata*** namely ***xtpmg*** as proposed by the Blackburne and Frank (2007).

From the literature, we can show that the general function that explains the growth of the economy is a factor of financial growth as below:

*RSP = f(RIP)*

From the above model, the long run model for the panel illustrated is as follows:

$$RSPit = \mu it + \beta tRIPit + \varepsilon it \qquad (1)$$

Where *i* represent cross-sections data and *t* represents number of periods t= 1,2,...,36 months from 12/01/2008 to 12/12/2010. If the variables are ***I***(1) and cointegrated, then the stationary term is ***I***(0) for all panels.

**Fixed Effect (FE) and Random Effect (RE) Model**

The FE model is also known as the least squares dummy variables. As the name suggest, it requires inclusion of dummy variables as a tool, to detect variation in the **intercept** across units. FE model imposes most restrictive constraints (towards the homogeneity) to all four assumptions except the intercept for each cross section. To estimate the FE and RE, the equation can be represented follows:

$$RSPit = \mu it + \beta tRIPit + \varepsilon it$$

$$\boldsymbol{RSPit = \mu i + \beta 1tRIPit + \gamma 2\omega 2t + \delta 2Zi2 + \varepsilon it} \qquad (2)$$

Where

$$\omega_{it} = \begin{cases} 1, \text{ for } i^{th} \text{ individual , } i=2,3,4 \\ 0, \text{ for otherwise} \end{cases}$$

$$Z_{it} = \begin{cases} 1, \text{ for } t^{th} \text{ time period , } t=2,3,....,T \\ 0, \text{ for otherwise} \end{cases}$$

$\gamma$ is the coefficient for dummy $\omega_{it}$ and $\delta$ becomes coefficient for $Z_{it}$. In order to avoid any event of singular matrix problem, the number of dummy variables allowed to be incorporated in the model is (N-1) + (T-1). One group will be selected as control group.

From (2), by allowing changes in the constant term ($\mu_i$) across panels, the distinctness in group specific estimated in FE model can be realized through the dummy. But, the validity on the inclusion of such dummy in the equation needs to be assessed by the standard global F-test. The null hypothesis that applicable for the FE model as follows:

$$\mathbf{H_0: \mu_{1=}\ \mu_2}$$

The null hypothesis above implies **homogeneity** of the constant term for each country.

On the other hands, by **relaxing the assumption on the common effect of error variance** among groups, the RE model can be estimated. This can be done when the constant term regarded as the 'random parameter' and not as 'fixed parameter' as documented in FE model. So, the variability of the constant term for each group can be represented as follows:

$$\boldsymbol{\mu_i = \mu + \alpha_i + v_t}$$

where $\alpha_i \sim N(0, \sigma^2_\alpha)$ = cross section error component (variation between group)

$v_t \sim N(0, \sigma^2_v)$ = time series error component (variation within individual group)

$\omega_i \sim N(0, \sigma^2_\omega)$ = combined error component

The deviation from mean will be equated with the error term as follows;

$$\boldsymbol{e_{it} = \alpha_i + v_t + \omega_i}$$

From model in (1), the model for RE model can be represented as follows;

$$RSPit = \mu it + \beta tRIPit + (\alpha i + vi + \omega it)$$

The RE model is perceived to be superior to FE model supported by the fact that RE model allows interactions of error variation within and among groups. The estimation of parameter will be conducted through GLS. This estimation can be done via 2SLS procedure where the residuals from OLS of the pooled observations become the input for the calculation of variance component. Subsequently, the variance component will be used to estimate the parameter via generalized least square (GLS). Besides that, according to Asteriou and Hall (2007), the RE requires smaller number of parameters and allows for additional explanatory variables where the number of observations must be equal within group. But, the limitation of the random error lies on its strict assumptions that the explanatory variables and missing cross sectional characteristics (random error component) **is not correlated** (which is hard to be satisfied for raw panel data).

For the dynamic panels, the bias is inexorable in simple OLS estimator, FE model and random effect model. The nature of dynamic model that incorporates the lagged terms of dependent/endogeneous/regressand variable in the right hand side, creates 'correlation' problem between the regressors and error term. For example, given dependent variable as $Y_{it}$, so $Y_{it}$ is a function of individual specific effect $\mu_i$ either random or fixed. So, logically the lagged term, $Y_{i,t-1}$ also is function of $\mu_i$. This phenomenon creates **bias** in the sense that the lagged regressor $Y_{i,t-1}$ will be **correlated** with the error term and makes the estimator becomes **bias** and **inconsistent.** The bias also remains for the heterogeneous panel data which makes estimator bias and inconsistent even when the number of the cross sections and observations are large. The solution for the heterogeneity bias can be solved through PMG and MG estimation as introduced by Pesaran, Shin and Smith (1999).

**Pool Mean Group (PMG) and Mean Group (MG)**

PMG technique is pooling the long run parameters while avoiding the inconsistency problem flowing from the heterogeneous short run dynamic relationships. Plus, the PMG relax the restriction on the common coefficient of short run while maintain the assumption on the homogeneity of long run slope. The estimation of the PMG requires reparameterization into error correction system.

The long run model in (1) will be transformed into the auto-regressive distributed lags ARDL (1,1,1) dynamic panel specification as follows:

$$RSPit = \mu it + \lambda RSPi,t-1 + \beta tRIPit-1 + \varepsilon it \quad (3)$$

By putting changes sign to the RSP, the model (3) becomes

$$\Delta \boldsymbol{RSPit = \mu it + (\lambda\text{-}1)RSPi,t\text{-}1 + \beta tRIPit\text{-}1 + \varepsilon it} \quad (4)$$

From (4), by normalizing each coefficient of the right hand side variables by the coefficient of the $RSP_{t-1}$, i.e ($\lambda_i$-1) or -(1-$\lambda_i$) since $\lambda_i$<1,

Let $\phi_i = -(1-\lambda_i)$

$$\theta_{0i} = \frac{\mu_i}{1-\lambda_i} \qquad \theta_{1i} = \frac{\beta_{10i} + \beta_{11i}}{1-\lambda_i} \qquad \theta_{2i} = \frac{\beta_{20i} + \beta_{21i}}{1-\lambda_i} \qquad \theta_{3i} = \frac{\beta_{30i} + \beta_{31i}}{1-\lambda_i}$$

By considering the normalized long run coefficient of (4), the error correction reparameterization of (4) will be;

$$\Delta RSPit = \underbrace{\mu it + \phi i(RSPi,t\text{-}1 - \theta 0i - \theta 1iRIPit)}_{\text{Long run relations}} + \underbrace{\beta t\Delta RIPit + \varepsilon it}_{\text{Short run dynamics}} \quad (5)$$

The MG estimator can easily computed from the long run coefficient of parameters from the average of the parameter value for individual groups. For instance, the dynamic specification as follows;

$$\boldsymbol{RSPit = \mu it + \lambda RSPi,t\text{-}1 + \beta tRIPit + \varepsilon it} \quad (6)$$

The long run parameter coefficient for equation above will be;

$$\theta_{1i} = \frac{\beta_{1i}}{1-\lambda_i} \quad (7)$$

So, the whole long run parameter will be represented as average of long run parameter across group as follows;

$$\bar{\theta} = \frac{1}{N}\sum_{i=1}^{N}\theta_i \qquad \bar{\mu} = \frac{1}{N}\sum_{i=1}^{N}\mu_i \quad (8)$$

When the number of groups and cross sections is considerably large, the estimator for MG will be efficient even when the series ***I(1)***. But the estimator tends to be bias and misleading when the number of time series observations is minuscule.

The estimation of PMG and MG will be based on the model (5). From the error correction model of (5), the primary interest is to see the long run coefficient (i.e $\theta_{1i}$ , $\theta_{2i}$ , $\theta_{3i}$ and $\theta_{4i}$). The long run coefficient provides information on the **elasticity** of RIP factor towards the RSP across different country stock market. For sure, due to the uniqueness of the operation for each country, the coefficient for each factors might varies across the panels. As the coefficient provides long term equilibrium, it contains the theoretical information which is very important for each country's policy making and its implications. The error correction speed adjustment, $\phi_i$ also provides significant information to the investors. The $\phi_i$ in equation (5) provides information on how long is needed for the short run dynamics to return to long run equilibrium. In normal situation, the short run coefficient usually will stay away from the long run equilibrium due to seasonality effect (noise), such economic boom or bust. But normally this temporaneous effects as explained by the short run dynamic result will eventually return to the long run equilibrium. The positive sign of the $\phi_i$ implies return to the long run relationships (Blackburne and Frank, 2007) from points above the regression line. The negative sign also shows the return to long run equilibrium but in opposite direction (from below). The ϕi is expected to be statistically significant as the insignifant coefficient of $\phi_i$ (i.e $\phi_i$=0) implies the absence of long run equilibrium. When the long run equilibrium do not exist, there's no theoretical information can be extracted from the analysis.

## 2. Empirical Findings

### Panel Unit Root Test

The treatment for stationary test for panel data is quiet distinct with the prevailing unit root test on univariate time series. As the panel estimation involves cross section, the test still adopt the common residual based approach and **Johansen Maximum likelihood (ML)** approach but with additional function to cater for the heterogeneity effect across groups. Currently, there are several methods for panel unit root test. They include Levin–Lin–Chu (LLC) test, Harris–Tzavalis test, Breitung test, Im–Pesaran–Shin (IPS) test and Fisher-type tests (combining p-values). According to Levin, Lin and Chu (2002), the LLC test uses pooled ADF test to cater for the heterogeneity effect across different sections in the panel. But, the LLC test subject to several assumptions such the autoregressive coefficient for the lagged dependent variable is homogenous across all groups of the panels and the LLC assumes the individual processes are cross sectionally independent. This constraint seems to be irrelevant since it neglects the significant of distortions due to the correlation between units. Given by this constraint on the LLC, we decide to conduct panel unit root test for all variables with the Im-Pesaran-Shin (IPS) test which can authorize for heterogeneity in dynamic panels.

According to **Im-Pesaran-Shin (1997**), the hypothesis testing being conducted by using two statistics namely LR-bar and t-bar which computed based on the average of the statistics gained from individual test. The t-bar test will be based on the ADF statistics while for the LR-bar test will be depend on log likelihood ratio test. From the *Eviews 6* package, only the t-bar test will be conducted given by the fact that the t-bar test does performs better than the LR-bar test with finite samples especially for large number for samples N. The modified panel autoregressive equation as follows;

$$\Delta Y_{it} = \alpha_i + \phi_i Y_{i,t-1} + \sum_{j=1}^{K} \alpha_j \Delta Y_{i,t-j} + e_{it}$$

Where the Y is the single variables to be tested, t=1,2,…,N and cross section i = 1,2,…, N. The null hypothesis for the IPS will be based on the autoregressive coefficient $\phi_i$ as follows:

**$H_0$: $\phi_i$ = 0 for all cross section *i* (The series has a unit root process)**

**$H_0$: $\phi_i$ < 0 for all cross section *i* (The series has no unit root process)**

The IPS has imposed restriction that the number of observation across sections must be identical or requiring balanced panel. Given by this restriction, the t-bar statistics can be easily calculated from the average individual of ADF t-statistics for testing $\phi_i$ = 0 and formula given as below:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\phi i}$$

Given by the t-bar statistics, the IPS statistics can be constructed as follows

$$t_{IPS} = \frac{\sqrt{N}(\bar{t} - \frac{1}{N} \sum_{i=1}^{N} E[t_{iT} | \phi_i = 0]}{\sqrt{Var[t_{iT} | \phi_i = 0]}}$$

where the $E[ti_T | \varphi_i=0]$ is the finite common mean and $Var[t_{iT} | \varphi_i=0]$ is the variance of $t_{iT}$

**Panel Unit Root Test**

The panel unit root test (using Eviews) will test the level form and the 1st difference form, for the individual intercept and trend using modified Aikake

**The null hypothesis : Non-stationary**

**Accept null if : p-value >10% (non-stationary) and**

**Reject null if :p-value<10% (stationary)**

From **Table 1**

We observed that we do not reject (accept) the Null hypothesis that it is non-stationary. We conclude that at level form, the individual intercept and trend for Real stock price (RSP) and Real Industrial production (RIP) is non-stationary.

However for the 1st difference, for the RSP, we reject the Null of non-stationary for LLC and Breitung t test. We confirm that the common unit root is stationary. For the individual unit root test, PP shows result of <10%, thus we reject the Null, and conclude that they are stationary at the 1st difference form. For the RIP, it is very clear that we reject Null of non-stationary at the 1st difference form. All tests, LLC and Breitung for common unit root and IPS,ADF and PP for individual unit root test, the p-value is <10%.

See the kernel Newey-West estimator, using LLC and Breitung t-stat p-value (for common unit root) and IPS,ADF (Augmented Dicky-Fuller) and PP (Phillip-Perron) all are more than 10%.

The results for the IPS unit root test on all variables at level form and at its difference form are presented in **Table 1,2,3** and **4**, as shown below;

**Table 1 - Real stock price level form**

Pool unit root test: Summary
Series: RSP1, RSP2, RSP3, RSP4, RSP5, RSP6, RSP7, RSP8, RSP9
Date: 03/28/12 Time: 10:31
Sample: 2008M01 2010M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic selection of lags based on MAIC: 0 to 1
**Newey-West** bandwidth selection using **Bartlett kernel**

| Method | Statistic | Prob.** | Cross-sections | Obs |
|---|---|---|---|---|
| Null: Unit root (assumes common unit root process) | | | | |
| **Levin, Lin & Chu t*** | -1.03013 | 0.1515 | 9 | 314 |
| **Breitung t-stat** | 0.96177 | 0.8319 | 9 | 305 |
| Null: Unit root (assumes individual unit root process) | | | | |
| **Im, Pesaran and Shin** W-stat | 0.99363 | 0.8398 | 9 | 314 |
| ADF - Fisher Chi-square | 9.84493 | 0.9369 | 9 | 314 |

| | | | | |
|---|---|---|---|---|
| PP - Fisher Chi-square | 10.2370 | 0.9239 | 9 | 315 |

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

## Table 2 - Real stock price 1st difference form

Pool unit root test: Summary
Series: RSP1, RSP2, RSP3, RSP4, RSP5, RSP6, RSP7, RSP8, RSP9
Date: 03/28/12 Time: 10:33
Sample: 2008M01 2010M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic selection of lags based on MAIC: 0 to 4
Newey-West bandwidth selection using Bartlett kernel

| Method | Statistic | Prob.** | Cross-sections | Obs |
|---|---|---|---|---|
| Null: Unit root (assumes common unit root process) | | | | |
| Levin, Lin & Chu t* | -2.94864 | 0.0016 | 9 | 284 |
| Breitung t-stat | -3.45566 | 0.0003 | 9 | 275 |
| Null: Unit root (assumes individual unit root process) | | | | |
| Im, Pesaran and Shin W-stat | -1.04867 | 0.1472 | 9 | 284 |
| ADF - Fisher Chi-square | 24.8899 | 0.1280 | 9 | 284 |
| PP - Fisher Chi-square | 107.350 | 0.0000 | 9 | 306 |

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

## Table 3 - Real industrial production in level form

Pool unit root test: Summary
Series: RIP1, RIP2, RIP3, RIP4, RIP5, RIP6, RIP7, RIP8, RIP9
Date: 03/28/12 Time: 10:35
Sample: 2008M01 2010M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic selection of lags based on MAIC: 0 to 2
Newey-West bandwidth selection using Bartlett kernel

| Method | Statistic | Prob.** | Cross-sections | Obs |
|---|---|---|---|---|
| Null: Unit root (assumes common unit root process) | | | | |
| Levin, Lin & Chu t* | 0.93992 | 0.8264 | 9 | 306 |
| Breitung t-stat | -0.47732 | 0.3166 | 9 | 297 |
| Null: Unit root (assumes individual unit root process) | | | | |
| Im, Pesaran and Shin W-stat | 0.84232 | 0.8002 | 9 | 306 |
| ADF - Fisher Chi-square | 11.3997 | 0.8766 | 9 | 306 |

| | | | | |
|---|---|---|---|---|
| PP - Fisher Chi-square | 26.0641 | 0.0983 | 9 | 315 |

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

## Table 4 - Real industrial production in 1st difference form

Pool unit root test: Summary
Series: RIP1, RIP2, RIP3, RIP4, RIP5, RIP6, RIP7, RIP8, RIP9
Date: 03/28/12 Time: 10:36
Sample: 2008M01 2010M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic selection of lags based on MAIC: 0 to 3
Newey-West bandwidth selection using Bartlett kernel

| Method | Statistic | Prob.** | Cross-sections | Obs |
|---|---|---|---|---|
| Null: Unit root (assumes common unit root process) | | | | |
| Levin, Lin & Chu t* | -11.7233 | 0.0000 | 9 | 301 |
| Breitung t-stat | -10.8532 | 0.0000 | 9 | 292 |
| Null: Unit root (assumes individual unit root process) | | | | |
| Im, Pesaran and Shin W-stat | -11.8926 | 0.0000 | 9 | 301 |
| ADF - Fisher Chi-square | 156.583 | 0.0000 | 9 | 301 |
| PP - Fisher Chi-square | 333.905 | 0.0000 | 9 | 306 |

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

## Panel Cointegration (Eviews)

## Table 5 – Pedroni Residual Cointegration Test

Pedroni Residual Cointegration Test
Series: RSP? RIP?
Date: 03/28/12 Time: 10:36
Sample: 2008M01 2010M12
Included observations: 36
Cross-sections included: 9
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Lag selection: Automatic SIC with a max lag of 8
Newey-West bandwidth selection with Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

| | Statistic | Prob. | Weighted Statistic | Prob. |
|---|---|---|---|---|
| Panel v-Statistic | -1.170578 | 0.8791 | -1.133448 | 0.8715 |
| Panel rho-Statistic | -0.796636 | 0.2128 | -0.785512 | 0.2161 |
| Panel PP-Statistic | -2.150374 | 0.0158 | -2.281459 | 0.0113 |

| | | | | |
|---|---|---|---|---|
| Panel ADF-Statistic | -2.517392 | 0.0059 | -2.633532 | 0.0042 |

Alternative hypothesis: individual AR coefs. (between-dimension)

| | Statistic | Prob. |
|---|---|---|
| Group rho-Statistic | -0.164985 | 0.4345 |
| Group PP-Statistic | -2.131569 | 0.0165 |
| Group ADF-Statistic | -2.554790 | 0.0053 |

Cross section specific results

Phillips-Peron results (non-parametric)

| Cross ID | AR(1) | Variance | HAC | Bandwidth | Obs |
|---|---|---|---|---|---|
| 1 | 0.840 | 0.007360 | 0.009274 | 1.00 | 35 |
| 2 | 0.844 | 0.016240 | 0.024103 | 2.00 | 35 |
| 3 | 0.732 | 0.025185 | 0.023153 | 1.00 | 35 |
| 4 | 0.468 | 0.030559 | 0.029701 | 1.00 | 35 |
| 5 | 0.456 | 0.002733 | 0.001900 | 6.00 | 35 |
| 6 | 0.311 | 0.008970 | 0.009236 | 3.00 | 35 |
| 7 | 0.764 | 0.010140 | 0.010811 | 1.00 | 35 |
| 8 | 0.619 | 0.032301 | 0.035087 | 1.00 | 35 |
| 9 | 0.425 | 0.024222 | 0.023208 | 2.00 | 35 |

Augmented Dickey-Fuller results (parametric)

| Cross ID | AR(1) | Variance | Lag | Max lag | Obs |
|---|---|---|---|---|---|
| 1 | 0.840 | 0.007360 | 0 | 8 | 35 |
| 2 | 0.766 | 0.012859 | 1 | 8 | 34 |
| 3 | 0.732 | 0.025185 | 0 | 8 | 35 |
| 4 | 0.468 | 0.030559 | 0 | 8 | 35 |
| 5 | 0.456 | 0.002733 | 0 | 8 | 35 |
| 6 | 0.311 | 0.008970 | 0 | 8 | 35 |
| 7 | 0.764 | 0.010140 | 0 | 8 | 35 |
| 8 | 0.619 | 0.032301 | 0 | 8 | 35 |
| 9 | 0.425 | 0.024222 | 0 | 8 | 35 |

## Testing of panel cointegration

We will view the cointegration of RSP and RIP using Pedroni residual cointegration test for Vector Error Correction Model (VECM) with Granger causality, also using Newey-est Bartlet kernel. The result is shown in **Table 5**. Cointegration refers to that for a set of variable that are individually integrated of order 1, some linear combination of these variables is stationary. The vector of the slope of coefficients that renders this combination stationary is referred to as the cointegrating vector. Thus, in effect, panel cointegration techniques are intended to allow researchers to selectively pool information regarding common long-run relationships from across the panel while allowing the associated short-run dynamics and fixed effects to be heterogeneous across different members of the panel.

Thus, we comprehend the test for the null hypothesis of **NO cointegration** is implemented as a residual-based test of the null hypothesis;

**H0:** $\gamma_i$ **for all** $i$ **Null**

**H1:$\gamma_i$=$\gamma$<1 for all *i*** **Alternative**

P-value for Panel PP-statistics and ADF-statistics was <10% for within dimension and between dimension. Thus we can **reject** the Null hypothesis of no cointegration. We can safely say that the common and individual auto regression coefficients are cointegrated.

**Estimates of Fixed Effect (FE) and Random Effect (RE)**

For the

- **null hypothesis; RE is preferred and**
- **null hypothesis; RE and FE are consistent, but FE is inefficient**
- **alternative ; RE is inconsistent**

We **did not reject** the null (as p > 10%), thus we conclude RE is preferred

From global Wald test, p-value <5%, shows that all regressors are **significant** and from individual regressor, p-value <5%, shows that RIP is significant at 5%. From the observed coefficient, an increase of 1 unit of RIP will increase RSP by a very significant 1.68 times (**168%**).

**Table 6 – Estimation of Fixed Effect (FE) model**

```
Fixed-effects (within) regression               Number of obs      =       324
Group variable: idcode                          Number of groups   =         9

R-sq:  within  = 0.3143                         Obs per group: min =        36
       between = 0.0629                                        avg =      36.0
       overall = 0.0647                                        max =        36

                                                F(1,314)           =    143.92
corr(u_i, Xb)  = -0.0035                        Prob > F           =    0.0000
```

| rsp | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| rip | 1.681952 | .1402035 | 12.00 | 0.000 | 1.406095 | 1.957809 |
| _cons | 5.149132 | .0143918 | 357.78 | 0.000 | 5.120816 | 5.177449 |
| sigma_u | 3.1084334 | | | | | |
| sigma_e | .21439192 | | | | | |
| rho | .99526552 | (fraction of variance due to u_i) | | | | |

F test that all u_i=0:     F(8, 314) =  7567.69               Prob > F = 0.0000

## Table 7 - Estimation of Random Effect (RE) model

```
Random-effects GLS regression                   Number of obs      =       324
Group variable: idcode                          Number of groups   =         9

R-sq:  within  = 0.3143                         Obs per group: min =        36
       between = 0.0629                                        avg =      36.0
       overall = 0.0647                                        max =        36

Random effects u_i ~ Gaussian                   Wald chi2(1)       =    144.84
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
```

| rsp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| rip | 1.681876 | .1397513 | 12.03 | 0.000 | 1.407968 | 1.955783 |
| _cons | 5.149128 | 1.105986 | 4.66 | 0.000 | 2.981435 | 7.316821 |
| sigma_u | 3.322842 | | | | | |
| sigma_e | .21439192 | | | | | |
| rho | .99585434 | (fraction of variance due to u_i) | | | | |

## Table 8 - Hausman Test (between FE and RE)

| | —— Coefficients —— | | | |
|---|---|---|---|---|
| | (b) fixed | (B) . | (b-B) Difference | sqrt(diag(V_b-V_B)) S.E. |
| rip | 1.681952 | 1.681876 | .0000762 | .0080966 |

```
                      b = consistent under Ho and Ha; obtained from xtreg
         B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.00
                Prob>chi2 =      0.9925
```

```
Bootstrap replications (50)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..................................................    50

Random-effects GLS regression                   Number of obs      =       324
Group variable: idcode                          Number of groups   =         9

R-sq:  within  = 0.3143                         Obs per group: min =        36
       between = 0.0629                                        avg =      36.0
       overall = 0.0647                                        max =        36

Random effects u_i ~ Gaussian                   Wald chi2(1)       =     46.05
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

                                  (Replications based on 9 clusters in idcode)
```

| rsp | Observed Coef. | Bootstrap Std. Err. | z | P>\|z\| | Normal-based [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| rip | 1.681876 | .2478354 | 6.79 | 0.000 | 1.196127 | 2.167624 |
| _cons | 5.149128 | .9137489 | 5.64 | 0.000 | 3.358213 | 6.940043 |
| sigma_u | 3.322842 | | | | | |
| sigma_e | .21439192 | | | | | |
| rho | .99585434 | (fraction of variance due to u_i) | | | | |

## Table 9 - Pool Mean Group (PMG)

```
Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): idcode                   Number of obs      =       315
Time Variable (t): time                      Number of groups   =         9
                                             Obs per group: min =        35
                                                            avg =      35.0
                                                            max =        35

                                             Log Likelihood     =  313.1814
```

| D.rsp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ECT | | | | | | |
| rip | -.6803302 | 1.057698 | -0.64 | 0.520 | -2.753379 | 1.392719 |
| SR | | | | | | |
| ECT | -.1076977 | .0139787 | -7.70 | 0.000 | -.1350954 | -.0803 |
| rip D1. | .4266959 | .2158688 | 1.98 | 0.048 | .0036009 | .8497909 |
| _cons | .4496817 | .0842905 | 5.33 | 0.000 | .2844754 | .614888 |

**Table 10 - Mean Group (MG)**

```
Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): idcode                    Number of obs      =       315
Time Variable (t): time                       Number of groups   =         9
                                              Obs per group: min =        35
                                                             avg =      35.0
                                                             max =        35

                                              Log Likelihood     =  313.1814
```

| D.rsp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| ECT | | | | | | |
| rip | -.6803302 | 1.057698 | -0.64 | 0.520 | -2.753379 | 1.392719 |
| SR | | | | | | |
| ECT | -.1076977 | .0139787 | -7.70 | 0.000 | -.1350954 | -.0803 |
| rip D1. | .4266959 | .2158688 | 1.98 | 0.048 | .0036009 | .8497909 |
| _cons | .4496817 | .0842905 | 5.33 | 0.000 | .2844754 | .614888 |

**Table 11- Hausman Test (between PMG and MG)**

| | ---- Coefficients ---- (b) mg | (B) pmg | (b-B) Difference | sqrt(diag(V_b-V_B)) S.E. |
|---|---|---|---|---|
| rip | -11.52063 | -.6803302 | -10.8403 | 10.50528 |

```
                 b = consistent under Ho and Ha; obtained from xtpmg
  B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

 Test:  Ho:  difference in coefficients not systematic

              chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =        1.06
            Prob>chi2 =      0.3021
```

**Table 12 - Final Estimation – PMG**

```
Iteration 0:   log likelihood =  312.96079  (not concave)
Iteration 1:   log likelihood =  313.08372
Iteration 2:   log likelihood =  313.17472
Iteration 3:   log likelihood =   313.1814
Iteration 4:   log likelihood =   313.1814

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): idcode                  Number of obs      =       315
Time Variable (t): time                     Number of groups   =         9
                                            Obs per group: min =        35
                                                           avg =      35.0
                                                           max =        35

                                            Log Likelihood     =  313.1814
```

| D.rsp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ECT | | | | | | |
| rip | -.6803302 | 1.057698 | -0.64 | 0.520 | -2.753379 | 1.392719 |
| SR | | | | | | |
| ECT | -.1076977 | .0139787 | -7.70 | 0.000 | -.1350954 | -.0803 |
| rip D1. | .4266959 | .2158688 | 1.98 | 0.048 | .0036009 | .8497909 |
| _cons | .4496817 | .0842905 | 5.33 | 0.000 | .2844754 | .614888 |

Final estimation of PMG in **Table 12** denotes that the p value of the Error Correction Term (ECT) is 0.52 (52%), which is > than 10%, we **did not reject** the null of no correlation. ECT is the long term combination of all variables. This means that with a 95% confidence interval, in the long run, real industrial production (RIP) is not significantly affecting real stock price (RSP).In the output also, the estimated long run real industrial production elasticity is significantly negative, as expected.

However, in the short run (SR), we can see the **elasticity** of RSP as against RIP. The p value for ECT is 0%, which is < than 10%, we **reject** the null hypothesis of no correlation. This means that in short run (short term), ECT is significantly affecting RSP. We can safely say that RSP depends on the long run equilibrium of the combination between the two variables (RSP and RIP). Intuitively, we can say that, RSP will return to equilibrium because of the long run interaction between RSP and RIP.

The ECT coefficient in the SR of -0.1077, reflects the period of which RSP will return to equilibrium. Here, in the long run, it will take roughly 10 periods, or **10 months** (referring to our data time scale), for RSP to return to equilibrium if it deviates from regression line (taken as 1 / 0.1077).

For the D1 rip, the p value of 4.8%, which is <than 10%, we **reject** the null of no correlation. Thus we can conclude that in the short run, RSP is significantly affected by RIP. The coefficient of 0.427 means that in the short run, any increase of one (1) unit of RIP will result in an increase of RSP by 0.42 unit, or alternatively an increase of 1% in RIP will trigger an increase of 0.43% of RSP, in the same direction.

In **Table 13** for Final PMG regression of individual countries, these idcodes represents;

We noticed that in the **long run**, ECT for all countries are the **same**. However, this cannot be said the same for the short run. The SR for each country is different, due the uniqueness of one country from the others. All countries except Egypt, South Korea and Philippines have p value of < than 10%. This means that, for all countries except these three, we do not reject the null hypothesis of no correlation. For these six countries, they confirm our expectations that all the variables are correlated in the short term.

However, the D1rip denotes some very interesting pattern. Except for China and South Korea, all the other countries have the p value of >than 10%; we reject the null of no correlation. This shows that except for China and South Korea, the RIP for all the other countries affects the respective RSP with different coefficient, as shown below;

**Table 13 - PMG Final Estimation of ECT and SR (Individual countries)**

| Country | **ECT coefficient** | **p value** | **RIP coefficient** | **p value** |
|---|---|---|---|---|
| **China** | -0.13 | 5.2% | 1.74 | 1% |
| **Egypt** | -0.09 | 11.5% | 0.06 | 86.1% |
| **India** | -0.18 | 0.8% | -0.05 | 88.7% |
| **Indonesia** | -0.09 | 9% | 0.94 | 22.9% |
| **South Korea** | -0.03 | 53.8% | 1.02 | 0% |
| **Malaysia** | -0.12 | 4% | 0.13 | 53% |
| **Philippines** | -0.10 | 12% | 0.02 | 90.3% |
| **Russia** | -0.12 | 4.5% | -0.07 | 86.3% |
| **Turkey** | -0.10 | 8.5% | 0.05 | 83.5% |

## Conclusion

In conclusion, all our estimations confirmed the existence of a link between real industrial production and real stock price, and that they are significant. With respect to the critical assumptions of the panel analysis, with regard to the homogeneity (of the four assumptions) across the panel, our empirical evidences have proven that Pool Mean Group (PMG) is the best model for the estimation of the short run and the long run relationship of the real stock price and the real industrial production of the nine countries under study. This answers our first research question. In addition, while there exists a strong link between RIP and RSP in the short run, it is proven that it is not significant in the long run.

Investors are more than ever interested in relationship between economic and financial indicators and how long the market will revert back to its equilibrium. This will influence their decision of the timing to enter and exit targeted market. Thus, for the second research questions, while we found out that although in the short run the coefficient of industrial production varies with each country (this might be due to the uniqueness of each country), they were the same in the long run.

This is to say that while a combination of all variables other than industrial production (across countries) are significantly affecting real stock price in the short term, they do not significantly affect the real stock price in the long run. And that in the long run, real stock price is very much dependent upon the equilibrium between real stock price and real industrial production. For the panel sample under study, it will take roughly ten months for the markets to revert back to equilibrium.

## References

Barbieri, L., (2006), Panel Unit Root Tests: A Review, Quaderni Del Dipartimento Di Scienze Economiche E Sociali, Universita Cattolica del Sacro Cuore, Piacenza, 1-33

Barbieri, L., (2007), Panel Cointegration Tests: A Review, Universita Cattolica del Sacro Cuore

Basher, S.A., Mohsin,M.,(2005), PPP Tests in Cointegrated Panels: Evidence from Asian Developing Countries, York University, Toronto

Bhattacharya ,M., Narayan,P.K., Rath,B.N.,(2011), The Productivity-wage and Productivity-employment nexus: A Panel Data Analysis of Indian Manufacturing, Empirical Economics, 40, 285-303

Blackburne ,E.F., Frank,M.W.,(2007), Estimation of Non-stationary Heterogeneous Panels, The Stata Journal, 7(2),197-208

Bresson, G.,(2002), Non-stationary Panels: Panel Unit Root Tests and Panel Cointegration, EuroLab Courses, CEPEA 2002

Cavalcanti, T.V., Mohaddes,K., Raissi,M.,(2011), Growth, development and natural resources: New evidence using a heterogeneous panel analysis, The Quarterly Review of Economics and Finance, 51, 305-318

Christopoulos ,D.K., Tsionas,E.G.,(2003), Productivity Growth and Inflation in Europe: Evidence from Panel Cointegration Tests, Empirical Economics, 30: 137-150

Lee, C.C. and Chang, C.P.,(2009), FDI, Financial Development and Economic Growth: International Evidence, Journal of Applied Economics.12 (2), 249-271

Lee, C.C.,(2005), Energy Consumption and GDP in developing countries: A cointegrated panel analysis, Energy Economics 27, 415-427

Peter Pedroni (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests With an Application to the PPP Hypothesis, Econometric Theory, 20 , 597-625

Pedroni, P.,(1999), Critical Values for CoIntegration Tests in Heterogeneous Panels with Multiple Regressors, Oxford Bulletin of Economics and Statistics, Special Issue

Smith, R.P.,(2001), Estimation and Inference with Non-stationary Panel Time-series Data, RC33 Conference paper, Cologne

**Appendix 1- PMG Final Estimation of ECT and SR (Individual countries)**

```
Iteration 0:   log likelihood =  312.96079  (not concave)
Iteration 1:   log likelihood =  313.08372
Iteration 2:   log likelihood =  313.17472
Iteration 3:   log likelihood =   313.1814
Iteration 4:   log likelihood =   313.1814

Pooled Mean Group Regression
(Estimate results saved as PMG)

Panel Variable (i): idcode                      Number of obs      =       315
Time Variable (t): time                         Number of groups   =         9
                                                Obs per group: min =        35
                                                               avg =      35.0
                                                               max =        35

                                                Log Likelihood     =  313.1814
```

| D.rsp | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ECT | | | | | | |
| rip | -.6803302 | 1.057698 | -0.64 | 0.520 | -2.753379 | 1.392719 |
| idcode_1 | | | | | | |
| ECT | -.1315522 | .0681233 | -1.93 | 0.053 | -.2650714 | .0019669 |
| rip D1. | 1.743896 | .6725832 | 2.59 | 0.010 | .4256569 | 3.062135 |
| _cons | .5495445 | .2890702 | 1.90 | 0.057 | -.0170228 | 1.116112 |
| idcode_2 | | | | | | |
| ECT | -.089516 | .0567643 | -1.58 | 0.115 | -.2007721 | .02174 |
| rip D1. | .0590045 | .3368803 | 0.18 | 0.861 | -.6012688 | .7192778 |
| _cons | .37691 | .2349636 | 1.60 | 0.109 | -.0836101 | .8374302 |
| idcode_3 | | | | | | |
| ECT | -.1843025 | .0699888 | -2.63 | 0.008 | -.3214781 | -.047127 |
| rip D1. | -.0496638 | .3494013 | -0.14 | 0.887 | -.7344779 | .6351502 |
| _cons | .3284465 | .1326921 | 2.48 | 0.013 | .0683748 | .5885182 |
| idcode_4 | | | | | | |
| ECT | -.0918844 | .0542535 | -1.69 | 0.090 | -.1982192 | .0144504 |
| rip D1. | .9418486 | .7832865 | 1.20 | 0.229 | -.5933647 | 2.477062 |
| _cons | 1.039405 | .6186231 | 1.68 | 0.093 | -.1730742 | 2.251884 |
| idcode_5 | | | | | | |
| ECT | -.0284173 | .0461486 | -0.62 | 0.538 | -.118867 | .0620323 |
| rip D1. | 1.017962 | .2733431 | 3.72 | 0.000 | .4822198 | 1.553705 |
| _cons | .2687833 | .429121 | 0.63 | 0.531 | -.5722784 | 1.109845 |
| idcode_6 | | | | | | |
| ECT | -.1237811 | .0602441 | -2.05 | 0.040 | -.2418575 | -.0057048 |
| rip D1. | .1261825 | .2008718 | 0.63 | 0.530 | -.2675191 | .519884 |
| _cons | .421741 | .2049905 | 2.06 | 0.040 | .0199669 | .823515 |
| idcode_7 | | | | | | |
| ECT | -.0955524 | .0614271 | -1.56 | 0.120 | -.2159474 | .0248425 |
| rip D1. | .0235659 | .1926948 | 0.12 | 0.903 | -.354109 | .4012407 |
| _cons | .5092077 | .3340904 | 1.52 | 0.127 | -.1455974 | 1.164013 |
| idcode_8 | | | | | | |
| ECT | -.1247878 | .0623043 | -2.00 | 0.045 | -.246902 | -.0026736 |
| rip D1. | -.0687015 | .3993846 | -0.17 | 0.863 | -.851481 | .714078 |
| _cons | .4122209 | .3167081 | 1.30 | 0.193 | -.2085156 | 1.032957 |
| idcode_9 | | | | | | |
| ECT | -.0994854 | .0577743 | -1.72 | 0.085 | -.2127209 | .0137502 |
| rip D1. | .0461685 | .2210871 | 0.21 | 0.835 | -.3871543 | .4794913 |
| _cons | .1408765 | .1168672 | 1.21 | 0.228 | -.088179 | .369932 |