THE IMPACT OF STOCK MARKET DEVELOPMENT ON INFLATION AND ECONOMIC GROWTH OF 16 ASIAN COUNTRIES: A PANEL VAR APPROACH

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Abstract
Empirical macroeconomists have investigated the possible link between the development of stock markets, economic growth, and inflation separately. Unlike earlier work, this paper investigates the nature of causal relations between these variables using a panel Granger causality test on a sample of 16 Asian countries over 1988-2012. Employing a panel vector autoregressive (VAR) model, our results also reveal that these variables are cointegrated, suggesting presence of a long-run equilibrium relationship among them.

Keywords: stock market developments, inflation, economic growth, panel VAR

JEL classification: E44, O43, O53, E31

1. Introduction

Stock markets are likely sources of or possible catalysts to economic growth in many economies. They allocate funds to the most productive sectors of the economy (Cooray, 2010; Billmeier and Massa, 2009; Caporale et al., 2004). More generally, stock markets can influence economic growth through mobilizing and directing savings, facilitating risk sharing, and providing a venue for investments (see Hou and Cheng, 2010; Arestis et al., 2001; Rousseau and Wachtel, 2000; Enisan and Olufisayo, 2009; Levine and Zervos, 1996; Levine, 1991). These interrelated functions of a stock market may be explained as follows. A stock market may assist in domestic savings mobilization by availing a set of financial instruments for individuals to diversify their portfolio. It can also provide opportunities for co-ownership thereby providing individuals with an efficient means of risk sharing. Finally, a stock market not only facilitates efficient allocation of capital to productive investments but also provides investment outlets for both domestic and foreign investments. It is therefore expected that stock markets have significant links with all productive activities in an economy. Hence, it is not surprising that a stock market is a leading indicator of the economic activity in a country (Pierce, 1984) and has a major influence on aggregate demand, particularly through aggregate consumption and investment (Nishat and Saghir, 1991).

While the stock market development may have a causal impact on the economic growth of a country, it is open to question whether causality flows in the other direction. That is, the possibility that economic growth leads to stock market development cannot
be dismissed. Of course, it is conceivable that causality proceeds in both directions simultaneously (Nieuwerburgh et al., 2006; Bosworth, 1975).

The purpose of this paper is to examine the causal link between stock market development, economic growth, and inflation in a large sample of Asian countries over a recent span of time. As is evident, inflation is a third variable in our analysis since inflation, especially in the context of developing economies, may be linked to rapid stock market development or economic growth.

Existing empirical evidence on the relationship between the three variables is rather mixed. One possible explanation of the inconclusive nature of results may be due to data. Researchers use different set of countries and different spans of time. Another culprit may be the econometric approach. This paper sheds further light on the subject by employing a novel and more sophisticated econometric methodology to determine the direction of causality between the variables in a sample of 16 Asian countries who have witnessed tremendous development in their economies over the past 25 years – the period of our study. Using our econometric model, we also comment on whether there is a long-run equilibrium relationship between the three variables.

The balance of this paper is structured in the following way. Section 2 presents a review of the related literature. Section 3 describes the econometric methodology. Section 4 presents the empirical results. The final section concludes.

2. Literature Survey

This paper melds three literatures, one investigating the link between stock market development and economic growth, another treating the link between inflation and economic growth, and the last examining the link between stock market development and inflation.

There exists a broad literature on the nexus between stock market development and economic growth. Most studies document a positive relationship between the two variables (see, for instance, Akinlo and Akinlo, 2009; Beck and Levine, 2004; Levine and Zervos, 1998; Harris, 1997, Mukherjee and Naka, 1995; Chen et al., 1986; Geske and Roll, 1983; Fama, 1990, 1981). Several other studies, on the contrary, have documented a negative relationship across the variables (see, for example, Hassapis and Kalyvitis, 2002; Garcia and Lin, 1999; Bhide, 1993; Shleifer and Vishny, 1986; Stiglitz, 1994, 1985). Yet other studies have documented a bi-directional causality between stock market development and economic growth (see, for instance, Enisan and Olufisayo, 2009; Shahbaz et al., 2008; Deb and Mukherjee, 2008; El-Wassal, 2005; Nishat and Saghir, 1991). Thus, the link between the two variables is open to question.

The literature on the correlation between inflation and economic growth is also vast. However, empirical work on the causal link between the two variables is not as abundant. Some studies report a positive link between inflation and economic growth (see, for instance, Hwang, 2001) while others report a negative relationship between the two (see, for example, Adam and Bevan, 2005; Arai et al., 2004; Bruno and Easterly, 1998; Barro, 1995; De Gregorio, 1993). On the other hand, Nguyen and Wang (2010) and Andres and Hernando (1997) document existence of a feedback causal relationship between these variables.

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1 A more detailed review of these studies can be seen in Pradhan (2011).
The pattern of the causal effect on the relationship between inflation and stock market development is also mixed. Some studies report a positive link between these variables (see, for example, Ratanapauorn and Sharma, 2007; Groenewold et al., 1997; Abdullah and Hayworth, 1993; Dhakal et al., 1993; Hamao, 1988). However, other studies maintain that the relationship between the two variables is negative (Humpe and Macmillan, 2009; DeFina, 1991; Chen et al., 1986; Fama, 1981; Fama and Schwert, 1977). Last, studies like Cakan (2013), Pradhan (2011) and Morley (2002) document existence of bi-directional causality between the two variables.  

As is evident, diverse and sometimes conflicting empirical evidence is present in both country-specific and cross-country studies that examine the direction of causality between these variables. The explanations for this disturbing inconsistency in results are rooted in differences in data series, data definitions, methodological approaches, and time periods of different studies (see, for instance, Ang, 2008; Beck and Levine, 2004; Khan and Senhadji, 2001 for a general discussion of how empirical studies can generate non-uniform results).

Although the goal of this study is similar to those of previous studies, the econometric methodology employed is novel in one significant direction: we conduct panel Granger causality tests, rather than simple univariate time series analysis. Panel methods allow for more robust estimates by utilizing variations between countries as well as variations over time. In addition, by employing a panel vector autoregressive (VAR) model, we are able to examine whether the three variables are cointegrated.

3. Data and Methodological Framework

The annual time series data over 1988-2012 is employed for the sixteen Asian countries: Hong Kong SAR, China, India, Israel, Jordan, Korea, Pakistan, Sri Lanka, Bangladesh, Indonesia, Japan, Kuwait, Malaysia, Philippines, Singapore, Thailand, and Turkey. Data are obtained from the World Development Indicators database of World Bank and the database of the International Monetary Fund. Our sample comprises of an interesting group of emerging economies which have experienced tremendous economic growth and stock market development over the past two to three decades. Availability of stock market data determines the starting year for the period of our study.

We use three distinct indicators of the stock market: stock market size, stock market liquidity and stock market turnover. Market capitalization of listed companies (in US$) is used as an indicator of the stock market size; total value of traded stocks (in US$) is used as an indicator of stock market liquidity; and stock market turnover ratio is used as an indicator of stock market turnover. Our study uses the percentage change in each of these variables as an indicator of stock market development.

Inflation is calculated by using the consumer price index (CPI). Our study adopts two measures of economic growth, one using gross domestic product and the other per capita gross domestic product (both in US$). Inflation is the defined as the percentage change in CPI, while economic growth is the percentage change in either gross domestic product or in per capita gross domestic product. Table 1 provides a summary of the variables.

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2 The conjoint role of stock market development and inflation in explaining economic growth is recognized in Khan (2004) and Wongbangpo and Sharma (2002).
Figure 1 presents the possible patterns of causal relations between stock market development, inflation, and economic growth.

The study tests the following hypotheses:

- $H_1$: Stock market development (SMD) in any year Granger-causes economic growth in a subsequent year. This is termed the SMD-led growth hypothesis.

- $H_2$: Inflation (INF) in any year Granger-causes economic growth in a subsequent year. This is termed the INF-led growth hypothesis.

- $H_3$: Stock market development in any year Granger-causes inflation in a subsequent year. This is termed the SMD-led inflation hypothesis.

In this study, the test for SMD-led growth hypothesis and its counterpart (the INF-led growth hypothesis and the SMD-led inflation hypothesis) will be performed in three steps: tests for the order of integration; tests for cointegration; and tests for the Granger causality. We conduct these three sets of tests at the panel level, based on the cluster of sixteen countries. These tests are described below.
3.1. Unit-Root Tests

These tests are deployed to determine the order of integration, where a time series variable attains stationarity. See Annex-

3.2. Cointegration Tests

The concept of cointegration, introduced by Granger (see, for example, Granger, 1988) is relevant to the problem of the determination of long-run relationship between variables. The basic idea behind cointegration is simple. If the difference between two non-stationary series is itself stationary, then the two series are cointegrated. If two or more series are cointegrated, it is possible to interpret the variables in these series as in a long-run equilibrium relationship. Lack of cointegration, on the other hand, suggests that the variables have no long-run relationship; i.e., in principle they can move arbitrarily far away from each other.

When a collection of time-series observations becomes stationary only after being first-differenced, the individual time series might have linear combinations that are stationary without differencing. Such collections of series are usually called cointegrated (Granger, 1988). If integration of ‘order one’ is implied, the next step is to employ cointegration analysis in order to establish whether there exists a long-run relationship among the set of such possibly ‘integrated’ variables. In such investigations Johansen’s Vector Auto Regression (VAR) test of cointegration (Johansen, 1988) is usually deployed. VAR is a systemic approach to check for cointegration, allowing for the determination of up to \( r \) linearly independent cointegrating vectors \((r <= g -1, \text{where } g \text{ is the number of variables tested for cointegration})\). The estimated cointegration equation is of the following form:

\[
Y_{it} = \beta_{i0} + \beta_{i1}X_{i1t} + \beta_{i2}X_{i2t} + \ldots + \beta_{ik}X_{ikt} + \varepsilon_{it}
\]

The equation may be re-written as:

\[
\varepsilon_{it} = Y_{it} - (\beta_{i0} + \beta_{i1}X_{i1t} + \beta_{i2}X_{i2t} + \ldots + \beta_{ik}X_{ikt})
\]

with the cointegration vector defined as:

\[
[1 - \beta_{i0} - \beta_{i1} - \beta_{i2} - \ldots - \beta_{ik}]
\]

We note that, as set up by Johansen (1988), the test above could not deal with panel settings. We thus use an enhancement, the Pedroni (2004) panel cointegration test, to test for the existence of cointegration. The Pedroni panel cointegration test is applied to the following time-series panel regression set-up:

\[
Y_{i,t} = \alpha_i + \sum_{j=1}^{p_j} \beta_{ji}X_{jt} + \varepsilon_{it}
\]

\[
\varepsilon_{it} = \rho_i \varepsilon_{it(-1)} + w_{it}
\]

where \( Y_{it} \) and \( X_{jt} \) are the observable variables; \( \varepsilon_{it} \) represents the disturbance term from the panel regression; \( \alpha_i \) allows for the possibility of country-specific fixed effects and the coefficients \( \{\beta_{ji}\} \) allow for variation across individual countries.

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3 The notion of cointegration arose out of concern about spurious time-series regressions. Specifically, a time series regression in terms of two economic variables often produces empirical results in which \( R^2 \) is quite high, but the Durbin-Watson statistic is quite low. This happens because economic time series are often dominated by smooth, long-term trends. However, such empirical results tell us little about the true nature of the relationship between the variables.
The null hypothesis of no cointegration of the pooled (within-dimension) estimation is:

\[ H_0: \rho_i = 1 \text{ for all } i \text{ against } H_1: \rho_i = \rho < 1 \]  \hspace{1cm} (14)

Under the first hypothesis, the within-dimensional estimation assumes a common value for \( \rho_i (= \rho) \). In brief, this procedure excludes any additional source of heterogeneity as between individual country members of the panel. The null hypothesis of no cointegration of the pooled (between-dimension) estimation is written

\[ H_0: \rho_i = 1 \text{ for all } i \text{ against } H_1: \rho_i < 1 \]  \hspace{1cm} (15)

Under the alternative hypothesis, the between-dimensional estimation does not assume a common value for \( \rho_i = \rho \). It thus allows for an additional source of possible heterogeneity across individual country members of the panel.

Pedroni suggested two types of tests to determine the existence of heterogeneity of the cointegration vector. First, the test uses the within-dimension approach (i.e. panel test). It uses four statistics that are panel \( v \)-statistic, panel \( \rho \)-statistic, panel PP-statistic and the panel ADF-statistic. These statistics pool the autoregressive coefficients across different panel members for the unit root tests to be performed on the estimated residuals. Second, the test is based on between-dimensional approaches (group test). It includes three statistics: a group \( \rho \)-statistic, a group PP-statistic and the group ADF-statistic. These statistics are based on estimators that simply average the individually-estimated autoregressive coefficients for each panel member. Next, the heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows:

Panel \( v \)-statistic

\[
Z_v = \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{it-1}^2 \right]^{-1}
\]  \hspace{1cm} (16)

Panel \( \rho \)-statistic

\[
Z_\rho = \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{11i}^2 \hat{\epsilon}_{it-1}^2 \right]^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left( \hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i \right)
\]  \hspace{1cm} (17)

Panel PP-statistic

\[
Z_t = \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{11i}^2 \hat{\epsilon}_{it-1}^2 \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left( \hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i \right)
\]  \hspace{1cm} (18)

Panel ADF-statistic

\[
Z_t^* = \left[ \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{11i}^2 \hat{\epsilon}_{it-1}^2 \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it}^*
\]  \hspace{1cm} (19)

Group \( \rho \)-statistic

\[
\hat{Z}_\rho = \sum_{i=1}^{N} \left( \sum_{t=1}^{T} \hat{\epsilon}_{it-1}^2 \right)^{-1} \sum_{t=1}^{T} \left( \hat{\epsilon}_{it} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i \right)
\]  \hspace{1cm} (20)
Group PP- statistic

$$\tilde{Z}_t = \sum_{i=1}^{N} \left( \hat{\sigma}_i^2 \sum_{t=1}^{T} \hat{\varepsilon}_{it}^2 \right)^{-0.5} \sum_{t=1}^{T} \left( \hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right)$$

(21)

Group ADF- statistic

$$\tilde{Z}_t^* = \sum_{i=1}^{N} \left( \sum_{t=1}^{T} \hat{s}_i^2 \hat{\varepsilon}_{it-1}^2 \right)^{-0.5} \sum_{t=1}^{T} \left( \hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it}^* \right)$$

(22)

where $\hat{\varepsilon}_{it}$ is the estimated residual appearing in equation (12) and $\hat{L}_{it}^{-2}$ is the estimated long-run covariance matrix for $\{ \Delta \hat{\varepsilon}_{it} \}$. Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ are the long-run and contemporaneous variances for individual member country $i$. All seven tests assume the existence of an asymptotically-standard normal distribution given by the respective panel/group cointegration statistic. The panel $v$ is a one-sided test where large positive values would reject the null hypothesis of no cointegration. The other remaining statistics diverge to negative infinity, which means that large negative values also reject the null hypothesis. Each of these tests is able to accommodate individual specific short-run dynamics, individual-specific fixed effects and deterministic trends, as well as individual-specific slope coefficients (Pedroni, 2004).


Traditionally, the standard Granger-causality test (Granger, 1981) has been used to detect the direction of causality in relation to individual time series. But for a panel-data setting, the approach developed in Holtz-Eakin et al. (1988) is preferable. We use two different models, depending upon the features of time-series data, for our Granger causality testing. The definition of all these variables appears in Table 1.

Table 1. Definition of Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC</td>
<td>Percentage change in the market capitalization of the listed companies: our first indicator of stock market development (as a proxy for the evolution in the size of the stock market)</td>
</tr>
<tr>
<td>TRA</td>
<td>Percentage change in the total value of traded stocks: our second indicator of stock market development (as a proxy for the evolution in the stock market liquidity)</td>
</tr>
<tr>
<td>TUR</td>
<td>Percentage change in the turnover ratio in the stock market: our third indicator of stock market development (used as a proxy for the evolution in stock market turnover)</td>
</tr>
<tr>
<td>INF</td>
<td>The inflation rate (in percentage) calculated by using the Consumer Price Index</td>
</tr>
<tr>
<td>GDP</td>
<td>Percentage change in gross domestic product: one indicator of economic growth</td>
</tr>
<tr>
<td>PGDP</td>
<td>Percentage change in per capita gross domestic product: used as an alternative indicator of economic growth</td>
</tr>
</tbody>
</table>

*Note: All monetary measures are in US dollars*
**Model 1:** If the time series variables are integrated of order one [i.e. I (1)] and are not cointegrated, we use the following causality models:

\[
\Delta GDP_t = \eta_{1j} + \sum_{k=1}^{p} \alpha_{1ik} \Delta GDP_{it-k} + \sum_{k=1}^{q} \beta_{1ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \gamma_{1ik} \Delta TRA_{it-1} + \sum_{k=1}^{s} \eta_{1ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{1ik} \Delta INF_{it-k} + \varepsilon_{1it} \]

\[
(23)
\]

\[
\Delta MAC_t = \eta_{2j} + \sum_{k=1}^{p} \alpha_{2ik} \Delta MAC_{it-k} + \sum_{k=1}^{q} \beta_{2ik} \Delta GDP_{it-k} + \sum_{k=1}^{r} \gamma_{2ik} \Delta TRA_{it-1} + \sum_{k=1}^{s} \eta_{2ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{2ik} \Delta INF_{it-k} + \varepsilon_{2it} \]

\[
(24)
\]

\[
\Delta TRA_t = \eta_{3j} + \sum_{k=1}^{p} \alpha_{3ik} \Delta TRA_{it-k} + \sum_{k=1}^{q} \beta_{3ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \gamma_{3ik} \Delta GDP_{it-1} + \sum_{k=1}^{s} \eta_{3ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{3ik} \Delta INF_{it-k} + \varepsilon_{3it} \]

\[
(25)
\]

\[
\Delta TUR_t = \eta_{4j} + \sum_{k=1}^{p} \alpha_{4ik} \Delta TUR_{it-k} + \sum_{k=1}^{q} \beta_{4ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \gamma_{4ik} \Delta TRA_{it-1} + \sum_{k=1}^{s} \eta_{4ik} \Delta GDP_{it-k} + \sum_{k=1}^{T} \mu_{4ik} \Delta INF_{it-k} + \varepsilon_{4it} \]

\[
(26)
\]

\[
\Delta INF_t = \eta_{5j} + \sum_{k=1}^{p} \alpha_{5ik} \Delta INF_{it-k} + \sum_{k=1}^{q} \beta_{5ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \gamma_{5ik} \Delta TRA_{it-1} + \sum_{k=1}^{s} \eta_{5ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{5ik} \Delta GDP_{it-k} + \varepsilon_{5it} \]

\[
(27)
\]

where GDP is economic growth (percentage change in the gross domestic product); MAC, TRA, and TUR are indicators of stock market development (percentage change in the stock market capitalization, percentage change in the volume of traded stocks, and percentage change in the turnover ratio in the stock market, respectively); and INF is the inflation rate in the economy expressed in percentage. We also estimate equations (23) through (32) using PGDP (percentage change in the per capita gross domestic product) instead of GDP as economic growth.

**Model 2:** If the time series variables are 1 (1) and cointegrated, we use the following causality models:

\[
\Delta GDP_t = \eta_{1j} + \sum_{k=1}^{p} \alpha_{1ik} \Delta GDP_{it-k} + \sum_{k=1}^{q} \beta_{1ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \gamma_{1ik} \Delta TRA_{it-1} + \sum_{k=1}^{s} \eta_{1ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{1ik} \Delta INF_{it-k} + \lambda_{1l} ECT_{1it-1} + \varepsilon_{1it} \]

\[
(28)
\]
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\[
\Delta MAC_{it} = \eta_{2j} + \sum_{k=1}^{p} \alpha_{2ik} \Delta MAC_{it-k} + \sum_{k=1}^{q} \beta_{2ik} \Delta GDP_{it-k} + \sum_{k=1}^{r} \delta_{2ik} \Delta TRA_{it-1} + \\
\sum_{k=1}^{s} \eta_{2ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{2ik} \Delta INF_{it-k} + \lambda_{2i} ECT_{2it-1} + \epsilon_{2it}
\]

\[
\Delta TRA_{it} = \eta_{3j} + \sum_{k=1}^{p} \alpha_{3ik} \Delta TRA_{it-k} + \sum_{k=1}^{q} \beta_{3ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \delta_{3ik} \Delta GDP_{it-1} + \\
\sum_{k=1}^{s} \eta_{3ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{3ik} \Delta INF_{it-k} + \lambda_{3i} ECT_{3it} + \epsilon_{3it}
\]

\[
\Delta TUR_{it} = \eta_{4j} + \sum_{k=1}^{p} \alpha_{4ik} \Delta TUR_{it-k} + \sum_{k=1}^{q} \beta_{4ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \delta_{4ik} \Delta TRA_{it-1} + \\
\sum_{k=1}^{s} \eta_{4ik} \Delta GDP_{it-k} + \sum_{k=1}^{T} \mu_{4ik} \Delta INF_{it-k} + \lambda_{4i} ECT_{4it-1} + \epsilon_{4it}
\]

\[
\Delta INF_{it} = \eta_{5j} + \sum_{k=1}^{p} \alpha_{5ik} \Delta INF_{it-k} + \sum_{k=1}^{q} \beta_{5ik} \Delta MAC_{it-k} + \sum_{k=1}^{r} \delta_{5ik} \Delta TRA_{it-1} + \\
\sum_{k=1}^{s} \eta_{5ik} \Delta TUR_{it-k} + \sum_{k=1}^{T} \mu_{5ik} \Delta GDP_{it-k} + \lambda_{5i} ECT_{5it-1} + \epsilon_{5it}
\]

where p, q, r, s and T are lag lengths for the differenced variables in the respective equations and can be determined by the Engle-Granger approach (Engle and Granger, 1987). The ECTs are error-correction term, derived from the cointegrating equations. The ECT represents the long-run dynamics, while differenced variables represent the short-run dynamics between the variables.

In relation to short-run causal relationships, if the null hypothesis \( \beta_{1ik} = 0 \) (or \( \alpha_{1ik} = 0 \)) is rejected, we have affirmed Granger causality running from MAC to GDP (or GDP to MAC). If the joint null hypothesis \( \delta_{1ik} = 0 \) (or \( \delta_{2ik} = 0 \)) is rejected, there is Granger causality from TRA to GDP (or MAC). If the joint null hypothesis \( \mu_{3ik} = 0 \) (or \( \mu_{4ik} = 0 \)) is rejected, there is Granger causality from INF to TRA (or TUR). In a similar fashion, we can discuss for other possibilities for Granger causality among stock market development indicators, inflation, and economic growth.

For long-run causal relationships, the null hypothesis \( \lambda_{1i} = 0, \lambda_{2i} = 0, \lambda_{3i} = 0, \lambda_{4i} = 0 \) and \( \lambda_{5i} = 0 \) needs to be rejected. The above tests can be performed by using a Wald test.

4. Estimated Results and Discussion

The elucidation of the econometric results proceeds in three stages. After a brief review of the methodology used, we provide results that pertain to stationarity of time series variables. Next, we examine whether there is cointegration among them. Finally, we attempt to explicate the Granger of causality among the three cointegrated variables whose behavior and relationships we presently study.

The analysis starts with the stationarity properties of the time series data. It is the primary requirement for cointegration and Granger causality tests. The study used panel unit root test to the sixteen Asian countries. Table 2, in the Annex, presents the results of
unit root tests at the panel levels. The test results indicate that time series variables, namely, stock market development indicators (MAC, TRA and TUR), inflation (INF), and economic growth (GDP/PGDP), have unit roots in their levels. This is because the estimated ADF statistics cannot reject the null hypothesis of non-stationarity at the 5% level of significance. However, all variables are stationary at the 5% significance level of the first difference. Hence, the variables are I(1), that is they are integrated of order one.

Having confirmed the existence of unit roots, the next step is to check the existence of long run equilibrium relationship among them. The panel cointegration test is applied for this purpose. Table 3, in the Annex, presents the Pedroni’s panel cointegration test results. The results reveal that there is cointegration between stock market development indicators, inflation, and economic growth in our panel of sixteen Asian countries. This reveals that stock market development and inflation have long run relations with economic growth in the sixteen Asian countries.

### Table 4. Granger Causality Test Results

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Independent Variables</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>∆GDP</td>
<td>∆MAC      10.6*</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>∆TRA      8.89*</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>∆TUR      11.2*</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>∆INF      -3.51*</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>EC         GDP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAC        TRA</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TUR        INF</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>PGDP       MAC</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TRA        TUR</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>INF        ---</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1**: EC: Error Correction Term; * indicates significance at 5% level; √ indicates presence of causality; X: Indicates absence of causality; other notations are defined earlier.

**Note 2**: Model 1 presents the Granger causality between GDP, MAC, TRA, TUR and INF, while Model 2 presents the Granger causality between PGDP, MAC, TRA, TUR and INF.

On the basis of unit root and cointegration test results in the above, we can predict the possibility of causality between stock market development indicators, inflation, and economic growth. Moreover, the existence of unit root and no cointegration among these variables imply the possibility of Granger causality among them. To test the same, we use vector error correction models for I(1) and cointegration (see, equations 28-32). The estimated models give clues about the direction of causality between stock market development indicators, inflation, and economic growth. Table 4 presents the results of Granger causality test at panel level.
The results show the presence of unidirectional causality from two indicators of stock market development to economic growth [MAC => GDP, MAC => PGDP; TRA => GDP, TRA => PGDP]. This supports the supply-leading hypothesis between stock market development and economic growth and is congruent with the findings in studies by Zivengwa et al. (2011), Akinlo and Akinlo (2009), Nowbutsing (2009), Deb and Mukherjee (2008), Shahbaz et al. (2008), Argwalla and Tuteja (2007), N’ Zué (2006), Levine and Zervos (1998) and Leigh (1997).

On the basis of this result, further development of stock markets ought to be a priority for developing countries – at least for the countries in our sample. In order to facilitate that laws and regulations pertaining to listing requirements need to be relaxed for both local and foreign investors. Additional actors operating in the stock market will likely enhance competition and the quality of securities offered on the floor of these markets. Regulators can also encourage additional trading of the stocks that are already listed by encouraging and further facilitating electronic trading. Finally, enhancing investor confidence through mandatory and timely disclosure of accurate information will likely lead to increased stock market activity and generate positive spin-offs for the economy.

Curiously, our study also finds the presence of bidirectional causality between a third indicator of stock market development and economic growth [TUR <= GDP; TUR <= PGDP] which supports the feedback hypothesis. This finding parallels to the studies by Enisan and Olufisayo (2009), Deb and Mukherjee (2008), Shahbaz et al. (2008) and El-Wassal (2005). The result here suggests that stock market development possess a noteworthy constructive long run impact on economic growth and vice versa. Naturally, the magnitude of the dependency of the stock market development on economic growth depends upon the policy framework in an economy. If economic growth is procured through promotion of stable and free markets, stock markets will likely prosper more and perform better over time.

Our results also uncover finds the existence of unidirectional causality from stock market development to inflation [MAC => INF; TRA => INF; TUR => INF] which supports the supply-leading hypothesis between stock market development and inflation. These findings are similar to those of Shahbaz et al. (2008), Han et al. (2008), Liu and Sinclair (2008), Wei and Yong (2007) and Zhao (1999). On the basis of this result, we can argue that stock market development has a significant role in determining macro policies of a developing country, including its optimal money supply which obviously also affects inflation.

Finally, our study reveals existence of bidirectional causality between inflation and economic growth [INF <=> GDP; INF <=> PGDP] which supports existence of feedback between these variables. The results are in line with the results obtained by Klasra (2011), Nguyen and Wang (2010), Andrés et al. (2004), Andres and Hernando (1997), and Baillie et al. (1996) and are intuitive. The findings reflect the notion that changes in the rate of inflation can produce changes in economic growth and vice versa and are consistent with the theory of endogenous-growth, which links the price level to the marginal product of capital and therefore the rate of economic growth. That is, changes in the price level can impact economic growth. Obversely, policies that raise growth (for instance, the expansionary fiscal and monetary policies) have the potential to raise prices. It may be fair to state that the long-run relation between inflation and output growth is
backward-bending: growth rises with inflation at low inflation rates, but falls with inflation at high inflation rates (see, for instance, Vaona, 2012; Billmeier and Massa, 2007).

5. Conclusions and Policy Implications

The paper investigates the causal relations among stock market development, inflation, and economic growth in 16 Asian countries for the period 1988-2012. The nexus between these three macro-economic entities are intriguing and of acute interest to policymakers. Using the state-of-the-art panel VAR model, this study reaches the following conclusions:

First, various indicators of stock market development, inflation, and economic growth are integrated of order one for the sixteen Asian countries in our panel. Second, Pedroni’s panel cointegration test confirms the existence of a long run equilibrium relationship among these variables. Third, panel Granger causality test confirms existence of a multitude of causal relations between the three variables. In particular, whether there is a unidirectional or bidirectional causal effect between stock market development and economic growth depends on which indicator of the stock market development one uses. Finally, results suggest that stock market development and inflation may accelerate the pace of economic performance of the countries.

The policy implications of our results are straightforward. If governments of emerging economies in Asia wish to generate additional economic growth, they should foster further development of the stock markets in their economies. However, policy makers should be cognizant of a downside to stock market development and economic growth, namely inflation. This inflation may be kept in check through appropriate mix of monetary and fiscal policies, including tighter control of the money supply, responsible government spending, and encouragement of productivity.

References


On line Annex at the journal Website: http://www.usc.es/economet/eaat.htm
Annex. Unit root

We deployed panel unit roots tests developed by Levin-Lin-Chu (LLC) [Levin et al., 2002] and Im-Pesaran-Shin (IPS) [Im et al. (2003)]. Both LLC and IPS are widely used and are consistent with the ADF approach. The LLC test assumes homogeneity in the dynamics of the autoregressive coefficients for all panel values, while the IPS test assumes heterogeneity in these dynamics. Therefore, the IPS test is known also as the “heterogeneous panel unit root test”.

LLC is a panel-based augmented Dickey-Fuller (ADF) test which restricts \( \gamma_i \) to keep it identical across cross-sectional countries. The subscript \( i \) on the intercept term suggests that the intercepts of countries may be different. The test supposes homogeneity of the autoregressive coefficient (\( \beta \)) to indicate the presence or absence of a unit root, whereas the intercept and trend can vary across individual series. The model allows heterogeneity only in relation to the intercept and can be represented as follows:

\[
\Delta Y_{i,t} = \alpha_i + \gamma_i Y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{i,j} \Delta Y_{i,t-j} + \varepsilon_{i,t} \tag{1}
\]

where \( Y_{i,t} \) is a time series for panel member (country) \( i = 1, 2, ..., N \) over period \( t = 1, 2, ..., T \), and \( p_i \) is the number of lags in the ADF regression. The error term \( \{\varepsilon_{i,t}\} \) is assumed to be IID \((0, \sigma^2)\) and independent across the members of the sample. The model allows for fixed effects, unit-specific time trends and common time effects. The coefficient \( \{\beta_{i,j}\} \) of the lagged dependent variable is restricted to be homogenous across all units of the panel. Hence, the null hypothesis of non-stationarity is stated as

\[
H_0: \gamma_i = 0 \text{ is tested against the alternative } H_A: \gamma_i = \gamma < 0 \text{ for all } i \tag{2}
\]

where the fixed effect model in equation (1) is based on the usual t-statistics.

\[
t_{}\gamma = \frac{\tilde{\gamma}}{s.e(\tilde{\gamma})} \tag{3}
\]

where \( \gamma \) is restricted by being kept identical across regions under both null and the alternate hypotheses. The IPS test arises from separate ADF regression for each cross section (country) member:

\[
\Delta Y_{i,t} = \alpha_i + \gamma_i Y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{i,j} \Delta Y_{i,t-j} + \varepsilon_{i,t} \tag{4}
\]

where series \( Y_{i,t} \) \( i = 1, 2,...,N; t = 1, 2, ..., T \) is the time series for panel member (country/region) \( i \) over period, \( p_i \) is the number of lags in the ADF regression, and the error terms \( \{\varepsilon_{i,t}\} \) are assumed to be IID \((0, \sigma_i^2)\) for all \( i \) and \( t \). Both \( \gamma_i \) and the lag order \( \beta_{i,j} \) in equation (4) are allowed to vary across sections (countries). IPS relaxes the assumption of homogeneity of the coefficient(s) of the lagged dependent variable. It appraises the null hypothesis that each time series in the panel has a unit root (i.e. its first differences are stationary) for all cross-section units against the alternative hypothesis that at least one of the series is stationary.

\[
H_0: \gamma_i = 0 \text{ is tested against the alternative } H_A: \gamma_i = \gamma_i < 0 \text{ for all } i \tag{5}
\]

The IPS developed two test statistics and then used those respectively in the LM-bar and the t-bar tests. The IPS t-bar statistic is calculated using the average of the individual Dickey-Fuller \( \tau \) statistic shown below.

\[
\bar{\tau} = \frac{1}{N} \sum_{i=1}^{N} \tau_i \tag{6} \quad \tau_i = \frac{\tilde{\gamma}_i}{s.e(\tilde{\gamma}_i)} \tag{7}
\]
Assuming that the cross-section, time-series data are independent of each other, IPS uses the standardized t-bar statistic,

\[ Z = \frac{\sqrt{N} (\bar{t} - E(\bar{t}))}{\sqrt{Var(\bar{t})}} \]  

(8)

The terms \( E(\bar{t}) \) and \( Var(\bar{t}) \) are the mean and variance respectively of the \( \tau \) statistic. These statistics are generated by simulation and their critical values are tabulated in Im et al. (2003).

### Table 2. Results from Panel Unit Root Test

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>PGDP</th>
<th>MAC</th>
<th>TRA</th>
<th>TUR</th>
<th>INF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: At the Level Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLC</td>
<td>3.37</td>
<td>4.10</td>
<td>-2.67</td>
<td>-2.97</td>
<td>-2.29</td>
<td>-3.28</td>
</tr>
<tr>
<td>IPS</td>
<td>6.19</td>
<td>6.14</td>
<td>-0.21</td>
<td>-0.43</td>
<td>-2.78</td>
<td>1.33</td>
</tr>
<tr>
<td>ADF</td>
<td>9.99</td>
<td>10.4</td>
<td>31.5</td>
<td>29.5</td>
<td>54.9</td>
<td>37.2</td>
</tr>
<tr>
<td>PP</td>
<td>11.1</td>
<td>11.0</td>
<td>36.9</td>
<td>43.4</td>
<td>67.5</td>
<td>18.3</td>
</tr>
<tr>
<td>Model 2: At the First Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLC</td>
<td>-6.78*</td>
<td>-6.78*</td>
<td>-9.43</td>
<td>-7.79*</td>
<td>-7.54*</td>
<td>-4.47*</td>
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<tr>
<td>IPS</td>
<td>-5.76</td>
<td>-5.74*</td>
<td>-9.24</td>
<td>-7.89*</td>
<td>-8.14</td>
<td>-4.26*</td>
</tr>
<tr>
<td>ADF</td>
<td>90.8*</td>
<td>90.5*</td>
<td>145*</td>
<td>123.4*</td>
<td>127*</td>
<td>75.90*</td>
</tr>
<tr>
<td>PP</td>
<td>148*</td>
<td>145.3*</td>
<td>459*</td>
<td>221.4*</td>
<td>268*</td>
<td>101.5*</td>
</tr>
</tbody>
</table>

**Note:** LLC: LLC statistics; IPS: IPS statistics; ADF: ADF statistics; PP: PP statistics. * indicates significance at 1% level. List of variables is given in Table 1.

### Table 3. Results from Pedroni’s Panel Cointegration Test

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel (within dimension)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel v- statistic</td>
<td>-3.9</td>
<td>-3.10</td>
</tr>
<tr>
<td>Panel ρ- statistic</td>
<td>0.23</td>
<td>-0.23</td>
</tr>
<tr>
<td>Panel PP- statistic</td>
<td>-2.52*</td>
<td>-2.17*</td>
</tr>
<tr>
<td>Panel ADF- statistic</td>
<td>-1.75**</td>
<td>-1.84**</td>
</tr>
<tr>
<td>Group (between dimension)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group ρ- statistic</td>
<td>1.89</td>
<td>1.47</td>
</tr>
<tr>
<td>Group PP- statistic</td>
<td>-2.85*</td>
<td>-2.81*</td>
</tr>
<tr>
<td>Group ADF- statistic</td>
<td>-0.99</td>
<td>-0.94</td>
</tr>
</tbody>
</table>

**Note 1:** *indicates significance at 1% level; ** indicates significance at 5% level; estimation follows no deterministic trend. **Note 2:** Model 1 presents the cointegration between GDP, MAC, TRA, TUR and INF, while Model 2 presents the cointegration between PGDP, MAC, TRA, TUR and INF. **Note 3:** Test for cointegration was performed under three different scenarios: with no intercept and trend; with only intercept; and with intercept and trend. The results reported in this table are for the case of no intercept and trend. Other cases generate similar results, which are available from the authors upon request.

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