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STOCK MARKET DEVELOPMENT AND ECONOMIC GROWTH: EVIDENCE FROM BOOTSTRAP PANEL GRANGER CAUSALITY TEST

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The paper presents causality analysis between stock market development and economic growth for 25 advanced economies over the period 1975-2011. We apply bootstrap panel Granger causality method (Emirmahmutoglu and Kose, 2011) for this purpose, which incorporates heterogeneity and cross-sectional dependence in a panel framework. Using alternative measures of stock market size and liquidity, we find evidence of uni-directional causality from stock market development to growth in case of individual countries as well as with panel statistics in the presence of cross-sectional dependence which support supply leading hypothesis (stock market led growth). However, we hardly find any evidence of demand-following hypothesis or feedback hypothesis. Findings also reveal that market size is relatively more important than liquidity measures in case of advanced economies despite favourable theoretical prediction that stock market liquidity might ease investments, improve allocation of capital and enhance prospects for economic growth. Probable policy implications that emerge from experiences of advanced economies is that despite several unfavourable features of stock market development, which put certain market dominated advanced economies in disadvantageous positions compared to certain bank-based economies, emerging economies should certainly focus on stock market development as alternative potential means of financial development and hence long-term economic growth.

Keywords: Stock Market Development, Economic growth, Panel Causality
JEL Classification: O16, O47, C23

1. INTRODUCTION

There are conflicting theoretical predictions about overall effect of financial development, as well as separate effects of stock market and banks, in the process of long-term economic growth. Several theoretical as well as empirical models predict that well-functioning markets and financial intermediaries facilitate the pace of mobilisation of savings and contribute to economic growth through reduction of information costs (Boyd and Prescott, 1986; Allen, 1990; Greenwood and Jovanovic, 1990), reduced transactions costs (Greenwood and Smith, 1997; Levine, 1997), through elimination of liquidity risk (Bencivenga et al., 1996) and diversification of risks (Greenwood and Jovanovic, 1990; Devereux and Smith, 1994). Levine (1997) concludes that countries with active stock markets and large banking networks grow faster over subsequent decades even after controlling for several other factors underlying economic growth. Industries and firms that rely heavily on external financing grow disproportionately faster in countries with well-developed banks and securities markets than in countries with poorly developed financial systems (Rajan and Zingales, 1998).

Existing literature also provides conflicting predictions as to whether stock markets and banks are substitutes or compliments or whether one is more conducive to growth than other. While Stiglitz (1985) argues that stock markets hardly improves resource allocation and corporate governance, Boyd and Prescott (1986) show that banks ease informational asymmetries in allocation of resources. On the other hand, Allen and Gale (1999) argue that with new technologies, investor's diversity of opinion reflects differences in prior beliefs rather than differences in information. Financial market in general, and stock market, in particular, however, have the advantage in that these markets allow individuals with similar views to join together in financing projects and finance can be provided by the market even when there is great diversity of opinion among investors. Allen and Gale (2000), further argue that markets may mitigate the monopoly power exercised by banks and emphasise that competition in markets may promote innovative and growth enhancing activities as opposed to conservative approaches of banks. Greenwood and Smith (1997) build their hypothesis on feedback effects in that markets play a crucial role in economic development and that economic development leads to the formation of new markets which is endogenous. They show that market formation would typically require some period of real development and market formation would, in turn, enhance growth afterwards because markets promote the allocation of capital to its highest return uses, alter composition of saving, and foster specialization.

Amidst this debate over stock market versus banks, it is worthy to mention specifically that stock market may affect economic growth through three specific channels – growth of savings, efficient allocation of investment resources and better allocation of existing resources performed by two market mechanisms: take-over mechanisms and pricing process. Singh (1993) mentions that stock markets encourage savings in an economy providing households additional financial instruments which may better meet their risk preferences and liquidity needs. In a well-developed stock market, share ownership provides individuals with relatively liquid means of sharing risks in investment projects. Contrary to expectations, however, evidence from developed country stock markets such as UK, USA, Germany and Japan reveal that performance of stock markets in growth of savings is either negative or barely positive over 1970-85, and internal sources of funds such as retained earnings appeared to be the major source of corporate finance (Mayer, 1990). These finding are also theoretically consistent with pecking order theory of finance. Second, pricing of shares in stock market is critical to allocative efficiency in that an efficient pricing mechanism leads to higher valuation of well-managed and profitable firms than unprofitable ones. This, in turn, leads to lowering of cost of capital and hence greater allocation of new investment capital to profitable firms.

Against this background, this paper exclusively looks into the direction of causality between stock market development and economic growth. In fact, our motivation lies in whether stock market development contributes to economic growth or it passively responds to growth. If stock market development causes economic growth, policies should aim at fostering stock market development as an engine of economic growth. However, if it merely responds to economic growth, it implies that immediate focus has to be on other growth determinants which would result in faster economic growth. This, in turn, would stimulate further development in stock market. Secondly, scant evidence on stock market-growth causal relationship motivates us to examine this relationship.

In doing this, we take recourse to three competing hypotheses of Patrick (1966) which summarised the link between financial development and economic growth: demand following, supply leading and feedback hypothesis. We test these hypotheses in the context of stock market-growth relationship. Under demand following hypothesis, higher economic growth creates demand for certain financial instruments and services, which leads to establishment of institutions (banks etc.) to cater to those needs (Robinson, 1952). On the contrary, under the supply leading hypothesis, a well-functioning stock market is supposed to channelize resources from surplus units to deficit units so as to provide an efficient allocation of resources and create conditions in the economy that result in higher economic growth and higher income per capita.[1] Third, feedback hypothesis states that financial development and growth reinforces each other. Following the third hypothesis, an economy with a well-developed stock market is supposed to promote higher economic expansion through allocation of capital to its highest return uses, changes in composition of saving, specialization and technological changes, which, in turn, would generate higher demand for stock market instruments. As stock market effectively responds to this demand, these changes will stimulate higher economic growth. Both stock market and economic development are, therefore, supposed to be positively interdependent as per the feedback hypothesis and their relationship could be bi-directional. We examine these hypotheses for a panel of advanced economies in Granger (1969) causality framework for 25 advanced economies for the period, 1975-2011. We apply Emirmahmutoglu and Kose (2011) panel Granger causality method which uses Toda and Yamamoto (1995) Granger causality testing procedure and employ bootstrapping.

Major contributions of this paper are as follows. First, to the best of our knowledge, this is perhaps the first study that examines exclusively, Granger causality relation

[1] For detailed review of role of financial development in economic growth, see Levine (1997, 2005).

between stock market development and growth in panel framework taking care of issues related to corss-sectional dependence. Causal relation between stock market and growth is important in the sense that it may provide policy guidance related to stock market development particularly in emerging and developing countries where stock markets are in nascent stages of development. Secondly, unlike previous studies on financial development in general, and stock market development in particular, and their relation to economic growth, we apply one of the most advanced causality framework (Emirmahmutoglu and Kose, 2011) which incorporates cross-sectional dependence in sample countries. This is important as ignoring cross-sectional dependence may produce biased results (Bai and Kao, 2006).[2] Moreover, this method allows us to investigate causal relation for each country in our sample. This aspect seems to be important as panel results overlooks heterogeneity in individual results. This method however, also allows for testing the joint hypothesis of Granger causality with panel statistics which have higher statistical power than time series based methods (Breitung and Pesaran, 2008). Considering the importance of both panel and individual results of Granger causality, both types of statistics seems to be important in providing robustness to the analysis. Thirdly, existing studies on causality mainly focus on measures of financial intermediary development (Demetriades and Hussein, 1996; Calderon and Liu, 2003; Christopoulos and Tsionas, 2004). However, our study exclusively focuses on causal relationship between stock market development and economic growth thereby explores the role of markets in long term economic growth. We also consider one of the longest time series data available which provides us sufficient number of time points to uncover causal patterns in individual as well panel results. Lastly, from methodological point of view, we use two additional panel statistics suggested by Choi (2001) in addition to Fisher statistic used in EK method which provides more robustness to our results.

Rest of the paper is structured as follows. Section 2 provides a brief review of relevant literature. Section 3 presents econometric methodology. Section 4 presents description of data. Section 5 provides empirical results and discusses the implications of our findings. Section 6 concludes the paper.

2. LITERATURE REVIEW

Since last two decades, there has been significant focus on the role of stock market in economic growth (Demirgüç-Kunt and Levine, 1996; Levine and Zervos, 1996, 1998; Korajczyk, 1996).[3] A considerable amount of empirical literature has evolved providing

[2] One important issue while dealing with panel data models is that cross-sections may be correlated and some common factor may influence observations in all the cross-sections which may make these individual units in panel cross-sectionally dependent. Accounting for cross-sectional dependence may alter results and substantially modify conclusions made by panel tests which doesn't account for cross-sectional dependence.

[3] Although, a sizable amount of empirical literature has evolved over the years, unavailability of

evidence in favour of growth stimulating effects of stock market development (Atje and Jovanovic, 1993; Levine and Zervos, 1996). Levine and Zervos (1998) investigate the effect of stock market development in economic growth for a sample of 47 countries for the period of 1976-93 and provide evidence in favour of positive effect of stock market development on economic growth and results are robust towards different indicators of stock market development. Rousseau and Wachtel (2000) study the link between stock market development and economic growth for 47 countries for the period 1980-1995 in a dynamic panel setting and concludes that stock market liquidity is highly important for economic growth. Mauro (2003) argued that stock market is a stable factor of economic growth in emerging economies. Henry (2000a, 2000b) finds that stock market liberalization results in reduction of cost of capital for firms and hence results in capital growth and ultimately leads to increased growth of per capita income. Arestis et al. (2001) finds in the context of select five developed economies, stock market exerts relatively less effect on growth than banks. Beck and Levine (2004) find that countries with greater stock market depth and liquidity grows, on an average, faster than countries with under-developed stock markets. Caporale et al. (2004) finds that well developed stock markets foster economic growth through its effect on capital accumulation and economic efficiency through better resource allocation.

also focused on unresolved issues as to the direction of causality between financial development and growth (Demetriades and Hussein, 1996; Calderon and Liu, 2003; Christopoulos and Tsionas, 2004). Christopoulos and Tsionas (2004) used a panel dataset of 10 developing economies and apply panel unit root tests and panel cointegration tests to examine the direction of causality between financial development and economic growth. They found fairly strong evidence of causality running from financial development to growth but hardly found any evidence of bi-directional causality. Calderon and Liu (2003) apply Geweke decomposition test on pooled data of 109 developing and industrial countries for the period 1960-1994 and examine direction of causality between financial development and growth focusing on measures of financial intermediary development. They find evidence in support of Granger causality from financial development to growth as well as from economic growth to financial development. On the whole, above-mentioned studies exhibit mixed evidence as to the direction of causality. That apart, most of these causality analyses used broad measures of financial intermediary development: such as money supply and bank credit expressed as proportions of GDP. None of these studies, however, focussed exclusively on measures of stock market development to examine Granger causal relation between stock market development and economic growth.

Empirical literature identified few channels through which stock market may influence growth. Stock markets provide alternative savings opportunities by making available a set of financial instruments to savers in addition to bank deposits thereby

systematic data on measures of stock market development for large set of countries and longer period of time, previously, posed a constraint on studies on stock market development and growth.

enabling savers to diversify their portfolios. This, in turn, provides an important source of investment capital (Dailami and Aktin, 1990). Greenwood and Smith (1997) and Levine and Zervos (1996) find that large stock markets can lower the cost of mobilizing savings and thereby facilitate investment in most productive technologies which leads to higher rate of economic growth. Savers, in general, are unwilling to relinquish control of their savings for longer period whereas innovative projects with highest returns often require long-term commitment of funds. Therefore, in the absence of well-developed stock markets, savings doesn't get channelized into long-term investments which may have adverse implications for growth. Levine and Zervos (1996) find that active stock markets reduce liquidity risk for the borrowers as investors can easily liquidate their stock holdings in an active stock market. Stock markets provide alternate source of raising capital to firms for long-term investments which are crucial for long-term economic growth of an economy. Stock markets may result in higher per capita income through reduction of transaction cost (Bencivenga et al., 1996) and hence, provide opportunity to savers to hold different stocks. This risk diversification leads to more activity in stock market; hence, more savings are channelized into investments (Devereux and Smith, 1994). Stock markets also foster growth through better corporate governance and control (Diamond and Verrecchia, 1982; Jensen and Murphy, 1990). In active stock markets, investors reward particular firms for better performance by generating demand for shares which may result in better managerial control for the firms (Levine, 1997). Kar et al. (2011) use the method proposed by Konya (2006) to examine the causality between financial development and economic growth and their findings show no evidence of causality between financial development and economic growth which supports Lucas's (1988) argument that the role of financial institutions is overemphasized in the process of economic development.

3. ECONOMETRIC METHODOLOGY

3.1. Test of Cross-Sectional Dependence

Prior to Granger causality tests using EK method, we test the assumption of cross-sectional dependence which tests whether errors in panels are cross-sectionally correlated or not. Cross-sectional dependence (or cross-sectional correlation) may arise due to fact that a shock originating in one country may also affect other countries due to high degree of globalization and financial integration (Kar et al., 2011; Chang et al., 2014). Given this, panel data sets are likely to exhibit substantial cross-sectional dependence, which may occur due to the presence of common shocks and unobserved components as a part of error term. Cross-sectional dependence across countries may play a crucial role in deriving causal linkages (in favour or against causality) between stock market development and economic growth. In particular, cross-sectional dependence in cross-country study such as ours may arise due to labour and capital migration, spatial correlations, spill-over effects, economic distance, omitted global variables and common unobserved shocks (Omay and Kan, 2010). In today's context of globalised financial markets, stock markets are integrated or cross-sectionally dependent due to fast computing and information flow across the continents which provides considerable ease to market participants to switch between stock markets for better returns and similarly, economic growth of advanced economies is linked through channels such as trade and investments etc (Kar et al., 2011).

We apply Pesaran (2004) test to check evidence of cross-sectional dependence in this study. The test has null hypothesis of no cross-sectional dependence and is based on CD-statistic, which is calculated as below.

$$CD = \sqrt{\frac{2T}{n(n-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}, \text{ and } CD \sim N(0,1), \quad (1)$$

where $\hat{\rho}_{ij}$s are the pairwise correlation coefficients of OLS residuals (e_{it}) from individual regression of cross-sections and is given as below.

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{i=1}^{T} e_{it}e_{jt}}{(\sum_{t=1}^{T} e_{it}{}^2)^{1/2}(\sum_{t=1}^{T} e_{jt}{}^2)^{1/2}}. \quad (2)$$

3.2. Bootstrap Panel Granger Causality

We examine causality between stock market development and economic growth using Emirmahmutoglu and Kose (2011, EK from hereon) method which allows us to test Granger causality for each cross-section as well as allows to test the joint hypothesis of Granger causality using panel statistics. EK method proposes a simple Granger causality test based on meta-analysis in heterogeneous mixed panels and can be used in mixed panels involving stationary, non-stationary, cointegrated and non-integrated series (Seyoum et al., 2015). EK method extended the time series based Granger causality testing procedure to panel settings using modified Wald statistic in a lag augmented vector autoregression (LA-VAR) framework proposed by Toda and Yamamoto (1995, TY from hereon) and applies bootstrapping to account for cross-sectional dependence. In LA-VAR framework, we estimate a level $VAR(k_i + dmax_i)$ in heterogeneous mixed panel. The reason for estimating lag augmented VAR model is that standard asymptotic theory is not applicable in Granger causality testing in level VAR model if variables are integrated or cointegrated (Park and Phillips, 1989; Sims et al., 1990; Toda and Phillips, 1993). Therefore, pre-testing of order of integration and cointegration is generally done to specify VAR model appropriately which results in pre-test bias (Emirmahmutoglu and Kose, 2011). This pre-test bias arises because unit root and cointegration tests have low statistical power and different testing procedures often provide contradictory results. Therefore, the failure to accurately specify VAR model in conventional Granger causality procedure may provide false prediction as to the direction of causality. TY provided an alternative method to circumvent this problem by using modified Wald statistic in a lag augmented VAR (LA-VAR) model as specified below.

$$y_{i,t} = \alpha_i + \sum_{l=1}^{k_i+dmax_i} \gamma_i y_{i,t-l} + \sum_{l=1}^{k_i+dmax_i} \beta_i x_{i,t-l} + \varepsilon_{i,t}, \tag{3a}$$
$$x_{i,t} = \alpha_i{}' + \sum_{l=1}^{k_i+dmax_i} \gamma_i{}' x_{i,t-l} + \sum_{l=1}^{k_i+dmax_i} \beta_i{}' y_{i,t-l} + \varepsilon_{i,t}{}'. \tag{3b}$$

Here, y_{it} and x_{it} denote measure of economic growth and indicators of stock market development, respectively; $t = 1, 2, 3, \cdots, T$ denotes time period and i (i=1, $\cdots$, N) denotes individual cross-sectional units; α_i and $\alpha_i{}'$ are two vectors of fixed effects; $\varepsilon_{i,t}$ and $\varepsilon_{i,t}{}'$ are column vector of error terms. Lag structure is denoted using k_i and may differ across cross-sectional units; l denotes number of lags; $dmax_i$ denotes the maximum order of integration suspected in the system for each cross-section.

VAR model specified in Eq (3a) and (3b) is estimated for each cross section and Wald Statistic obtained for each cross-section is termed the modified Wald statistic (M-Wald); it is chi-square distributed with $k_i + dmax_i$ degrees of freedom.[4] Inference on Granger causality is drawn on the basis of M-Wald statistics. In TY methodology, we need not know exact order of integration to be specified for VAR model; here, we need to calculate maximum order of integration to be specified in VAR system of equations ($dmax_i$) through conventional time series unit root test procedure. The joint hypothesis of Granger causality for the panel is tested through panel statistics which have higher statistical power than corresponding time series based testing procedure (Breitung and Pesaran, 2008). The hypothesis of Granger causality testing from x to y in panel set-up is specified as:

$H_0: \beta_i = 0$, for all i,

Against

$H_1: \beta_i \neq 0$, for at least one i.

Panel statistics suggested by EK (2011) is based on Fisher (1932) type statistic and is calculated as:

$$F = -2 \sum_{i=1}^{n} ln(p_i). \tag{4}$$

Here, n denotes number of cross-sections; p_i is the p-value corresponding to the M-Wald statistic of i^{th} cross-section. The advantage of using Fisher-type panel statistic

[4] Yamada and Toda (1998) shown that pre-test bias and size distortions can be avoided asymptotically by using LA-VAR model in which we need not to test for correct order of integration or cointegration. And, actual size of LA-VAR quickly approaches the asymptotic size as the sample size increase.

is that, we need not make homogeneity assumption while making inference on causality. If the individual cross-sections are independent (i.e. there is no cross-sectional dependence), then F statistics is chi square distributed with 2*n degrees of freedom.

In addition to usual Fisher test (Fisher, 1932), we also calculate two more statistics of the same form as used by Choi (2001) in the context of panel unit root, these are calculated as:

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{n} \Phi^{-1}(p_i) \Rightarrow N(0,1), \quad (5)$$

$$L = \frac{1}{\sqrt{\frac{\pi^2 N}{3}}} \sum_{i=1}^{n} ln\left(\frac{p_i}{1-p_i}\right) \Rightarrow N(0,1). \quad (6)$$

In above equations, $\Phi(\cdot)$ is the standard normal cumulative distribution. Z statistic is proposed by Stouffer et al. (1949) and is called inverse normal test. L test is termed as the logit test (George, 1977). Choi modified these test statistics and apply these in the context of panel unit root testing which we termed as $Zchoi$ and $Lchoi$. Advantage of using above panel statistics is that heterogeneity of individual cross-sectional units in panel is well taken care of while calculating panel statistics. However, as mentioned above, panel statistics have standard distributions only if the individual units are cross-sectionally independent. Therefore, to account for cross-sectional dependence, EK suggest bootstrap procedure to calculate critical values of the modified Wald statistic as well as panel statistics (bootstrap procedure applied in EK method is described in appendix).

4. DATA DEFINITION AND SOURCES

In this paper, we consider an unbalanced panel of 25 advanced economies[5] for 1975-2011. Real annual per capita GDP growth (GROWTH) is considered as the indicator of economic development and data are procured from PWT 8.1 (Feenstra et al., 2015).[6] Three indicators of stock market development are employed in this study: 1)

[5] Our sample countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Israel, Italy, Japan, South Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States. These are classified as advanced economies as per IMF classification. https://www.imf.org/external/pubs/ft/weo/2014/02/weodata /groups.htm. We consider this set of advanced economies in our study as these economies mostly have established stock markets compared to those in emerging and developing economies such that we obtain sufficiently consistent long data series. Moreover, inferences on causality in mature stock markets may provide policy implications for stock market development even for economies with stock markets in nascent stages of development.

[6] Available at http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1 (accessed 21st June, 2016)

stock market capitalisation to GDP ratio (MARKET CAP), 2) ratio of value of total shares traded to market capitalization (TURNOVER RATIO) and 3) ratio of value of total shares traded to GDP (VALUE TRADED).[7] MARKET CAP is considered as the indicator of stock market size and signifies the extent to which investors can diversify risk (Demirgüç-Kunt and Maksimovic, 1996; Levine and Zervos, 1996). TURNOVER RATIO measures the degree of activity in the stock market and VALUE TRADED also signifies activities of a stock market. While VALUE TRADED is measured with respect to size of the economy, TURNOVER RATIO is measured with respect to size of the stock market. Therefore, turnover ratio of small stock market in a relatively bigger economy can be large even if value traded is smaller. Thus, liquidity measures compliment the measure of stock market size and may significantly affect growth by easing investments in long-term projects, promote acquisition of information about firms and managers, thereby improving corporate governance (Holmstrom and Tirole, 1993). Stock market capitalization to GDP ratio (MARKET CAP) shows the kind of diversification opportunities available to investors and therefore, it can be presumed that these big stock markets (with large MARKET CAP) are also liquid. One notable exception is, Luxembourg, where stock market is large in terms of MARKET CAP but the market is less liquid than many other European markets (See Table 1).

Data pertaining to indicators of stock market development is procured from World Development Indicators (WDI).[8] Table 1 present average value of all variables in the study period. We observe that average GDP per capita growth ranges from 0.83% in Italy to 5.61% in South Korea. Hong Kong, Singapore, Switzerland and Luxembourg appear to have the largest stock market in terms of market capitalisation. Hong Kong, Switzerland and United States have most liquid stock markets in terms of value traded to GDP ratio. As far as turnover ratio is concerned, South Korea and Switzerland are among the most developed stock markets. In Figure A1 of appendix, we present average movement of indicators of stock market development over the study period and observe that all indicators of stock market development (market cap, value traded and turnover ratio) have shown, in general, an upward trend during the study period. However, we observe significant slowdown in terms of all indicators during recessionary episodes such as internet bubble-burst in early 2000s and subprime crisis later in that decade.

5. RESULTS AND DISCUSSIONS

We first test whether panel of advanced economies in our sample are cross-sectionally dependent or not. We test cross-sectional dependence using Pesaran (2004) test. Table 2 reveals that null hypothesis of no cross-sectional dependence is

[7] These three indicators of stock market development are most commonly used stock in the literature (See: Levine and Zervos, 1998; Rousseau and Wachtel, 2000; Beck and Levine, 2004).

[8] Available at http://databank.worldbank.org/ (accessed 21st June, 2016).

rejected at 1% level for all the variables, which implies that panel methods testing for causality must account for cross-sectional dependence.

Table 1. Country-wise Mean of Indicators of Stock Market Development and Economic Growth: 1975-2011

Country	GROWTH	MARKET CAP	TURNOVER RATIO	VALUE TRADED
Australia	1.836	75.423	48.204	44.491
Austria	1.974	15.614	51.994	7.006
Belgium	1.710	40.473	22.229	11.126
Canada	1.570	100.475	36.035	39.272
Denmark	1.517	36.040	39.265	20.395
Finland	1.994	68.423	58.560	53.907
France	1.419	40.128	59.995	28.941
Germany	1.826	28.236	97.312	32.342
Greece	1.284	37.754	48.803	22.200
Hong Kong	4.269	325.902	39.225	174.043
Israel	1.871	47.917	40.840	19.564
Italy	0.832	30.686	101.357	35.252
Japan	2.026	65.564	94.142	48.460
South Korea	5.608	39.862	138.456	62.880
Luxembourg	3.159	124.747	1.495	1.771
Netherlands	1.667	62.180	62.264	47.873
New Zealand	1.136	39.770	21.008	8.398
Norway	1.937	35.882	61.953	25.413
Portugal	1.640	30.510	53.389	18.542
Singapore	4.481	154.713	45.522	73.704
Spain	1.658	69.309	57.055	48.962
Sweden	1.723	59.907	58.296	48.782
Switzerland	1.158	140.100	131.410	132.583
United Kingdom	1.868	91.359	54.092	52.101
United States	1.760	83.543	104.348	104.572

Note: GROWTH: growth of real GDP per capita; VALUE TRADED: stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market. Average values of real GDP per capita growth, market cap, value traded and turnover ratio are reported

Table 2. Test of Cross-sectional Dependence

Variable	CD-test	p-value
Growth	12.77***	0.000
Value Traded	45.73***	0.000
Market Cap	48.63***	0.000
Turnover Ratio	28.44***	0.000

Note: *** denotes statistical significance at 1%. GROWTH: growth of real GDP per capita; VALUE TRADED: stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

As stated in previous section, Granger causality test using Toda-Yamamoto (1995) method only requires knowing maximum order of integration ($dmax_i$) suspected in the VAR system of equations. For Granger causality test through VAR set-up (eq. 3a-b) for each country, we need to specify $dmax_i$ for VAR set-up for each country. For this purpose, we conduct augmented Dicky-Fuller unit root test (Dickey and Fuller 1979) for all countries and (Tables 3-5). We observe that while economic growth is stationary at levels for few countries and is integrated of order one for the rest of the countries except Greece and Portugal, which are integrated of order two. For, most countries, MARKET CAP is integrated of order one and for few other countries such as Greece, Italy, New Zealand, Portugal, it is integrated of order two. Therefore, maximum order of integration ($dmax_i$) is one for majority of countries and two for the rest. Similarly, in case of VALUE TRADED and TURNOVER RATIO, ($dmax_i$) is equal to one for majority of countries and two for a few.

Table 3. Maximum Order of Integration-growth and Market Cap

Country	GROWTH			MARKET CAP			dmax
	Level	1st Diff	2nd Diff	Level	1st Diff	2nd Diff	
Australia	0.0126**			0.7686	0.0067***		1
Austria	0.0220**			0.4464	0.0007***		1
Belgium	0.0060***			0.5300	0.0091***		1
Canada	0.0099***			0.2263	0.0027***		1
Denmark	0.0503*	0.0003**		0.8019	0.0025***		1
Finland	0.0835*	0.0048**		0.4720	0.0064***		1
France	0.0115**			0.6681	0.0001***		1
Germany	0.0022***			0.5548	0.0092***		1
Greece	0.9719	0.7682	0.0011***	0.4365	0.0702*	0.0000***	2
Hong Kong	0.1418	0.0000***		0.9979	0.0101**		1
Israel	0.0000***			0.5732	0.0006***		1
Italy	0.4904	0.0019***		0.4883	0.1346	0.0000***	2
Japan	0.6046	0.0002***		0.0592*	0.0028***		1
South Korea	0.1404	0.0000***		0.8495	0.0001***		1
Luxembourg	0.3735	0.0405**		0.3615	0.0327**		1
Netherlands	0.0152**			0.4978	0.0230**		1
New Zealand	0.2639	0.0152**		0.1084	0.1444	0.0000***	2
Norway	0.1790	0.0024***		0.2510	0.0000***		1
Portugal	0.2322	0.0817*	0.0061***	0.4108	0.2379	0.0711*	2
Singapore	0.0404**			0.5228	0.0014***		1
Spain	0.1793	0.0035***		0.4104	0.0063***		1
Sweden	0.0168**			0.6172	0.0041***		1
Switzerland	0.0064***			0.5766	0.0384**		1
United Kingdom	0.1265	0.004***		0.6137	0.0022***		1
United States	0.0049***			0.6709	0.0203**		1

Note: The p-values reported here are MacKinnon p-values as per Augmented Dickey Fuller (ADF) test. ***/**/* denotes statistical significance at 1%, 5% and 10% respectively. GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

Table 4. Maximum Order of Integration: GROWTH and TURNOVER RATIO

Country	GROWTH			TURNOVER RATIO			dmax
	Level	1st Diff	2nd Diff	Level	1st Diff	2nd Diff	
Australia	0.0126**			0.8283	0.0006***		1
Austria	0.0220**			0.0147**			1
Belgium	0.0060***			0.6496	0.0065***		1
Canada	0.0099***			0.8111	0.0001***		1
Denmark	0.0503*	0.0003**		0.7274	0.0001***		1
Finland	0.0835*	0.0048**		0.7975	0.0033***		1
France	0.0115**			0.1400	0.0000***		1
Germany	0.0022***			0.2748	0.0007***		1
Greece	0.9719	0.7682	0.0011***	0.1593	0.0510*	0.0046***	2
Hong Kong	0.1418	0.0000***		0.4088	0.0002**		1
Israel	0.0000***			0.0398**			0
Italy	0.4904	0.0019***		0.7514	0.0011***		1
Japan	0.6046	0.0002***		0.0094***			1
South Korea	0.1404	0.0000***		0.6253	0.0025***		1
Luxembourg	0.3735	0.0405**		0.2074	0.0525*	0.0001***	2
Netherlands	0.0152**			0.5819	0.0000***		1
New Zealand	0.2639	0.0152**		0.5384	0.1423	0.0134**	1
Norway	0.1790	0.0024***		0.2902	0.0027***		1
Portugal	0.2322	0.0817*	0.0061***	0.1996	0.0155**		2
Singapore	0.0404**			0.2647	0.0020***		1
Spain	0.1793	0.0035***		0.3843	0.0009***		1
Sweden	0.0168**			0.6455	0.0006***		1
Switzerland	0.0064***			0.4934	0.0032***		2
United Kingdom	0.1265	0.004***		0.7632	0.0002***		1
United States	0.0049***			0.8791	0.0051***		1

Note: The p-values reported here are MacKinnon p-values as per Augmented Dickey Fuller (ADF) test. ***/**/* denotes statistical significance at 1%, 5%, 10% respectively. GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

Table 5. Maximum Order of Integration-growth and Value Traded

Country	Growth			Value Traded			dmax
	Level	1st Diff	2nd Diff	Level	1st Diff	2nd Diff	
Australia	0.0126**			0.8594	0.0043***		1
Austria	0.0220**			0.1904	0.0020***		1
Belgium	0.0060***			0.5551	0.0191**		1
Canada	0.0099***			0.8104	0.0196**		1
Denmark	0.0503*	0.0003**		0.6813	0.0014***		1
Finland	0.0835*	0.0048**		0.5647	0.0035***		1
France	0.0115**			0.6824	0.0048***		1
Germany	0.0022***			0.3810	0.0115**		1
Greece	0.9719	0.7682	0.0011***	0.1517	0.0189**		2
Hong Kong	0.1418	0.0000***		0.9182	0.0127**		1
Israel	0.0000***			0.4264	0.0208**		1
Italy	0.4904	0.0019***		0.4107	0.0412**		1
Japan	0.6046	0.0002***		0.2852	0.0151**		1
South Korea	0.1404	0.0000***		0.9191	0.0004***		1
Luxembourg	0.3735	0.0405**		0.1191	0.0370**		1
Netherlands	0.0152**			0.5777	0.0037***		1
New Zealand	0.2639	0.0152**		0.5664	0.1242	0.0266**	2
Norway	0.1790	0.0024***		0.5200	0.0636*	0.0040***	2
Portugal	0.2322	0.0817*	0.0061***	0.2497	0.0852*	0.0058***	2
Singapore	0.0404**			0.6663	0.0007***		1
Spain	0.1793	0.0035***		0.4280	0.0027***		1
Sweden	0.0168**			0.7097	0.0012***		1
Switzerland	0.0064***			0.0059***	0.0036***		1
United Kingdom	0.1265	0.004***		0.8810	0.0036***		1
United States	0.0049***			0.8925	0.0015***		1

Note: The p-values reported here are MacKinnon p-values as per Augmented Dickey Fuller (ADF) test. ***/**/* denotes statistical significance at 1%, 5%, 10% respectively. GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

Table 6 presents results based on the test of joint hypothesis of Granger causality between indicators of stock market development and economic growth.[9] We observe

[9] We also conducted Granger causality testing between indicators of stock market development through EK method. As per panel statistics, we observe bi-directional causality between value traded to GDP ratio and stock market capitalisation to GDP ratio; bi-directional causality between turnover ratio and value traded; uni-directional causality from market cap to turnover ratio. We don't present these results in order to focus on causal relationship between stock market development and growth. These results, however, are available on request from authors.

significant evidence of uni-directional causality from MARKET CAP to GROWTH and from TURNOVER RATIO to GROWTH since all panel statistics appear to be statistically significant at 1% and no evidence of reverse causality is observed in any of three indicators of stock market development. These findings support supply-leading view of the role of stock market in growth process. Significant effect of turnover ratio in growth process is consistent with previous literature (Levine and Zervos, 1998; Rousseau and Wachtel, 2000) which found that market liquidity has statistically significant effect on economic growth. However, in case of value traded to GDP ratio (VALUE TRADED), there is no evidence of Granger causality in either direction.

TURNOVER RATIO as well as VALUE TRADED are considered two important measures of liquidity of stock market. Turnover ratio is measured with respect to size of economy and VALUE TRADED is measured with respect to size of the economy. However, absence of causality in either direction in case of VALUE TRADED to GROWTH and presence of causality in case of TURNOVER RATIO to GROWTH reflect that liquidity measured with respect to the size of stock market (i.e. TURNOVER RATIO) is relatively more important than measured with respect to size of economy (i.e., VALUE TRADED). As mentioned in Levine and Zervos (1998), TURNOVER RATIO is a better indicator of stock market liquidity than stock market value traded to GDP ratio.

Table 6. Panel Causality Results

	Panel Statistics	Bootstrap Critical Values			Panel Statistics	Bootstrap Critical Values		
		99%	95%	90%		99%	95%	90%
	MARKET CAP TO GROWTH				GROWTH TO MARKET CAP			
Fisher	250.502***	92.984	78.452	72.565	36.359	99.367	80.857	73.619
Z-Choi	-10.679***	-2.969	-2.18	-1.768	1.810	-3.425	-2.386	-1.854
L-Choi	-13.309***	-3.141	-2.339	-1.849	1.878	-3.719	-2.493	-1.963
	TURNOVER RATIO TO GROWTH				GROWTH TO TURNOVER RATIO			
Fisher	193.365***	90.295	75.804	69.804	51.818	96.053	78.406	70.854
Z-Choi	-6.131***	-2.762	-2.001	-1.565	-0.550	-3.182	-2.126	-1.671
L-Choi	-8.455***	-2.98	-2.126	-1.669	-0.523	-3.413	-2.269	-1.748
	VALUE TRADED TO GROWTH				GROWTH TO VALUE TRADED			
Fisher	53.021	91.068	76.036	69.786	49.647	98.381	79.761	72.875
Z-Choi	-0.178	-2.969	-2.049	-1.570	0.562	-3.368	-2.235	-1.733
L-Choi	-0.208	-3.237	-2.133	-1.631	0.251	-3.637	-2.417	-1.820

Note: ***/**/* denotes statistical significance at 1%, 5%, 10% respectively and ***/**/* in parenthesis denotes statistical significance at 1%, 5%, 10% respectively as per Bootstrap critical values. Lag length is chosen as per SIC and 5000 replications are used to generate bootstrap critical values. GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

Tables 7-9 present results of Granger causality between alternative indicators of stock market development and economic growth for individual countries. [10] Conventional p-values are reported for M-Wald statistic. We compare M-Wald statistics for each country with their respective bootstrap critical values (90, 95 and 99 per cent) to make inference about Granger causality in the presence of cross-sectional dependence. Comparing results based on conventional p-values and bootstrap critical values, we observe that bootstrap critical values are more conservative than conventional critical values (with the assumption of no cross-sectional dependence). The results, however, based on conventional p-values are mostly consistent with results based on bootstrap critical values barring few exceptions. However, inference is mainly made on the basis of bootstrap critical values as these are supposed to be robust towards cross-sectional dependence (Emirmahmutoglu and Kose, 2011). Table 7 shows that null hypothesis of Granger no-causality from MARKET CAP to GROWTH is rejected for 18 of the 25 countries at 5% level (or less) of significance ($p<0.05$). However, we do not find evidence of reverse causality except in case of South Korea, although uni-directional causality from MARKET CAP to GRWOTH is significant at 10% as per conventional p-values for South Korea. However, as per bootstrap critical values, M-Wald statistic turns out to be statistically insignificant even at 10% level that rules out uni-directional causality from stock market capitalization to GDP ratio (MARKET CAP) to economic growth (GROWTH) in the presence of cross-sectional dependence. Weak evidence of reverse-causality (growth led stock market development) is present for South Korea at 10% level of significance (as per bootstrap critical values). Similarly, while looking at causality from MARKET CAP to GROWTH, M-Wald statistic is statistically significant at 5% level for Portugal at conventional p-values, it, however, is significant only at 10% as per bootstrap critical values. Above results also illustrate that not accounting for cross-sectional dependence may provide misleading evidences of Granger causality in few cases.

Table 8 provides evidence in favour of Granger causality from TURNOVER RATIO to GROWTH in ten countries (Belgium, Canada, Germany, Hong Kong, Italy, South Korea, Norway Singapore, United Kingdom and United States) at 5% level of significance in terms of both conventional p-values and bootstrap critical values. However, for Portugal, M-Wald statistic is statistically significant only at 10% level. In case of Spain, M-Wald statistic is statistically significant at 10% level as per conventional p-values but not significant as per bootstrap critical values, hence we rule out causality from TURNOVER RATIO to GROWTH in Spain. Netherlands exhibit evidence of bi-directional causality between GROWTH and TURNOVER RATIO. In case of value traded to GDP ratio (VALUE TRADED), we find evidence in support of supply leading hypothesis (uni-directional causality from VALUE TRADED to GROWTH) for Netherlands and Norway only, whereas South Korea is the only country

[10] We thank Furkan Emirmahmutoglu for providing Matlab code to carry out the Panel Granger Causality analysis, available at http://www.runmycode.org/companion/view/89.

exhibiting reverse causality at 1% level of significance (Table 9). Therefore, for much of the European countries, we find evidence in support of stock market development leading to economic growth. It is interesting to note that market capitalization to GDP ratio (MARKET CAP) as well as value traded to GDP ratio are influenced by high economic growth in South Korea. Stock market development in South Korea also contributes to growth through high turnover ratio. In case of fast-growing economies such as Hong Kong, robust stock market development leads to larger stock market size and liquidity which, in turn, contributes to faster economic growth.

Table 7. Country-wise Bootstrap Granger Causality Results: MARKET CAP and GROWTH

Country	GROWTH TO MARKET CAP					MARKET CAP TO GROWTH				
	M-Wald Stat	p-value	Bootstrap Critical Values			M-Wald Stat	p-value	Bootstrap Critical Values		
			99%	95%	90%			99%	95%	90%
Australia	0.002	0.965	7.401	4.025	2.718	0.041	0.839	8.886	4.635	2.990
Austria	0.329	0.848	11.413	6.430	4.940	22.758***(***)	0.000	10.600	6.494	4.840
Belgium	1.001	0.606	11.455	6.655	4.835	10.21***(**)	0.006	11.083	6.532	4.917
Canada	0.031	0.985	10.746	6.548	4.917	19.129***(***)	0.000	11.406	6.806	5.240
Denmark	0.850	0.654	11.234	6.996	5.105	6.742**(**)	0.034	11.100	6.477	4.794
Finland	0.479	0.489	9.999	4.929	3.283	0.942	0.332	9.958	4.330	2.826
France	1.644	0.439	11.999	7.012	5.047	11.329***(***)	0.003	10.492	6.314	4.788
Germany	1.992	0.369	10.361	6.656	4.971	17.191***(***)	0.000	10.642	6.690	4.956
Greece	0.573	0.449	8.877	4.915	3.289	0.367	0.545	8.512	4.454	3.027
Hong Kong	0.595	0.743	12.469	7.116	5.161	7.768**(**)	0.021	12.832	7.408	5.212
Israel	0.000	0.993	7.405	4.116	2.809	5.683**(**)	0.017	7.371	3.902	2.706
Italy	0.334	0.846	16.738	8.519	6.062	10.533***(**)	0.005	15.602	9.118	6.524
Japan	0.605	0.437	7.280	4.294	2.921	5.606**(**)	0.018	7.737	4.391	2.917
South Korea	6.274**(*)	0.043	13.293	7.704	5.736	4.767*	0.092	12.286	6.993	5.045
Luxembourg	1.724	0.189	7.887	4.318	3.068	0.298	0.585	7.275	4.146	2.920
Netherlands	0.056	0.972	11.391	6.609	5.027	34.516***(***)	0.000	12.494	6.935	5.067
New Zealand	2.075	0.354	13.499	7.513	5.459	3.113	0.211	15.170	8.115	5.804
Norway	2.575	0.276	11.665	7.183	5.329	4.074	0.130	11.468	6.911	5.152
Portugal	0.461	0.794	16.167	8.647	6.236	7.773**(*)	0.021	14.550	8.329	5.946
Singapore	4.060	0.131	11.912	6.596	4.940	8.915**(**)	0.012	11.903	6.948	5.177
Spain	0.008	0.927	7.798	4.128	2.963	8.669***(***)	0.003	7.772	4.159	2.894
Sweden	0.153	0.696	7.814	4.116	2.879	8.274***(***)	0.004	8.217	4.371	2.976
Switzerland	1.629	0.202	7.444	4.129	2.811	4.637**(**)	0.031	7.488	4.206	2.887
United Kingdom	1.544	0.462	10.921	6.447	4.950	19.707***(***)	0.000	10.710	6.691	5.066
United States	0.352	0.839	10.914	6.797	4.939	11.527***(***)	0.003	10.715	6.782	5.101

Note: GROWTH: Growth of real GDP per capita; MARKET CAP: Stock market capitalisation to GDP ratio. ***/**/* denotes statistical significance at 1%, 5%, 10% respectively and ***/**/* in parentheses denotes statistical significance at 1%, 5%, 10% respectively as per Bootstrap critical values. Lag length is chosen as per Schwarz Information Criteria (SIC) and 5000 replications are used to generate bootstrap critical values.

Table 8. Country-wise Bootstrap Granger Causality Results: TURNOVER RATIO and GROWTH

Country	GROWTH TO TURNOVER RATIO					TURNOVER RATIO TO GROWTH				
	M-Wald Stat	p-value	Bootstrap Critical Values			M-Wald Stat	p-value	Bootstrap Critical Values		
			99%	95%	90%			99%	95%	90%
Australia	0.614	0.433	7.517	4.093	2.840	0.053	0.817	10.287	4.918	2.991
Austria	0.102	0.750	12.687	4.469	2.733	0.231	0.631	9.491	4.055	2.646
Belgium	0.260	0.610	7.720	4.321	2.950	9.583***(***)	0.002	7.534	4.224	2.882
Canada	2.126	0.145	7.485	4.098	2.838	9.168***(***)	0.002	8.341	4.205	2.809
Denmark	0.746	0.388	7.925	4.214	2.804	0.067	0.796	7.425	4.253	2.847
Finland	0.496	0.481	7.671	4.167	2.839	0.998	0.318	8.046	4.208	2.926
France	0.006	0.938	10.419	4.885	3.131	0.740	0.390	8.291	4.287	2.823
Germany	1.382	0.240	7.308	4.303	2.805	12.987***(***)	0.000	7.752	4.181	2.825
Greece	0.329	0.566	10.536	4.982	3.272	0.004	0.952	9.129	4.780	3.263
Hong Kong	0.243	0.622	7.991	4.331	2.962	13.524***(***)	0.000	8.577	4.361	2.933
Israel	0.255	0.614	7.165	4.216	2.921	0.464	0.496	6.934	4.061	2.824
Italy	1.517	0.218	9.571	4.859	3.070	9.767***(***)	0.002	9.571	4.655	3.088
Japan	3.001	0.391	13.215	8.959	6.982	0.066	0.996	12.698	8.669	6.933
South Korea	1.742	0.419	16.824	8.999	5.848	41.453***(***)	0.000	20.047	9.323	5.857
Luxembourg	1.899	0.168	8.979	4.618	3.138	0.029	0.866	7.992	4.308	3.025
Netherlands	4.418**(**)	0.036	7.525	4.276	2.922	13.693***(***)	0.000	8.298	4.420	2.937
New Zealand	0.971	0.324	8.775	4.838	3.304	0.944	0.331	9.442	4.571	3.021
Norway	0.867	0.352	7.330	4.057	2.868	9.379***(***)	0.002	7.704	4.227	2.909
Portugal	0.125	0.724	9.110	4.851	3.182	3.339*(*)	0.068	8.733	4.510	3.107
Singapore	0.003	0.956	7.502	4.314	2.872	6.999***(**)	0.008	7.466	4.192	2.793
Spain	0.067	0.796	7.352	4.157	2.906	2.750*	0.097	6.881	3.974	2.935
Sweden	1.383	0.240	7.942	4.216	2.892	0.350	0.554	6.652	3.944	2.813
Switzerland	0.019	0.890	7.991	4.374	2.985	0.017	0.897	8.297	4.270	2.975
United Kingdom	4.868	0.027	8.128	4.295	2.946	6.597**(**)	0.010	7.622	4.149	2.947
United States	1.193	0.275	6.917	4.184	2.776	9.702***(***)	0.002	8.695	4.261	2.850

Note: GROWTH: Growth of real GDP per capita; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market. ***/**/* denotes statistical significance at 1%, 5%, 10% respectively and ***/**/* in parenthesis denotes statistical significance at 1%, 5%, 10% respectively as per Bootstrap critical values. Lag length is chosen as per SIC and 5000 replications are used to generate bootstrap critical values.

Table 9. Country-wise Bootstrap Granger Causality Results: VALUE TRADED and GROWTH

Country	GROWTH to VALUE ADDED					VALUE TRADED to GROWTH				
	M-Wald Stat	p-value	Bootstrap Critical Values			M-Wald Stat	p-value	Bootstrap Critical Values		
			99%	95%	90%			99%	95%	90%
Australia	0.135	0.713	6.962	3.936	2.771	0.059	0.808	10.178	5.133	3.159
Austria	0.197	0.657	7.830	4.137	2.771	1.513	0.219	7.559	4.385	2.996
Belgium	0.017	0.898	8.125	4.069	2.918	1.667	0.197	7.670	4.343	2.971
Canada	0.351	0.553	7.656	4.014	2.828	1.077	0.299	8.094	4.385	2.900
Denmark	0.323	0.570	7.333	4.021	2.786	0.006	0.937	7.719	4.352	3.037
Finland	2.212	0.137	9.269	4.420	2.921	0.747	0.387	9.205	4.902	3.240
France	0.069	0.793	7.987	4.591	3.100	0.061	0.805	8.136	4.258	2.930
Germany	0.021	0.884	8.100	4.256	2.893	2.191	0.139	7.203	4.142	2.880
Greece	0.142	0.706	10.013	4.988	3.435	0.213	0.645	7.069	4.131	2.884
Hong Kong	0.009	0.924	9.620	4.790	3.101	0.372	0.542	7.413	4.172	2.919
Israel	0.371	0.543	7.183	4.132	2.917	1.710	0.191	7.829	4.331	2.847
Italy	0.486	0.486	9.572	4.607	3.121	1.001	0.317	8.785	4.769	3.109
Japan	2.844	0.241	12.894	7.361	5.523	0.069	0.966	11.412	6.990	5.228
South Korea	17.300***(***)	0.000	20.816	9.346	5.931	1.591	0.451	14.769	7.448	5.305
Luxembourg	0.132	0.716	7.962	4.305	2.983	0.091	0.762	7.993	4.191	2.953
Netherlands	1.722	0.423	12.561	6.933	4.928	6.926**(**)	0.031	12.006	6.724	4.953
New Zealand	0.008	0.928	9.195	4.922	3.293	1.895	0.169	9.191	4.774	3.263
Norway	1.512	0.470	13.206	7.581	5.517	9.38***(**)	0.009	11.040	6.687	5.085
Portugal	0.029	0.865	9.070	4.822	3.202	0.048	0.827	9.296	4.489	3.072
Singapore	1.869	0.172	7.232	3.914	2.688	0.108	0.742	8.367	4.122	2.796
Spain	0.016	0.901	8.626	4.320	3.003	0.005	0.946	7.423	4.089	2.919
Sweden	2.423	0.120	7.251	4.019	2.814	0.434	0.510	7.696	4.366	3.014
Switzerland	0.549	0.459	7.878	4.052	2.839	0.068	0.795	8.023	4.277	2.965
United Kingdom	0.515	0.473	8.068	4.290	2.851	0.845	0.358	7.720	3.944	2.726
United States	0.735	0.391	7.821	4.040	2.865	1.309	0.253	7.922	4.262	2.951

Note: GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio. ***/**/* denotes statistical significance at 1%, 5%, 10% respectively and ***/**/* in parenthesis denotes statistical significance at 1%, 5%, 10% respectively as per Bootstrap critical values. Lag length is chosen as per SIC and 5000 replications are used to generate bootstrap critical values.

Overall, we find that in most of the advanced economies having well-developed stock markets, Granger causality mostly runs from stock market development to economic growth and supports supply leading hypothesis and few evidence of either demand following hypothesis or feedback hypothesis also exhibited by these countries. These findings support the predictions of few previous studies (Atje and Jovanovic, 1993; Greenwood and Smith, 1997; Levine and Zervos, 1996) which also finds evidence in support of stock market size (MARKET CAP) as the most important indicator of stock market development for growth in majority of sample countries where greater market size provides more diversification opportunity to investor. Second, liquidity measures exhibited different patterns as to Granger causal relation with GROWTH: in case of TURNOVER RATIO, we find evidence in support of supply leading hypothesis value traded to GDP ratio, however, neither Granger causes economic growth nor there is evidence of reverse causality barring three countries (Granger causality from VALUE TRADED to GROWTH is observed for Netherlands and Norwy and reverse causality from GROWTH to VALUE TRADED is noticed for South Korea). In fact, we do not find substantial evidence of favourable theoretical prediction that stock market liquidity eases investment in long term, which leads to potentially more profitable investment projects, improve allocation of capital and enhance prospects for economic growth (Levin and Zervos, 1996). Our findings on causality for liquidity measures of stock market development, particularly, value traded are also in line with theoretical predictions of Bencivenga and Smith (1991) that greater stock market liquidity through reduction of uncertainty, may substantially reduce savings rate and hence, may reduce growth in view of the fact that savers are generally reluctant to relinquish control of their savings for a long period of time. Third, we also do not find any consistent evidence of feedback hypothesis across advanced economies with respect to stock market development and growth although theory predicts that markets promote growth and that growth, in turn, encourages formation of stock markets (Greenwood and Smith, 1997).

One important question that arise from above findings relates to what are the appropriate policy lessons to developing economies as to the direction of the development of stock market that is conducive to economic growth. Previous empirical studies draw mostly on the experiences of advanced economies with well-developed stock markets. Singh (1993) argues that so long, developing economies with underdeveloped stock markets and high volatility of stock prices are affected by speculation, lack of investor commitment and short-termism, these economies should foster bank-based financial system in lines with experiences of countries such as Germany, Japan and France. However, it does not necessarily preclude potential role that stock markets can play in these emerging economies with stocks market in the early stages of development.

These economies can focus on stock market development with favourable market conditions ensuring investor safety, corporate control, controlled speculation and fairplay, and ensuring investor commitment to long-term projects on one hand and ensuring fund-raising opportunities to not only large firms but also for small and medium enterprises by maintaining investor trust in the market. (Singh, 1993; Atje and Jovanovic, 1993).

6. CONCLUDING REMARKS

The paper examines Granger causality between stock market development and economic growth in a sample of 25 advanced economies over the period 1975-2011. We use three indicators of stock market development and apply bootstrap based panel

Granger causality procedure developed by Emirmahmutoglu and Kose (2011) that accounts for cross-sectional dependence and heterogeneity in a panel. We find that not accounting for cross-sectional dependence may provide misleading evidence in support of causality. Overall, we find evidence supporting strong inter-linkage between stock market and real economy and direction of causality running mostly from stock market development to growth in advanced economies. For both panel as well as individual countries, mostly, we find evidence of uni-directional causality from stock market development to growth for indicators of market size (market capitalisation to GDP ratio) and market liquidity (turnover ratio). These findings are in favour of supply leading hypothesis (stock market led growth), which are similar to the findings of Calderon and Liu (2003) and Christopoulos and Tsiaonas (2004) which use indicators of financial intermediary development. However, we scantly find evidence of either demand-following hypothesis or feedback hypothesis. Another important finding of this paper is that liquidity measures of stock market development such as turnover ratio and value traded ratio are relatively less important than measure of market size such as market capitalization in long-term growth process of advanced economies. This observation runs contrary to theoretical prediction that stock market liquidity eases investments in long-run, potentially lead to more profitable investment projects, improve the allocation of capital and enhances prospects for economic growth. The policy implication from above analysis is that emerging economies must also focus on stock market development for long term economic growth. However, we do not advocate in favour of haphazard stock market development as it may also contribute towards growth volatility. The role of stock market in volatility of growth may be an important area of future research.

APPENDIX

A1. Bootstrap Algorithm

Bootstrapping procedure to account for cross-sectional dependence while carrying out Granger causality test is discussed as follows. Consider vector autoregression (VAR) model with number of lags, $k_i + dmax_i$ used for testing Granger causality testing between two variables x and y in in heterogeneous mixed panels as specified below:

$$x_{i,t} = \alpha_i + \sum_{j=1}^{k_i+dmax_i} A_{11,ij}x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} A_{12,ij}y_{i,t-j} + \varepsilon_{i,t}, \qquad \text{(A1)}$$

$$y_{i,t} = \alpha_i' + \sum_{j=1}^{k_i+dmax_i} A_{21,ij}x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} A_{22,ij}y_{i,t-j} + u_{i,t}. \qquad \text{(A2)}$$

Here, $dmax_i$ is the maximum order of integration suspected to occur in the system for ith cross-sectional unit.

The bootstrapping procedure applied for Granger causality testing from variable x to y is described in following steps (Eq. A2, same procedure is applied for bootstrapping in causality testing from $y\ to\ x$ (Eq. A1)).

1. First, we test for maximum order of integration using conventional time series based unit root tests such as augmented Dickey-Fuller Test (ADF) for each variable corresponding to each country (cross-section). Then, estimate equation (A2) for each cross-section by using ordinary least squares (OLS) for each cross-section and select the maximum lag orders k_i by lag selection criteria such as Akaike information criteria (AIC) or Schwarz information criteria (SIC).

2. Next, we use k_i and $dmax_i$ obtained by previous step and re-estimate Eq. (A2) by OLS under the null of no-causality ($A_{21,i1} = \cdots = A_{21,ik} = 0$ and obtain residuals for each cross-section as below.

$$\hat{u}_{i,t} = y_{i,t} - \alpha_i' + \sum_{j=k_i+1}^{k_i+dmax_i} A_{21,ij}x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} A_{22,ij}y_{i,t-j}, \quad \text{(A3)}$$

3. The residuals obtained in last step are centred as suggested by Stine (1987) as below.

$$\tilde{u}_t = \hat{u}_t - (T - k - l - 2)^{-1} \sum_{t=k+l+2}^{T} \hat{u}_t,$$

where $\hat{u}_t = (\hat{u}_{1t}, \hat{u}_{2t}, \ldots, \hat{u}_{nt})$, $k = max(k_i)$ and $l = max(dmax_i)$. These residuals are saved as $[\tilde{u}]_{T*N}$ and re-semple with replacement by choosing full column at a time, which preserves cross-sectional dependence between within cross-sections. Denote these re-sampled residuals by $\tilde{u}_{i,t}^*$, where $t = 1, 2, 3, \ldots, T$.

4. Next, we generate the bootstrap sample for y under the null hypothesis as:

$$y_{i,t}^* = \hat{\alpha}_i' + \sum_{j=1}^{k_i+dmax_i} \hat{A}_{21,ij}x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} \hat{A}_{22,ij}y_{i,t-j} + u_{i,t}^*,$$

where $\hat{\alpha}_i$, $\hat{A}_{21,ij}$ and $\hat{A}_{22,ij}$ are estimations from step 3.

5. Use $y_{i,t}^*$ in place of $y_{i,t}$ to estimate Eq. (A2) without imposing any parameter restriction and calculate the Wald statistic for each individual to test the null hypothesis of no-causality. As Wald statistics is chi square distributed, obtain the p-values. From these p-values, three Fisher statistics are calculated as given by equation (4), (5) and (6) in Section 3.2.

Finally, steps 3-5 are repeated 5000-10000 times and bootstrap, empirical distribution of Fisher test statistics are generated and 90%, 95% and 99% bootstrap critical values are obtained from the empirical distribution for selecting appropriate percentiles of these sampling distributions. Emirmahmutoglu and Kose demonstrate that performance of LA-VAR approach under both conditions of cross-section independence and cross-sectional dependence seem to be satisfactory for all values of T and N.

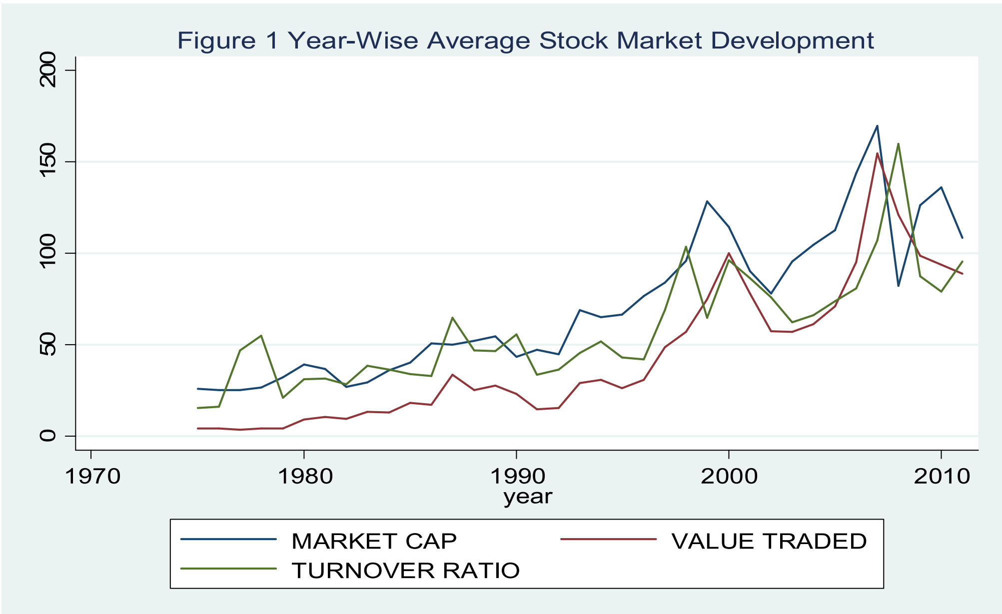

Figure A1. Movement of Stock Market Development Indicators and Economic Growth: 1975-2011

Notes: GROWTH: Growth of real GDP per capita; VALUE TRADED: Stock market value traded to GDP ratio; MARKET CAP: Stock market capitalisation to GDP ratio; TURNOVER RATIO: Ratio of stock market value traded to the size of stock market.

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