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STOCK PRICES AND MACROECONOMIC VARIABLES NEXUS IN SOUTH ASIAN COUNTRIES

The paper examines the interactions between stock prices, exchange rate, interest rate, inflation and income in Bangladesh, India, Pakistan and Sri Lanka using monthly data for the period 1997:07 to 2013:06. The motivation is to establish the causal and cointegrating relationship between stock prices and macroeconomic variables. The results indicate that cointegration holds between these variables in all countries. Temporal causality results are mixed, from unidirectional causality to bi-directional and even no causality between stock prices and macroeconomic variables. Causality results generally support the 'portfolio approach' that stock prices lead changes in exchange rate. However, the results of impulse response analysis, based on the structural VAR model, support the 'traditional approach' and suggest that it is exchange rate innovations that affect stock prices. Variance decomposition analysis also supports the findings of impulse response analysis.

Keywords: Stock Prices, South Asia, SVAR
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1. INTRODUCTION

Well-developed and smoothly operating financial markets have a profound impact on the development of the economy. Schumpeter (1912) was the first to highlight the importance of financial markets in economic development. According to Schumpeter's 'creative destruction' theory, innovation and entrepreneurship are the driving forces of economic development. Schumpeter viewed that innovation and entrepreneurship will thrive only when a country has an efficient financial system. A well-functioning financial market leads to economic development by mobilizing savings for productive purposes, allocating resources efficiently, reducing problems of information asymmetry, improving risk management and through the creation of liquidity. Many factors including macroeconomic variables affect stock markets. Some of these macroeconomic variables are domestic income (GDP), inflation rate, exchange rate, interest rate, money

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supply, foreign income, etc. However, the most important macroeconomic variables, which are highlighted in the literature that affect stock markets are exchange rate, interest rate, inflation and domestic income (Fama, 1981; Chen *et al.,* 1986; Flannery and Protopapadakis, 2002). Theoretically, the relationship between stock market and macroeconomic factors is of a reversible model, i.e. both stock prices and macroeconomic factors may affect each other. For instance, the 'traditional approach', which is based on interest parity hypothesis, stipulates that exchange rates affect the stock prices. In turn, the 'portfolio approach' states that it is stock market that affects foreign exchange market first. Interest rate has a negative effect on stock prices. As interest rate increases, investors will switch their capital from share markets to banks so the demand and hence the price of shares will decrease. In turn, stock prices positively affect interest rate. An exogenous increase in domestic stock prices will increase investors' income. It will increase the demand for money, so domestic interest rate will increase. According to 'tax-effect hypothesis', inflation reduces stock prices. Similarly, 'reverse causality hypothesis' stipulates that stock returns reduce inflation via fiscal and monetary linkages. As income increases stock market prices will also increase. By providing portfolio diversification, stock market also increases income.

The relationship between stock markets and macroeconomic variables has some important implications. For instance, stock market is an important source of company finance as firms often borrow by issuing more shares. Thus, stock market can be a source of private finance when bank finance is limited. This will increase investment in stock market, which could lead to more employment and economic growth. Stock market also provides investment opportunities to small investors and raises government capital for development projects. Development in stock market increases the wealth of the people, which will increase consumer spending, this increases economic growth. Stock market also provides hedging against inflation if average return is greater than inflation rate. To be brief, stock market may be considered as a barometer of the economy. An upward movement in stock price index indicates that the economy is growing, while a downward trend indicates that economy is weak. In turn, unfavourable macroeconomic variables adversely affect stock market. For instance, high inflation, high interest rates, etc. are signs of a weak economy. A weak economy reduces company revenues and expected future earnings, thereby reducing intrinsic values and lowering the stock prices. Given this, the analysis and understanding of the dynamic effects of stock markets and macroeconomic factors on each other in developing economies become crucial.

By applying cointegration and the Granger causality techniques, this study examines the short and the long-term relationships, and the direction of causation between stock prices and macroeconomic variables in South Asian countries (SACs). Monthly data will be used for the period 1997:07 to 2013:06. The main contribution of this study to the existing literature is that it examines the relationship between stock prices and macroeconomic variables using the Structural VAR (SVAR) analysis. Previous studies have used a simple VAR technique which is *atheoretic* technique as it is not based on any economic theory, while the SVAR technique is based on economic theory and therefore it is preferred over the simple VAR technique (Enders, 2014). Furthermore, previous studies have used the ADF and Phillips-Perron unit root tests to check stationarity of the variables. These tests suffer from finite sample power and size problems, and therefore fail to identify the true data generating process of the variables. This study uses the Ng-Perron unit root test as this test has better power and size properties. Moreover, this study provides a comparison of the stock markets of South Asian countries using the recent dataset. Thus, this is going to be the first study of its nature in South Asia which will use the structural VAR analysis using recent dataset.

South Asian countries have liberalized their financial markets in the last two decades and have taken steps to develop their financial sector in order to maximize its contribution towards the economic development of their countries. As a result, the stock markets of South Asia have attracted the attention of investors and have grown rapidly in recent years. The Pakistan stock market was ranked third among the best performing top ten markets in the world in 2014. Indian stock markets have also touched new heights during 2014. There are also great opportunities for foreign investors to invest in the capital (stock) markets of South Asia. High growth potential, higher returns compared to other counterparts, potential diversification benefits of developed stock portfolios, and the increase in returns due to currency depreciation are just a few among other reasons for foreign investors to invest in these markets. Thus, it is interesting to examine the impact of macroeconomic variables on the stock markets of South Asian countries as it will provide useful knowledge to foreign investors about the South Asian stock markets. Investors can formulate methods to predict stock prices from macroeconomic factors. This is also important in terms of regulatory changes and policy making decisions about the future of the South Asian stock markets.

The rest of the paper is organized as follows. Section 2 presents a literature review. Section 3 describes the theoretical linkages between stock prices and macroeconomic variables. Section 4 provides the estimated results and discussion. The final section concludes the paper.

2. LITERATURE REVIEW

Previously, various empirical studies have examined the association between stock prices and macroeconomic variables for different stock markets and time periods. A wealth of literature is available for developed countries. However, for developing and emerging countries like SACs only scant literature is available. In South Asia most of the previous studies take stock prices as dependent variable and macroeconomic variables as independent variables and have used regression analysis to see the effect of macroeconomic variables on stock prices. For instance, see Mohiuddin *et al.* (2008) for Bangladesh, Mohammad *et al.* (2009) for Pakistan, Menike (2006) for Sri Lanka, and Thokala (2011) and Kalra (2012) for India. Only limited studies have checked the interdependency between stock prices and macroeconomic variables using causality tests but most of these studies have used only one macroeconomic variable to check causality with the stock exchange index. For instance, Abdalla and Murinde (1997,) find that exchange rates Granger cause stock prices in Pakistan and India and that there is a long-term relationship between these variables. Similarly, Muhammad and Rasheed (2002) examine cointegration and the causal relationship between stock prices and exchange rate for Bangladesh, India, Pakistan and Sri Lanka for the period from 1994 to 2000. For India and Pakistan, the study finds neither short-term nor long-term links. However, for Bangladesh and Sri Lanka, bi-directional (positive) links could be confirmed. Smyth and Nandha (2003) extend the work done by Muhammad and Rasheed (2002), and investigate the same countries for the period 1995 to 2001. The study finds that there is a unidirectional causality from exchange rate to stock price in India and Sri Lanka but this causal relationship is short term, which does not hold in the long run. Chatrath *et al.* (1997) and Hu and Willett (2000) provide evidence from India and Ahmed and Mustafa (2012) provide evidence from Pakistan that there are negative and significant relationships between inflation and real stock returns. Bhattacharya and Mukherjee (2002) have shown a two-way causation between stock prices and the rate of inflation in India. Further, Singh (2010) finds that in India stock price has a bilateral causal relationship with income and a unilateral relationship with inflation running from stock price to inflation.

There are only a few studies which have used more than one macroeconomic variable to examine the long-term and causal relationship with stock prices. Ali *et al.* (2010) have examined the link between stock prices, inflation, trade balance, exchange rate and income in Pakistan. The estimated results show that there is no causality between stock price index and any macroeconomic variable. Srinivasan (2011) has shown that stock prices in India have a long-term relationship with macroeconomic variables (money supply, interest rate, exchange rate and income). However, interest rate is the only variable that Granger causes stock prices. Gunasekarage *et al.* (2004) have examined the causal relationship between stock prices, inflation, money supply, interest rate and exchange rate in Sri Lanka using monthly data for the period 1985 to 2001. The results show that there is unidirectional causality from inflation and money supply to stock prices and bidirectional causality between stock prices and interest rate. Wickremasinghe (2011) has explored the relationship between stock prices and macroeconomic variables in Sri Lanka using monthly data for the period 1985 to 2004. Macroeconomic variables included are: exchange rate, interest rate, inflation, money supply and income. The findings show that there is a bidirectional causality between stock price and interest rate, and between stock price and income. There is a unidirectional causality running from stock price to inflation, money supply and exchange rate. The study concludes that stock prices in Sri Lanka can be predicted using macroeconomic variables. In a recent study, Joarder *et al.* (2014) have shown that macroeconomic variables (money supply, exchange rate and income) affect stock prices in Bangladesh. The study concludes that the Bangladesh stock market is informationally inefficient due to the presence of this causality.

Thus in South Asia the empirical literature is inconclusive about the causal relationship between stock prices and macroeconomic variables. In fact, estimation techniques, data frequency and time period are the sensitive and influencing factors for investigating the relations. This gives an opportunity to extend research in this area using various theoretically sound macroeconomic variables that could affect stock prices. Understanding this issue is important in SACs as these countries attempt to develop their financial markets.

3. THEORETICAL FRAMEWORK

3.1. Stock prices and exchange rates

According to the 'traditional approach', changes in exchange rates will bring changes in stock prices (Dornbusch and Fischer, 1980). For instance, depreciation of the local currency may increase or decrease stock prices. This depends on whether a country is an exporter or importer of inputs. If a country is an exporter of goods then the depreciation of the domestic currency will increase the competitiveness of the exports markets, which will have a favourable impact on local stock prices since the incomes of the exporters will increase in the short run; it will increase their net worth (Maysami *et al.,* 2004). In the long run, depreciation of local currency will boost output growth which will help in the development of the stock exchange market. Depreciation may also lead foreign investors to purchase cheaper domestic shares; this will raise inflow of portfolio equity capital. Thus, the demand for domestic shares will increase, which, in turn, will increase share prices in the short run (Mukherjee and Naka, 1995).[1] Conversely, if a country is an importer of inputs then the depreciation of the local currency will escalate imported input costs, which will adversely affect the stock market. If a country is both an exporter and importer of goods then its stock prices could move in either direction.

According to the 'portfolio approach', it is stock price that affects exchange rate. The intuition is that an increase (decrease) in stock prices will increase (decrease) the income of domestic investors. This will increase (decrease) the demand for money, which will increase (decrease) interest rates. The higher (lower) interest rates encourage capital inflows (outflows), ceteris paribus, which, in turn, cause currency appreciation (depreciation) (Krueger, 1983). In this (portfolio) approach, stock prices negatively affect exchange rates. Moreover, when domestic stock prices are high, demand for domestic assets will increase, this will appreciate domestic currency by increasing its demand. Thus, an increase (decrease) in stock prices may appreciate (depreciate) exchange rate by increasing the demand (supply) of domestic currency. Furthermore, a general upward movement of the stock market will motivate investors to purchase stock shares. This increases the demand for money, pushing interest rates up, causing further inflow of funds

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[1] However, Mukherjee and Naka (1995) argue that in the long run interest rate will increase due to high capital inflows and increased exports, which will diminish the initial increase in stock prices.

and hence appreciating the currency. Thus, theoretically there is no consensus about the direction of causality between stock prices and exchange rate. However, empirically, the majority of previous studies have supported the traditional approach, i. e. causality runs from exchange rate to stock prices. Only a few studies have indicated the causality in the opposite direction.

3.2. Stock prices and interest rate

An increase in interest rate decreases stock prices as high interest rates put economic activities under depression. Furthermore, when interest rate increases people will switch their capital from share markets to banks. This will decrease the demand for shares and hence their prices. Moreover, when interest rate increases, investment in share markets will decrease, which will decrease the demand and hence price of shares. Thus, theoretically, interest rate has an adverse effect on stock prices. Stock prices also affect the interest rate. For instance, an exogenous increase in domestic stock prices will increase the domestic investors' income. This will increase the demand for money, so domestic interest rate will increase.[2] Thus, theoretically, stock prices have a positive effect on interest rate.

3.3. Stock prices and inflation

Inflation is a kind of tax on corporate income, which reduces profits of investors. As a result, investors will invest less in the stock market, so the demand for shares will decrease, which will decrease the share prices. In literature this is known as the 'tax-effect hypothesis' (Feldstein, 1980). Furthermore, when inflation increases, domestic income will decrease and hence investment in stock market will also decrease. As a result, demand for shares will decrease, which will decrease share prices. Moreover, a hiked inflation is an indication of slow economic growth. This economic downturn will lead firms to sell their shares, and this will decrease share prices by increasing their supply. Conversely, inflation and stock prices may also be positively correlated. For instance, an unexpected inflation may increase firms' equity value if these firms are net debtors (Kessel, 1956; Ioannidis *et al.,* 2005). In literature this is known as the 'proxy-effect hypothesis' (Fama, 1981).

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[2] For literature on interest rate and stock prices see Alam and Uddin (2009).

According to Fama (1981), there is a negative relationship between stock returns and inflation and it is induced by the positive correlation between stock returns and real activity and the negative correlation between inflation and real activity – the Proxy Hypothesis. Simply put, when stock prices are high then firms will increase their investment, so production will increase. This will decrease price level as supply will become more than demand. Another argument hinges on the money demand behaviour of rational agents who perceive an increase in economic activity, therefore they increase money demand for cash holding, which creates deflation. Moreover, when stock market increases, output will increase; government budget deficit will decrease, government will borrow or print less money, so inflation will decrease. Thus, stock returns and inflation are negatively related due to a fiscal and monetary linkage – the Reverse Causality Hypothesis (Geske and Roll, 1983). Empirically, Bhattacharya and Mukherjee (2002) have shown a two-way causation between stock price and the rate of inflation.

3.4. Stock prices and income

Domestic income level has a positive impact on stock prices, because as the economy grows, aggregate consumption increases and this increases corporate profitability (Chen *et al.,* 1986; Chaudhuri and Smiles, 2004). With reference to the present value model, this increases anticipated dividends and investors will purchase more shares and hence stock prices will increase. In turn, when investors expand their business, the demand for loanable funds will increase and hence interest rate will also increase, which reduces the present value of a firm's future cash flows and causes stock prices to fall. Stock market (development) has a positive effect on income (growth) in developing countries. The intuition is that stock markets attract foreign capital in low income countries which cannot generate sufficient domestic savings. Furthermore, equity markets provide portfolio diversification, which enables individual firms to engage in specialized production. This increases efficiency gains and hence income growth will increase (for more details see Filer *et al.*, 2000).

4. DATA, RESULTS AND DISCUSSION

4.1. Data overview

Monthly time series data is collected for the period 1997:07 to 2013:06 for four South Asian countries – Bangladesh, Pakistan, India and Sri Lanka. Data on stock prices for Bangladesh is taken from the Dhaka Stock Exchange, for India from the Bombay Stock Exchange, for Pakistan from the Karachi Stock Exchange and for Sri Lanka from the Colombo Stock Exchange. Exchange rate is defined as domestic currency per unit of foreign currency (the US dollar is taken as the foreign currency). An increase in exchange rate implies a depreciation of domestic currency and vice versa. Discount rate data is used for interest rate. Inflation is measured by the consumer price index. Since monthly data is not available for GDP, income is proxied by the industrial production index. Data for these variables is taken from EconStats, International Financial Statistics, the Bangladesh Bank, the Bank of Sri Lanka, and the Karachi Stock Exchange. All variables are expressed in natural logarithmic form except interest rate.

An analysis of Figures 1 to 5 reveals that stock price indices and macroeconomic variables are time varying. This implies that these time series are not stationary in levels. Moreover, all the series except interest rate have an upward trend with an intercept. A more thorough analysis of figures reveals certain common trends in variables. Some variables display high volatility and this is particularly obvious in stock indices, exchange rates, and industrial production indices in each country. Table 1 provides the descriptive statistics of the variables. Standard deviations of the variables indicate that stock price indices are highly volatile followed by inflation, while the interest rates show the least volatility. Table 2 provides the correlation between the variables. The most interesting column is the first column, which shows the unconditional relationship between stock prices and macroeconomic variables. The signs of these correlations are consistent with our prior suggestions. We interpret these high simple correlations between stock prices and macroeconomic variables as validating our choice of variables. This statistical analysis remains, however, simplistic, and calls for a more rigorous framework which is performed in the next section.

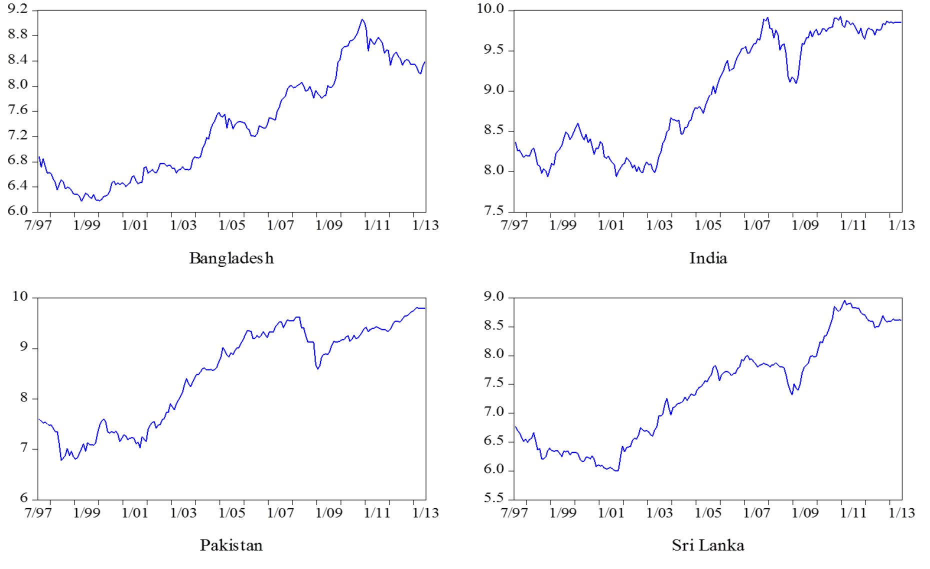

Figure 1. Times series of the four South Asian Stock indices

Source: developed by the authors

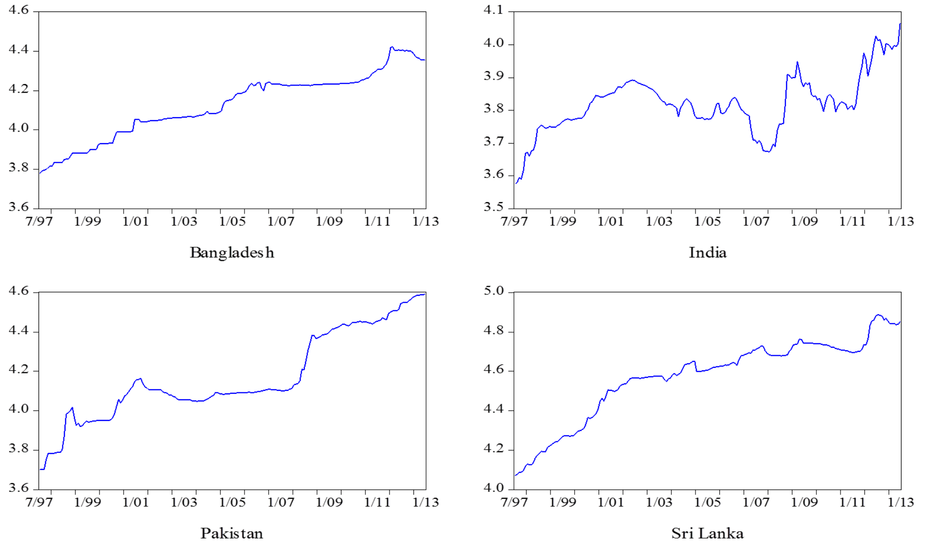

Figure 2. Times series of the four South Asian exchange rates

Source: developed by the authors

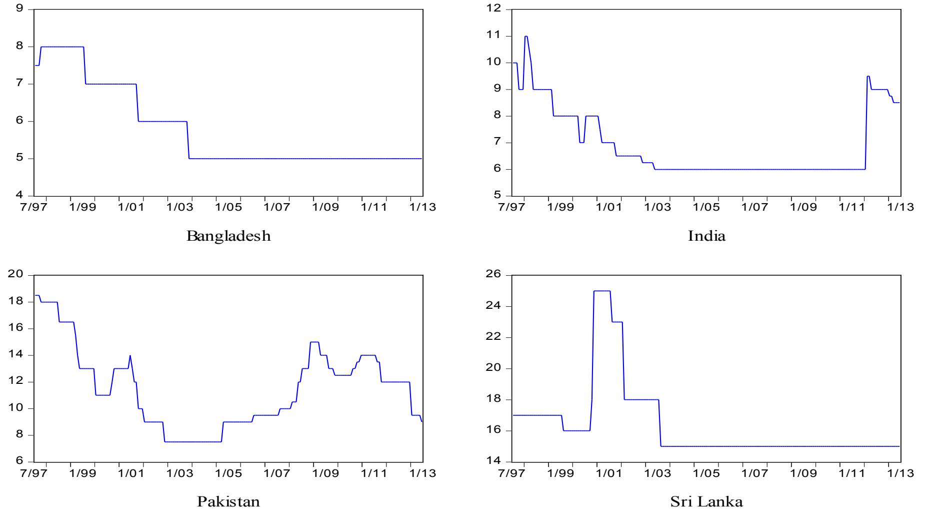

Figure 3. Times series of the four South Asian interest rates

Source: developed by the authors

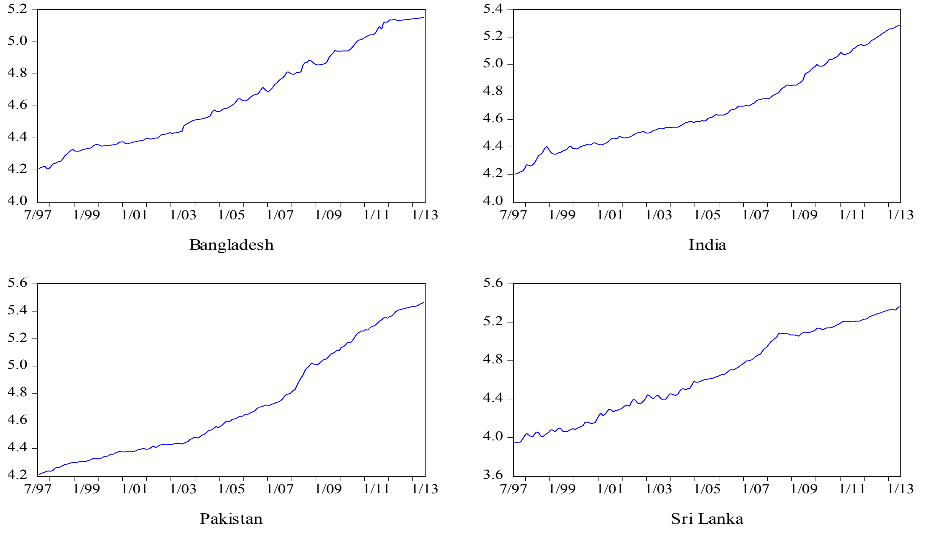

Figure 4. Times series of the four South Asian inflation rates

Source: developed by the authors

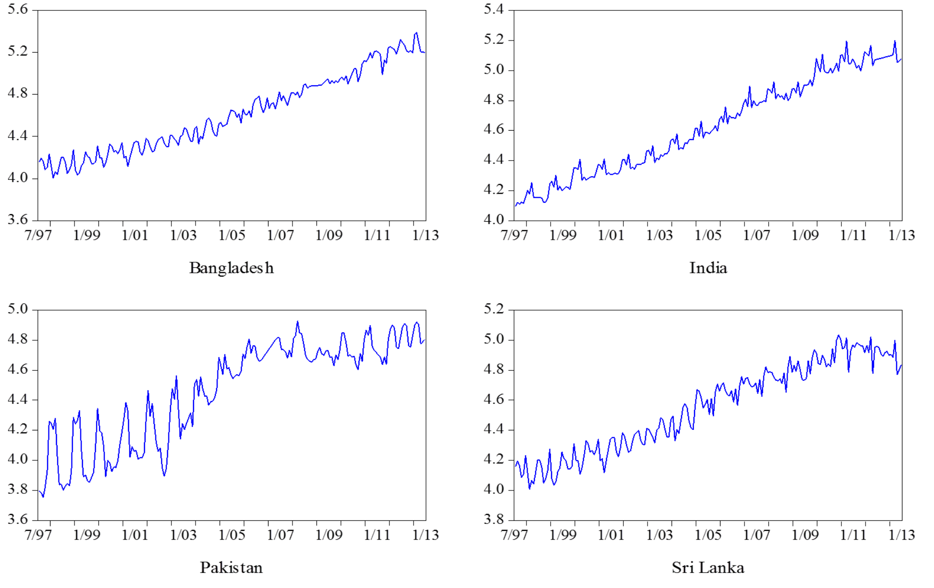

Figure 5. Times series of the four South Asian production indices

Source: developed by the authors

Table 1

Descriptive statistics of the variables

Bangladesh							**India**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
Mean	2273.5	62.8	5.8	109.1	108.7		Mean	9783.5	45.8	6.9	112.9	107.8
Median	1552.1	64.0	5.0	99.5	97.8		Median	7414.6	45.6	6.0	99.5	99.7
Max	8602.4	83.4	8.0	172.6	219.0		Max	20509.1	58.2	11.0	197.5	181.4
Min	480.6	43.8	5.0	67.0	55.0		Min	2810.7	35.7	6.0	66.8	60.1
SD	1951.3	10.2	1.1	33.0	42.3		SD	6186.8	4.0	1.3	35.2	34.4

Pakistan							**Sri Lanka**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
Mean	7080.7	66.2	11.5	121.4	91.4		Mean	2337.1	98.6	16.2	114.9	98.5
Median	6982.4	60.4	12.0	100.3	99.3		Median	1733.5	102.1	15.0	100.2	99.2
Max	18173.7	98.6	18.5	236.0	138.1		Max	7798.0	132.8	25.0	213.5	153.9
Min	879.6	40.5	7.5	67.4	42.7		Min	403.6	58.7	15.0	51.8	55.2
SD	5129.2	15.1	3.0	51.7	27.9		SD	2024.9	18.5	2.4	49.8	28.8

Source: authors' calculations

Table 2

Correlation matrix between stock prices and macroeconomic variables

Bangladesh							India					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	1						s_t	1				
e_t	0.874	1					e_t	0.257	1			
i_t	-0.778	-0.887	1				i_t	-0.296	-0.081	1		
p_t	0.951	0.946	-0.787	1			p_t	0.887	0.612	-0.228	1	
y_t	0.941	0.946	-0.791	0.984	1		y_t	0.938	0.494	-0.360	0.966	1

Pakistan							Sri Lanka					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	1						s_t	1				
e_t	0.713	1					e_t	0.813	1			
i_t	-0.308	-0.077	1				i_t	-0.634	-0.391	1		
p_t	0.837	0.951	0.000	1			p_t	0.931	0.916	-0.498	1	
y_t	0.919	0.729	-0.271	0.810	1		y_t	0.933	0.898	-0.533	0.966	1

Source: authors' calculations

4.2. Unit root tests and cointegration

The necessary (but not sufficient) condition for cointegration to hold is that all variables should contain unit roots and should have the same order of integration (greater than zero) or that all series should contain a deterministic trend (Granger, 1986). The unit root properties of all the variables for each country are examined using the ADF, Phillips-Perron (PP) and Ng-Perron tests. Tables 3 and 4 provide the results of unit root tests. The results indicate that all variables are non-stationary at levels (L) and are stationary at first differences (D) as the null hypothesis of unit root is accepted at levels and is rejected at first differences. Thus, all the series are integrated of order zero at levels and are integrated of order one at first differences, i. e. all the variables are $I(0)$ at levels and are $I(1)$ at first differences.

Given that all the variables have the same level of integration, we can test the long run cointegrating relationship between the variables. Table 5 provides cointegration test statistics using the Johansen cointegration technique, which assesses the null (of no cointegration) against both the homogeneous and the heterogeneous alternatives. Both trace and maximum

Table 3

ADF unit root tests

	Bangladesh		India		Pakistan		Sri Lanka	
	ADF τ statistics							
	L	D	L	D	L	D	L	D
s_t	1.349	-13.475	1.456	-12.265	1.774	-11.777	1.817	(-11.393)
	(0.955)	(0.000)	(0.9639)	(0.000)	(0.982)	(0.000)	(0.983)	(0.000)
e_t	4.304	-9.824	1.927	-9.560	4.068	-8.295	4.766	-8.738
	(1.000)	(0.000)	(0.987)	(0.000)	(1.000)	(0.000)	(1.000)	(0.000)
i_t	-1.631	-13.747	-0.750	-13.162	-1.925	-12.540	0.275	-10.852
	(0.096)	(0.000)	(0.390)	(0.000)	(0.052)	(0.000)	(0.764)	(0.000)
p_t	7.911	-8.850	9.077	-7.918	12.742	-6.719	7.169	-8.417
	(1.000)	(0.000)	(1.000)	(0.000)	(1.000)	(0.000)	(1.000)	(0.000)
y_t	1.066	-15.330	1.238	-23.616	0.575	-12.732	0.681	-19.761
	(0.925)	(0.000)	(0.944)	(0.000)	(0.839)	(0.000)	(0.862)	(0.000)
	Phillips-Perron (PP) Test Statistics							
s_t	1.232	-13.528	1.228	-12.383	1.653	-11.777	1.477	-11.489
	(0.944)	(0.000)	(0.944)	(0.000)	(0.976)	(0.000)	(0.965)	(0.000)
e_t	3.791	-9.702	1.645	-9.584	2.883	-8.346	3.161	-9.245
	(1.000)	(0.000)	(0.976)	(0.000)	(0.999)	(0.000)	(1.000)	(0.000)
i_t	-1.656	-13.748	-0.789	-13.521	-1.734	-12.727	0.183	-10.832
	(0.092)	(0.000)	(0.373)	(0.000)	(0.079)	(0.000)	(0.738)	(0.000)
p_t	6.916	-9.152	9.077	-8.266	8.120	-7.329	7.004	-8.095
	(1.000)	(0.000)	(1.000)	(0.000)	(1.000)	(0.000)	(1.000)	(0.000)
y_t	3.286	-17.713	4.774	-27.709	1.217	-14.245	2.412	-26.984
	(1.000)	(0.000)	(1.000)	(0.000)	(0.943)	(0.000)	(0.996)	(0.000)

Note: Values in parentheses are p-values. L variable is in level and D variable is in first difference.

Source: authors' calculations

statistics reject the null hypothesis of no cointegration at the 5% critical values. Therefore we may conclude that r is at most of order one. All this indicates that all the variables are cointegrated. In other words, there is a long-term relationship between stock prices, exchange rate, interest rate, inflation and output in each country, which indicates that variables do not drift apart in long run.[3]

Table 4

Ng-Perron unit root test

	Za		**MZt**		**MSB**		**MPT**	
Bangladesh	**L**	**D**	**L**	**D**	**L**	**D**	**L**	**D**
s_t	0.402	-41.550*	0.336	-4.516*	0.836	0.109*	45.102	0.707*
e_t	1.173	-73.122*	2.670	-6.030*	2.276	0.082*	345.487	0.372*
i_t	0.189	-94.999*	0.177	-6.892*	0.938	0.073*	52.408	0.258*
p_t	1.767	-83.784*	6.078	-6.462*	3.440	0.077*	878.032	0.315*
y_t	0.054	-94.995*	0.030	-6.888*	0.552	0.073*	22.098	0.265*
India								
s_t	0.565	-55.990*	0.462	-5.279*	0.818	0.094*	44.967	0.467*
e_t	1.498	-83.799*	1.190	-6.300*	0.794	0.075*	51.055	0.645*
i_t	-1.478	-94.822*	-0.847	-6.886*	0.573	0.073*	16.282	0.258*
p_t	2.185	-84.264*	7.867	-6.491*	3.601	0.077*	1036.780	0.291*
y_t	0.329	-81.258*	0.227	-6.373*	0.691	0.078*	32.510	0.303*
Pakistan								
s_t	0.882	-88.184*	0.834	-6.639*	0.945	0.075*	61.748	0.280*
e_t	1.633	-76.365*	3.036	-6.179*	1.860	0.081*	255.047	0.321*
i_t	0.215	-94.360*	0.194	-6.851*	0.901	0.073*	49.185	0.294*
p_t	2.164	-85.882*	10.568	-6.553*	4.885	0.076*	1895.010	0.286*
y_t	-1.460	-94.274*	-0.661	-6.865*	0.453	0.073*	12.845	0.261*
Sri Lanka								
s_t	0.898	-71.984*	0.872	-5.995*	0.971	0.083*	64.987	0.350*
e_t	1.111	-82.624*	2.879	-6.420*	2.592	0.078*	440.072	0.312*
i_t	-5.004	-87.038*	-1.538	-6.597*	0.307	0.076*	5.009	0.281*
p_t	1.617	-83.346*	5.286	-6.444*	3.269	0.077*	771.195	0.318*
y_t	-1.082	-85.835*	-0.536	-6.550*	0.496	0.076*	15.296	0.287*

Note: * null of unit root is rejected at 5% significance level.

Source: authors' calculations

[3] The study has also checked the structural break of the financial crisis of 2007 by introducing a dummy variable in the cointegration analysis. The dummy takes the value of 1 in 2007 onwards and zero before 2007. The coefficient on this dummy variable turned out to be statically insignificant. Therefore, this dummy variable is dropped from the model.

Table 5

Cointegration test based on Johansen's maximum likelihood method

λ_{trace} test						$\lambda_{\max}$ test				
			critical values						critical values	
H_0	H_1	λ_{trace} value	5%	p-values†		H_0	H_1	$\lambda_{\max}$ value	5%	p-values†
Bangladesh						Bangladesh				
$r = 0$	$r = 1$	117.836*	69.819	0.000		$r = 0$	$r > 0$	80.426*	33.877	0.000
$r = 1$	$r = 2$	37.409	47.856	0.329		$r \leq 1$	$r > 1$	17.466	27.584	0.540
India						India				
$r = 0$	$r = 1$	88.040*	69.818	0.000		$r = 0$	$r > 0$	58.062*	33.876	0.000
$r = 1$	$r = 2$	29.978	47.856	0.720		$r \leq 1$	$r > 1$	16.154	27.584	0.652
Pakistan						Pakistan				
$r = 0$	$r = 1$	104.198*	69.819	0.000		$r = 0$	$r > 0$	59.769*	33.877	0.000
$r = 1$	$r = 2$	44.429	47.856	0.101		$r \leq 1$	$r > 1$	18.582	27.584	0.448
Sri Lanka						Sri Lanka				
$r = 0$	$r = 1$	89.440*	69.819	0.001		$r = 0$	$r > 0$	52.986*	33.877	0.000
$r = 1$	$r = 2$	36.453	47.856	0.374		$r \leq 1$	$r > 1$	18.379	27.584	0.464

* denotes rejection of the null hypothesis at the 5% significance level.
† MacKinnon-Haug-Michelis (1999) p-values.

Source: authors' calculations

4.3. VECM and causality

Cointegration only depicts the presence or absence of causality, it does not show the direction of causality between the variables. The Vector Error Correction Model (VECM) is used to examine both the direction of causality, and short and long-term causality. Table 6 reports the results of short run causality, while Table 7 provides a summary of these results.[4] It is evident from the results that in Bangladesh there is unidirectional causality running from interest rate to stock prices and from stock prices to inflation. There is bi-directional causality between income and inflation. No causality is found between any other variables in Bangladesh. In India there is

[4] Based on Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ) and Wald lag exclusion test, optimal lag length 1 is selected for causality analysis.

unidirectional causality running from stock prices to exchange rate, from stock prices to interest rate, from inflation to stock prices, from interest rate to income and from inflation to income. No causality either unidirectional or bidirectional is found between other variables. In Pakistan there is bidirectional causality between stock prices and exchange rate and between inflation and interest rate. There is also unidirectional causality running from interest rate to stock prices, from output to stock prices, from interest rate to exchange rate, from inflation to exchange rate, from output to exchange rate, and from inflation to output. Finally, in Sri Lanka unidirectional causality is running from stock prices to exchange rate, from interest rate to inflation, from interest rate to income, and from inflation to income. No causality either unidirectional or bidirectional is found between other variables. Overall, the Granger causality results suggest both bidirectional and unidirectional causality and even no causality between stock prices and macroeconomic variables in SACs. The results further show that all the variables jointly Granger causes each other, as the null hypothesis that all variables do not Granger cause stock prices/exchange rate/ interest rate/inflation/output is rejected in every equation.

If we compare our results with previous literature, Abdalla and Murinde (1997), have shown that cointegration holds between stock prices and exchange rate and that causality runs from exchange rate to stock prices in India. While for Pakistan, Abdalla and Murinde have not found cointegration between stock prices and exchange rate, but like in India they have found unidirectional causality running from exchange rate to stock prices in Pakistan. Similarly, Smyth and Nandha (2003) suggest that there is no cointegrating relationship between these two financial variables in any of the four countries. Smyth and Nandha have found unidirectional causality running from exchange rates to stock prices in India and Sri Lanka, but in Bangladesh and Pakistan exchange rates and stock prices are independent. Bhattacharya and Mukherjee (2002) have found two-way causation between inflation and stock prices in India but our results suggest unidirectional causality from inflation to stock prices. Our results also refute the findings of Ali *et al.* (2010), that macroeconomic variables are not linked with stock prices in Pakistan. However, our results support the findings of Wickremasinghe (2011), that there is unidirectional causality from stock prices to exchange rate in Sri Lanka. Thus, our cointegration and causality results are somewhat different from the findings of previous studies and the main reason lies in the time period selected as we used the most recent dataset.

Table 6

The results of Granger causality tests (χ^2 Statistics)

H_0	Bangladesh			India			Pakistan			Sri Lanka	
Dependent variable Δs_t											
$\Delta e_t \not\rightarrow \Delta s_t$	2.393	(0.122)		1.283	(0.257)		4.696*	(0.030)		1.835	(0.176)
$\Delta i_t \not\rightarrow \Delta s_t$	3.917*	(0.048)		0.459	(0.498)		7.339*	(0.007)		0.526	(0.468)
$\Delta p_t \not\rightarrow \Delta s_t$	0.336	(0.562)		2.774**	(0.096)		1.311	(0.252)		0.355	(0.552)
$\Delta y_t \not\rightarrow \Delta s_t$	0.687	(0.407)		0.321	(0.571)		3.863*	(0.049)		0.006	(0.937)
All $\not\rightarrow \Delta s_t$	7.155	(0.128)		4.833	(0.305)		16.944*	(0.002)		3.424	(0.490)
Dependent variable Δe_t											
$\Delta s_t \not\rightarrow \Delta e_t$	0.122	(0.727)		12.144*	(0.001)		8.546*	(0.004)		5.314*	(0.021)
$\Delta i_t \not\rightarrow \Delta e_t$	0.663	(0.416)		0.498	(0.480)		9.679*	(0.002)		2.198	(0.138)
$\Delta p_t \not\rightarrow \Delta e_t$	0.020	(0.887)		0.072	(0.789)		2.811**	(0.094)		0.016	(0.899)
$\Delta y_t \not\rightarrow \Delta e_t$	1.576	(0.209)		0.905	(0.341)		4.494*	(0.034)		0.153	(0.695)
All $\not\rightarrow \Delta e_t$	2.282	(0.684)		15.711*	(0.003)		23.673*	(0.000)		8.513**	(0.075)
Dependent variable Δi_t											
$\Delta s_t \not\rightarrow \Delta i_t$	0.390	(0.532)		3.661**	(0.056)		0.075	(0.784)		0.067	(0.796)
$\Delta e_t \not\rightarrow \Delta i_t$	0.570	(0.450)		0.566	(0.452)		0.087	(0.768)		0.041	(0.839)
$\Delta p_t \not\rightarrow \Delta i_t$	0.001	(0.971)		0.885	(0.347)		6.939*	(0.008)		0.386	(0.535)
$\Delta y_t \not\rightarrow \Delta i_t$	0.868	(0.351)		0.806	(0.369)		0.169	(0.681)		0.018	(0.892)
All $\not\rightarrow \Delta i_t$	1.999	(0.736)		5.765	(0.217)		8.258**	(0.083)		0.593	(0.964)
Dependent variable Δp_t											
$\Delta s_t \not\rightarrow \Delta p_t$	6.992*	(0.008)		0.600	(0.439)		0.123	(0.726)		0.114	(0.736)
$\Delta e_t \not\rightarrow \Delta p_t$	0.003	(0.959)		2.506	(0.113)		1.843	(0.175)		0.001	(0.972)
$\Delta i_t \not\rightarrow \Delta p_t$	0.352	(0.553)		1.041	(0.308)		4.080*	(0.043)		3.119**	(0.077)
$\Delta y_t \not\rightarrow \Delta p_t$	3.910*	(0.048)		0.048	(0.826)		0.032	(0.857)		1.278	(0.258)
All $\not\rightarrow \Delta p_t$	10.520*	(0.033)		4.331	(0.363)		6.449	(0.168)		4.536	(0.338)
Dependent variable Δy_t											
$\Delta s_t \not\rightarrow \Delta y_t$	0.022	(0.882)		0.428	(0.513)		0.031	(0.861)		0.024	(0.877)
$\Delta e_t \not\rightarrow \Delta y_t$	1.058	(0.304)		0.056	(0.813)		0.211	(0.646)		0.733	(0.392)
$\Delta i_t \not\rightarrow \Delta y_t$	0.023	(0.879)		11.792*	(0.001)		0.074	(0.785)		3.522**	(0.061)
$\Delta p_t \not\rightarrow \Delta y_t$	4.165*	(0.041)		19.952*	(0.000)		4.057*	(0.044)		11.780*	(0.001)
All $\not\rightarrow \Delta y_t$	5.444	(0.245)		30.755*	(0.000)		4.810	(0.307)		16.659*	(0.002)

Notes: $\not\rightarrow$ implies does not Granger cause. p-values are in (). * (**) H_0 is rejected at 5% (10%) significance level. DV is dependent variable.

Source: authors' calculations

Table 7

Summary of Granger causality test

	Bangladesh	**India**	**Pakistan**	**Sri Lanka**
$\Delta e_t \rightarrow \Delta s_t$	No	No	Yes	No
$\Delta s_t \rightarrow \Delta e_t$	No	Yes	Yes	Yes
$\Delta i_t \rightarrow \Delta s_t$	Yes	No	Yes	No
$\Delta s_t \rightarrow \Delta i_t$	No	Yes	No	No
$\Delta p_t \rightarrow \Delta s_t$	No	Yes	No	No
$\Delta s_t \rightarrow \Delta p_t$	Yes	No	No	No
$\Delta y_t \rightarrow \Delta s_t$	No	No	Yes	No
$\Delta s_t \rightarrow \Delta y_t$	No	No	No	No
$\Delta i_t \rightarrow \Delta e_t$	No	No	Yes	No
$\Delta e_t \rightarrow \Delta i_t$	No	No	No	No
$\Delta p_t \rightarrow \Delta e_t$	No	No	Yes	No
$\Delta e_t \rightarrow \Delta p_t$	No	No	No	No
$\Delta y_t \rightarrow \Delta e_t$	No	No	Yes	No
$\Delta e_t \rightarrow \Delta y_t$	No	No	No	No
$\Delta p_t \rightarrow \Delta i_t$	No	No	Yes	No
$\Delta i_t \rightarrow \Delta p_t$	No	No	Yes	Yes
$\Delta y_t \rightarrow \Delta i_t$	No	No	No	No
$\Delta i_t \rightarrow \Delta y_t$	No	Yes	No	Yes
$\Delta y_t \rightarrow \Delta p_t$	Yes	No	No	No
$\Delta p_t \rightarrow \Delta y_t$	Yes	Yes	Yes	Yes

Note: → implies Granger causes.

Source: authors' calculations

The long-term causality is examined through the statistical significance of lagged error correction term (ect_{t-1}) by applying t-test statistics. The results of t-statistics are provided in Table 8. The results indicate long-term causality in Pakistan and Sri Lanka running from macroeconomic variables to stock prices. However, this causality does not hold in Bangladesh and India. For exchange rate, long-term causality holds only in India. Long-term causality does not exist for the interest rate in any of the countries as the error correction term is statistically insignificant. For inflation, long-term causality holds only in Bangladesh. Finally, as expected long-term causality exists in every country in cases of income proxied by industrial production index. The error correction term basically depicts the stability of a long-term relationship. Negative signs of the error correction terms indicate that convergence holds in the models, i.e. the effect of any shock will be adjusted gradually over time.

Table 8

The results of Granger causality tests (t Statistics of ect_{t-1})

	Dependent Variable				
	Δs_t	Δe_t	Δi_t	Δp_t	Δy_t
Bangladesh	0.002	0.001	-0.001	-0.003	-0.008
	(1.496)	(1.131)	(-0.633)	(-2.390)*	(-8.739)*
India	0.003	-0.009	0.121	-0.001	-0.078
	(0.175)	(-2.210)*	(1.317)	(-0.572)	(-7.489)*
Pakistan	-0.086	-0.001	-0.012	-0.002	-0.160
	(-3.658)*	(-0.233)	(-0.086)	(-1.028)	(-6.257)*
Sri Lanka	-0.015	-0.001	0.030	0.001	-0.048
	(-1.712)**	(-0.691)	(0.367)	(0.402)	(-5.900)*

Note: numbers in () are t-values. * (**) indicates significant at 5% (10%) level of significance

Source: authors' calculations

4.4. Diagnostic tests of VECM

The vector error correction model is estimated by the least squares method, so there is a possibility that the estimated test statistics may be inconsistent due to non-spherical disturbances. To check this possibility some diagnostic tests are performed for each equation. Table 9 provides a summary of the LM serial correlation and the White heteroscedasticity tests of vector error correction models. The results of these tests meet the standard assumptions, i.e. the LM test indicates the absence of a serial correlation problem and the White test shows that there is no heteroscedasticity problem in the models.

Table 9

Summary of the diagnostic tests of VECM

	Δs_t	Δe_t	Δi_t	Δp_t	Δy_t
Bangladesh					
χ^2_{LM}	1.182	2.767	0.085	0.825	3.912
	(0.553)	(0.096)	(0.957)	(0.662)	(0.142)
χ^2_{WHITE}	21.371	20.580	8.628	7.239	18.911
	(0.616)	(0.663)	(0.998)	(0.989)	(0.756)
India					
χ^2_{LM}	1.535	7.282	1.076	2.313	2.589
	(0.464)	(0.121)	(0.583)	(0.314)	(0.273)
χ^2_{WHITE}	22.723	8.551	12.325	28.793	17.223
	(0.625)	(0.987)	(0.992)	(0.371)	(0.776)
Pakistan					
χ^2_{LM}	3.252	1.238	2.734	3.513	2.678
	(0.196)	(0.265)	(0.254)	(0.172)	(0.264)
χ^2_{WHITE}	20.125	9.431	18.512	36.560	2.515
	(0.613)	(0.973)	(0.887)	(0.103)	(0.112)
Sri Lanka					
χ^2_{LM}	1.570	0.419	2.804	3.317	2.491
	(0.455)	(0.517)	(0.246)	(0.181)	(0.252)
χ^2_{WHITE}	23.157	27.738	17.764	21.200	2.515
	(0.568)	(0.320)	(0.875)	(0.681)	(0.112)

Note: numbers in () are p-values. LM test for the null of no autocorrelation. The White test for the null of no heteroscedasticity.

Source: authors' calculations

4.5. Impulse response

The Granger causality test only indicates the direction of causality, it cannot predict the sign of correlations. For this, a correlation test or an impulse response analysis needs to be carried out (Granger *et al.*, 2000). Rather than using a simple *atheoretic* VAR model to find an impulse response, this study applies the structural VAR (SVAR) model which is based on economic theory. Unlike standard VAR, in the structural VAR, the restrictions needed for the identification of the underlying structural model are provided by economic theory.[5] In the present study, the structural disturbances are given one standard deviation shocks. These impulse responses are presented in Figures 6 to 9. The solid lines show the point

[5] See appendix for identification of the structural model.

estimate of the responses and the dashed lines show the upper and lower error bands. These error bands are calculated by adding and subtracting two standard errors of the point estimators. The monthly time period is taken on the horizontal axis and the minimum and the maximum lengths of the responses are given on the vertical axis. The responses are plotted for a period of 30 months following the occurrence of the shocks. Details of all shocks are presented as follows.

4.5.1. Effects of macroeconomic variables on stock prices

In Figures 6 to 9 the first row shows the response of stock prices to one structural standard deviation unanticipated shock in the endogenous variables of each country, while the first column of the figures shows the response of each endogenous variable to one standard deviation shock in stock prices. It is found that in each country the response of stock prices to macroeconomic variables is somewhat mixed. In Bangladesh, the stock exchange plummeted following the exchange rate shock and then it started increasing immediately, and after a 30-month period the stock exchange returned to its equilibrium position. This implies that the exchange rate shock had a negative effect on the stock exchange in Bangladesh. Unlike Bangladesh, in India, Pakistan and Sri Lanka the stock exchanges shot up following the exchange rate shock and then they started declining immediately. In Pakistan, within the 30-month period the stock exchange returned to its equilibrium position. While in India and Sri Lanka it took more than 30 months for the stock prices to return to their equilibrium positions. This shows that the exchange rate shock had a positive effect on the stock exchanges of these three countries.

A bird's eye view of the interest rate shocks on the stock exchanges reveals that in Bangladesh and Pakistan the stock exchanges went up, hit the maximum levels and remained stable at their new position permanently. This suggests that in Bangladesh and Pakistan interest rate shocks had positive impacts on their stock exchanges and this effect lasted for a long time. In turn, in India and Sri Lanka we observed negative responses of the stock exchanges following the interest rate shock. In India, in response to the interest rate shock, the stock exchange fell immediately and after hitting the bottom it started increasing and attained the equilibrium path after 25 months. While in Sri Lanka, in response to the interest rate shock, the stock exchange fell immediately and it remained stable at this new position even after the passing of 30 months. This implies that after the interest rate shock, the stock exchange in Sri Lanka declined quickly and recovered slowly. In fact, the effect of the interest rate shock on the stock exchange in all the countries was only negligible.

The response of stock prices to inflation shock is more or less same as the response of stock prices to interest rate. However, the effect of inflation shock on stock prices is higher than the effect of interest rate shock in each country. In Bangladesh and Pakistan, stock prices went up after the inflation shock, hit the maximum levels and remained stable at the new position permanently. In Pakistan this new position was higher than in Bangladesh. This suggests that in Bangladesh and Pakistan, inflation shocks have positive impacts on the stock exchanges and this effect lasted for a long time. In India and Sri Lanka, the response of the stock exchange following the inflation shock was negative. In both countries the stock exchanges fell immediately after inflation shock, hit the bottom and remained stationary at the new position even after the passing of 30 months. This implies that after the inflation shock, the stock exchanges in both countries declined quickly and recovered slowly.

Finally, the effect of output shock on the stock exchanges in Bangladesh and Pakistan was similar. The response of the stock exchanges to the output shock was initially negative and after ten months stock prices started increasing and the negative effect of shocks completely died out after the 30th month in Bangladesh and after the 25th month in Pakistan. Both in India and Sri Lanka the effect of the output shock on the stock prices was positive. This positive response of the stock prices to the output shock was greater in India than in Sri Lanka. This positive effect remained stable in both countries.

Stock prices movements also affect macroeconomic variables and this effect is relatively greater in Pakistan than in other countries, and the effect of stock price movements is greater on output than on any other variable in all countries. One important result that immediately emerges is that contrary to the results of Granger causality, the results of impulse response analysis support the 'traditional approach' and support the importance of the foreign exchange market as the leader on the existence of feedback interaction with stock prices. In the language of impulse response, it is exchange rate movements that affect stock prices more than the effect of stock price movements have on the exchange rates. This is true even with all macroeconomic variables, i.e. shocks in macroeconomic variables have a greater effect on stock prices than the shocks in stock prices have on macroeconomic variables. The results of Granger causality between stock prices and interest rate are maintained. In Bangladesh and Pakistan, interest rate shocks have more dominant effect on the stock prices than the stock price shocks have on interest rate and the opposite holds for India. In Sri Lanka, like in Granger causality, the relationship between stock prices and interest rate is very weak.

Unlike the Granger causality results, the impulse response analysis indicates a causal relationship between stock prices and inflation in Pakistan and Sri Lanka, and that inflation (stock prices) shocks have dominant (weak) effect on stock prices (inflation). Finally, contrary to what Granger causality has found, there is a causal relationship between stock prices and income in all countries as the impulse response functions indicate. This implies that both variables cause each other. To be brief, the overall results indicate that stock prices and macroeconomic variables are basically interdependent.

4.5.2. Summary of other effects

As far as the effect of endogenous variables on each other is concerned, an inspection of the figures reveals that the results from the impulse response analysis are not in conformity with that of the Granger causality test. This is to say, if the Granger causality test indicates that if in Bangladesh interest rate, inflation and income neither Granger cause exchange rate and nor are caused by exchange rate, the impulse response functions indicate that these variables cause each other and they are interdependent. This is also the case with India and Sri Lanka. In Pakistan Granger causality shows a unidirectional causality running from interest rate, inflation and income to exchange rate, while the impulse response analysis shows a bi-directional relationship between these variables.

Furthermore, impulse response functions stipulate that inflation and interest rate, and income and interest rate are inter-related. This result again does not verify the findings of the Granger causality test which indicates that there is no causality between inflation and interest rate in Bangladesh and India, bi-directional causality in Pakistan and unidirectional causality from interest rate to inflation in Sri Lanka, also that there is no causality between interest rate and income in Bangladesh and Pakistan and unidirectional causality in India and Sri Lanka running from interest rate to income. Finally, impulse response analysis postulates that inflation has a dominant effect on income rather than the other way round. This generally verifies the results of the Granger causality which indicates that there is a unidirectional causality running from inflation to income in all the countries, except in Bangladesh where it is bi-directional.

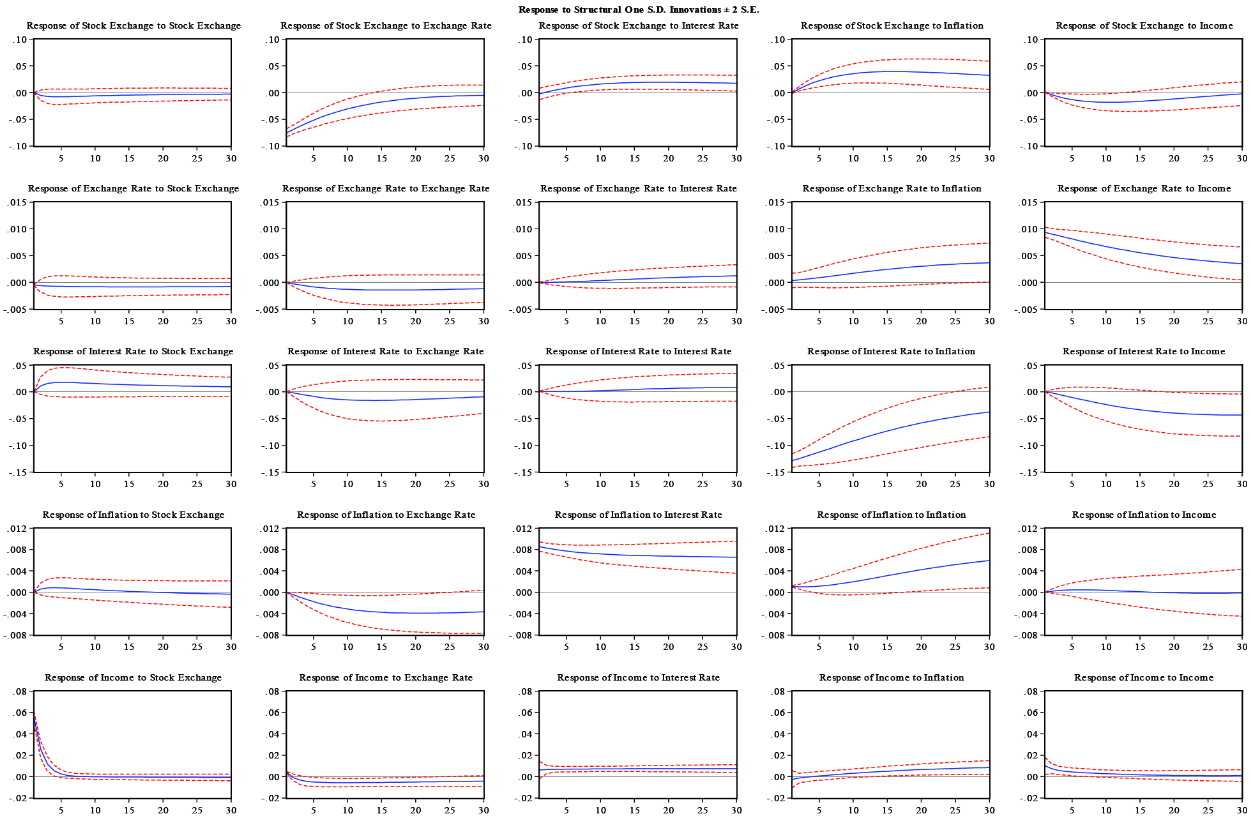

Figure 6. Impulse response function for Bangladesh

Source: authors' calculations

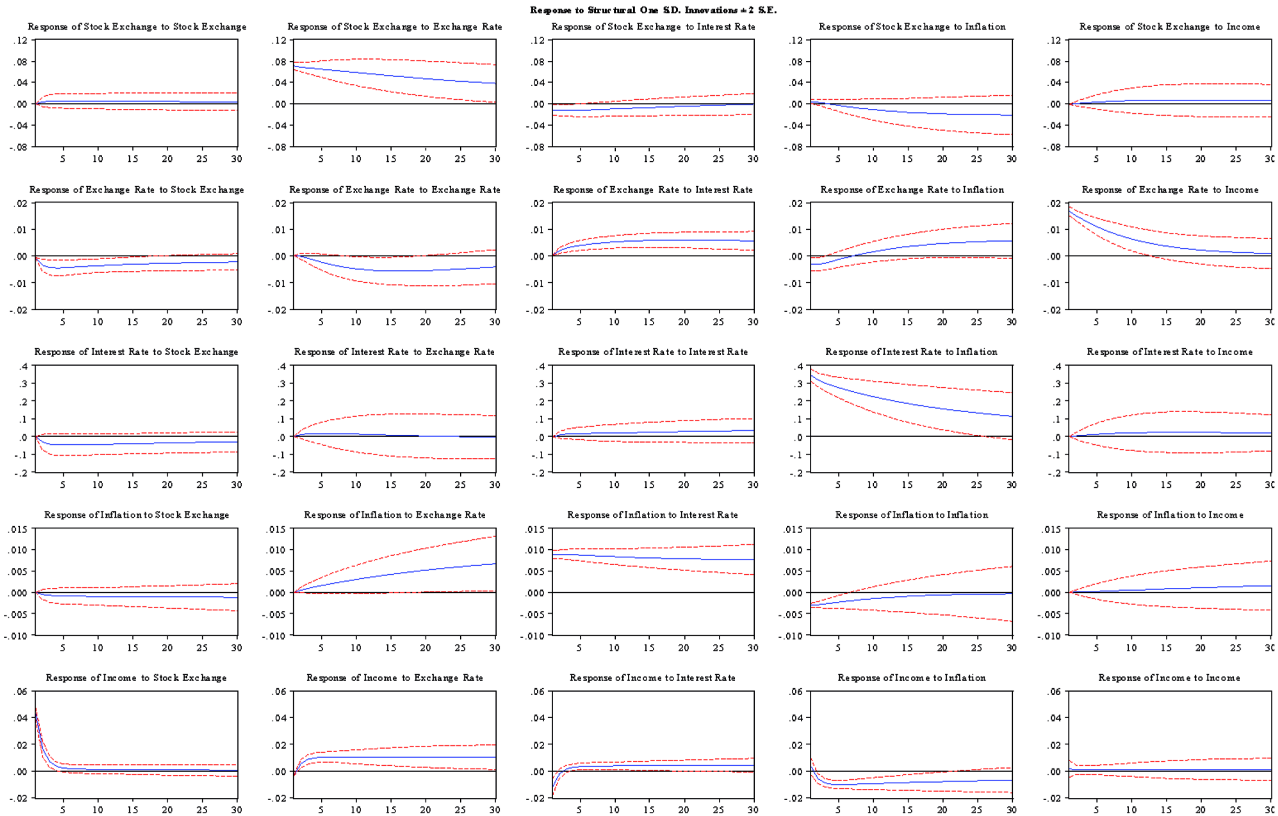

Figure 7. Impulse response function for India

Source: authors’ calculations

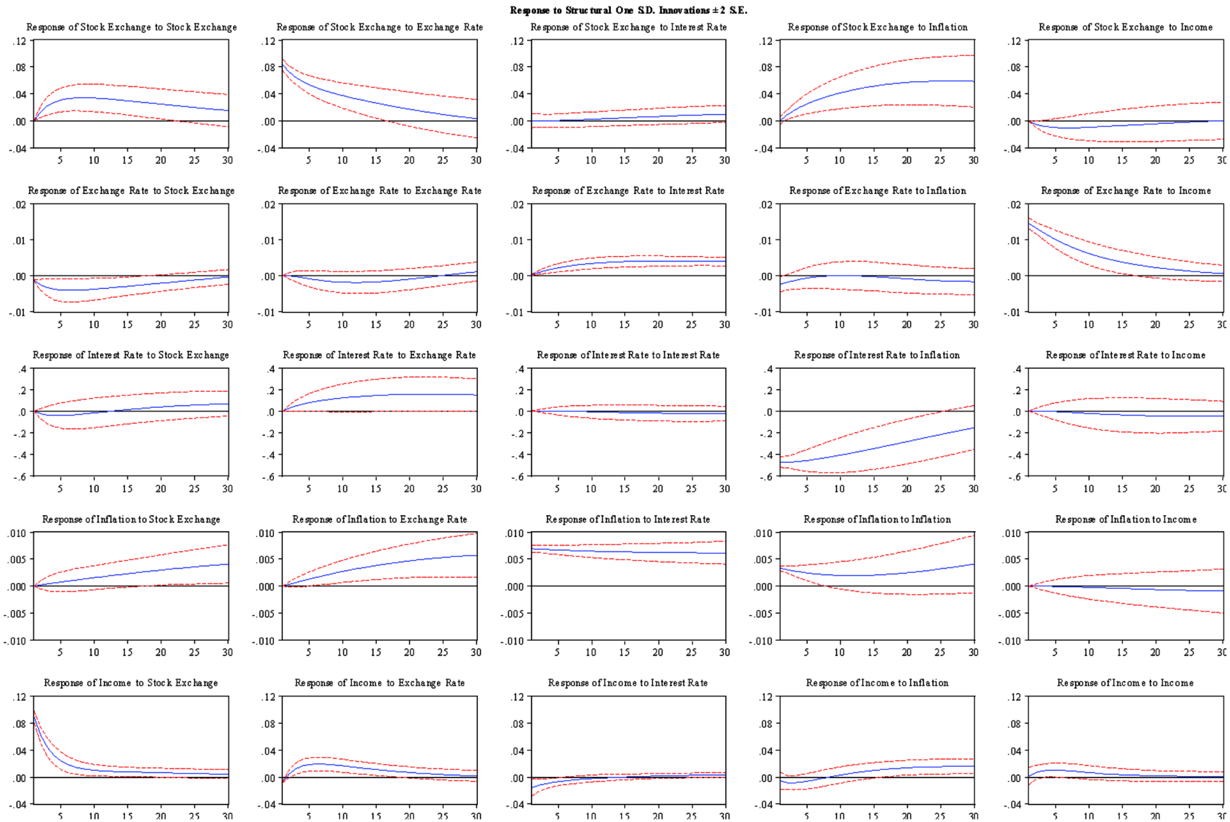

Figure 8. Impulse response function for Pakistan

Source: authors' calculations

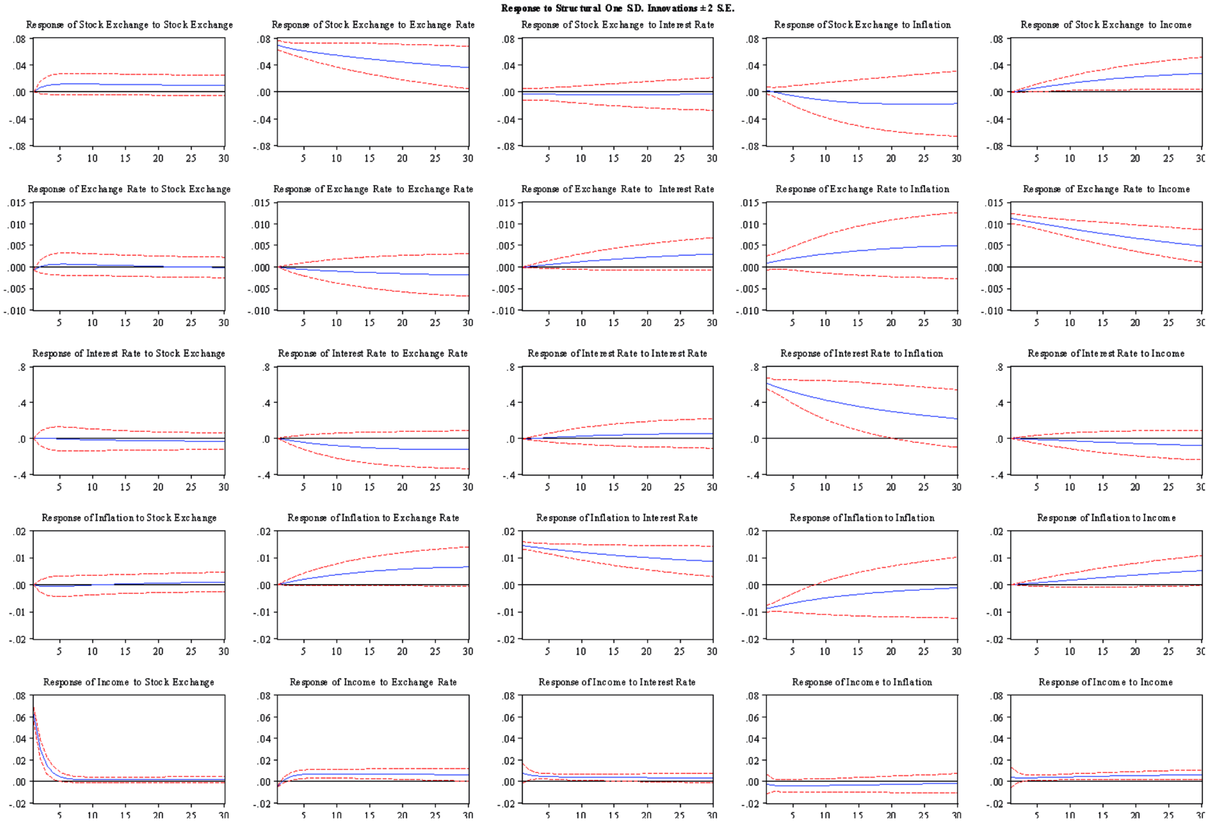

Figure 9. Impulse response function for Sri Lanka

Source: authors' calculations

4.6. Variance decomposition

The Granger causality test may be interpreted as a within-sample causality test, while a variance decomposition analysis may be seen as an out-of-sample causality test. It partitions the variance of the forecast error of a given variable into proportions attributable to changes (or shocks) in each variable in the system, including its own. A variable that is optimally forecasted from its own lagged values will have all its forecast error variance accounted for by its own disturbances (and hence considered as an exogenous variable). Tables 10 and 11 present the variance decompositions of all endogenous variables for each country over a 12-month post-shock horizon. The decompositions are taken in percentage form at different horizons. The second column of the tables presents the standard errors of the decompositions. The next five columns show the percentage contribution of the five shocks to the variance of a specific variable. It is evident from the tables that in each country, exchange rate movements play the most significant role in the forecast error of the stock exchange for the short, medium and long term. Built on the results of impulse response analysis, variance decomposition analysis lends further support to the importance of the foreign exchange market as the leader to affect stock markets. Interest rate, inflation and output shocks are also contributing to stock exchange standard errors but only insignificantly. However, inflation in Bangladesh and Pakistan affects stock exchange standard errors moderately but only in the long run.

Output shock is explaining a major part of the forecasted standard error of exchange rate in all the countries. Besides, in India and Pakistan the stock exchange and the interest rate shocks also explain the modest variation in the exchange rate. In the case of Pakistan, the contribution of inflation shocks to exchange rate standard error is almost zero. In Bangladesh and Sri Lanka, both stock exchange and interest rate have almost zero impact on the forecasted standard errors of the exchange rate. Similarly, in all the countries except Pakistan, inflation has a minor effect on the forecasted standard error of the exchange rate but only in the long run. The role of inflation is most significant in describing the forecasted standard errors of interest rate. Stock prices, exchange rate and output are contributing minutely in explaining the forecasted standard errors of interest rate. The role of interest rate is more prominent in explaining standard errors of inflation. The role of exchange rate shocks is also somewhat prominent. However, stock exchange and output are not contributing much in the standard errors of inflation. These results indicate that inflation and interest rate affect each other, which

Table 10

Forecast error variance decomposition

Bangladesh							India						
Period	**Forecasted Standard Error**	**Stock Exchange Shock**	**Exchange Rate Shock**	**Interest Rate Shock**	**Inflation Shock**	**Income Shock**	**Period**	**Forecasted Standard Error**	**Stock Exchange Shock**	**Exchange Rate Shock**	**Interest Rate Shock**	**Inflation Shock**	**Income Shock**
Percentage Contribution to Standard Error of Stock Exchange							Percentage Contribution to Standard Error of Stock Exchange						
1	0.075	0.000	99.870	0.120	0.002	0.009	1	0.072	0.000	97.064	2.573	0.336	0.027
4	0.136	0.771	95.007	0.332	2.828	1.063	4	0.139	0.331	96.324	3.153	0.145	0.047
8	0.177	1.176	81.934	1.853	11.318	3.719	8	0.190	0.472	95.695	3.130	0.478	0.226
12	0.206	1.216	68.556	3.855	20.561	5.812	12	0.225	0.519	94.718	2.920	1.404	0.439
Percentage Contribution to Standard Error of Exchange Rate							Percentage Contribution to Standard Error of Exchange Rate						
1	0.009	0.311	0.002	0.004	0.105	99.578	1	0.017	0.179	0.001	0.017	3.077	96.726
4	0.018	0.536	0.269	0.002	0.348	98.845	4	0.031	5.531	0.371	2.584	3.221	88.293
8	0.024	0.751	0.930	0.015	1.097	97.208	8	0.039	8.241	3.258	6.863	2.207	79.431
12	0.028	0.931	1.649	0.075	2.454	94.891	12	0.044	9.133	7.637	11.188	2.437	69.606
Percentage Contribution to Standard Error of Interest Rate							Percentage Contribution to Standard Error of Interest Rate						
1	0.129	0.000	0.000	0.007	99.993	0.000	1	0.344	0.000	0.000	0.008	99.992	0.000
4	0.248	1.115	0.105	0.003	98.643	0.134	4	0.632	1.242	0.157	0.133	98.427	0.041
8	0.331	1.725	0.527	0.005	96.854	0.889	8	0.824	2.011	0.243	0.265	97.302	0.179
12	0.383	1.931	1.028	0.020	94.660	2.362	12	0.941	2.411	0.259	0.395	96.583	0.351
Percentage Contribution to Standard Error of Inflation							Percentage Contribution to Standard Error of Inflation						
1	0.009	0.000	0.000	98.368	1.632	0.000	1	0.009	0.000	0.000	89.453	10.547	0.000
4	0.017	0.631	1.084	96.589	1.584	0.111	4	0.019	0.441	0.766	89.690	9.095	0.008
8	0.023	0.722	4.496	92.381	2.194	0.208	8	0.026	0.720	2.867	89.225	7.134	0.054
12	0.028	0.580	8.220	87.338	3.668	0.194	12	0.032	0.875	5.837	87.510	5.629	0.149
Percentage Contribution to Standard Error of Income							Percentage Contribution to Standard Error of Income						
1	0.057	94.966	0.540	1.149	0.207	3.138	1	0.045	91.719	0.459	6.996	0.701	0.124
4	0.066	89.710	1.150	3.978	0.216	4.946	4	0.053	78.583	7.735	5.613	7.907	0.162
8	0.069	82.474	3.550	7.820	0.381	5.775	8	0.061	59.567	17.807	5.690	16.752	0.184
12	0.071	75.945	5.764	11.245	1.200	5.846	12	0.068	48.357	24.322	5.902	21.202	0.218

Source: authors' calculations

Table 11

Forecast error variance decomposition

Pakistan							Sri Lanka						
Period	**Forecasted Standard Error**	**Stock Exchange Shock**	**Exchange Rate Shock**	**Interest Rate Shock**	**Inflation Shock**	**Income Shock**	**Period**	**Forecasted Standard Error**	**Stock Exchange Shock**	**Exchange Rate Shock**	**Interest Rate Shock**	**Inflation Shock**	**Income Shock**
Percentage Contribution to Standard Error of Stock Exchange							Percentage Contribution to Standard Error of Stock Exchange						
1	0.083	0.000	99.977	0.000	0.001	0.021	1	0.069	0.000	99.634	0.262	0.092	0.013
4	0.148	6.564	89.416	0.001	3.207	0.812	4	0.133	1.466	97.950	0.273	0.139	0.173
8	0.199	14.639	72.406	0.006	11.397	1.552	8	0.181	2.475	95.352	0.319	0.901	0.953
12	0.238	17.991	59.587	0.040	20.662	1.720	12	0.215	2.886	92.423	0.368	2.088	2.235
Percentage Contribution to Standard Error of Exchange Rate							Percentage Contribution to Standard Error of Exchange Rate						
1	0.015	0.770	0.005	0.028	2.527	96.670	1	0.011	0.384	0.002	0.008	0.656	98.950
4	0.027	4.694	0.050	0.874	1.652	92.731	4	0.022	0.221	0.087	0.055	1.601	98.037
8	0.034	8.730	0.589	3.126	1.099	86.456	8	0.030	0.288	0.283	0.308	3.317	95.805
12	0.037	10.983	1.434	6.075	0.895	80.614	12	0.035	0.279	0.539	0.753	5.433	92.996
Percentage Contribution to Standard Error of Interest Rate							Percentage Contribution to Standard Error of Interest Rate						
1	0.473	0.000	0.000	0.005	99.995	0.000	1	0.613	0.000	0.000	0.021	99.979	0.000
4	0.947	0.388	0.871	0.005	98.735	0.001	4	1.154	0.001	0.144	0.009	99.838	0.008
8	1.316	0.504	2.602	0.003	96.869	0.022	8	1.519	0.015	0.647	0.047	99.241	0.050
12	1.565	0.394	4.438	0.010	95.055	0.103	12	1.746	0.047	1.411	0.139	98.260	0.144
Percentage Contribution to Standard Error of Inflation							Percentage Contribution to Standard Error of Inflation						
1	0.008	0.000	0.000	81.615	18.385	0.000	1	0.017	0.000	0.000	73.018	26.982	0.000
4	0.015	0.232	0.693	83.571	15.502	0.002	4	0.033	0.095	0.405	74.910	24.546	0.043
8	0.021	1.040	3.270	83.082	12.592	0.017	8	0.044	0.095	1.681	76.413	21.552	0.259
12	0.026	2.288	7.034	79.992	10.627	0.058	12	0.052	0.071	3.519	76.754	18.956	0.700
Percentage Contribution to Standard Error of Income							Percentage Contribution to Standard Error of Income						
1	0.091	95.912	0.658	2.993	0.406	0.032	1	0.063	97.523	0.467	1.483	0.167	0.360
4	0.127	90.293	3.181	3.607	1.463	1.457	4	0.073	93.987	1.446	2.681	1.007	0.880
8	0.140	81.731	10.036	3.599	1.581	3.053	8	0.076	87.777	4.624	3.746	2.115	1.739
12	0.146	77.154	14.100	3.411	1.780	3.555	12	0.079	82.252	7.569	4.488	2.897	2.794

Source: authors' calculations

corroborates the ‘Fisher hypothesis’. Finally, the stock exchange is dominant in describing fluctuations in output. Exchange rate, interest rate and inflation shocks also explain a minor portion of the forecasted standard errors of output but only in the long run.

4.7. Robustness of results

It is argued that the results of impulse response and variance decompositions change considerably for different orderings of the variables. Since we have five variables in our model, so 5! that is 120 total orderings are possible. It is next to impossible for us to check the robustness of the results by changing the orderings of the variables 120 times. Alternatively, we can examine the covariance matrix estimated from the reduced form VAR. If this covariance matrix is close to being diagonal then the ordering of the variables will not influence the structural inference (Masih and Masih, 1996). Table 12 provides the results of the covariance matrix. It is evident from the table that the covariance matrix is close to diagonal which indicates that the orderings of the variables do not affect the impulse response

Table 12

Variance–Covariance matrix

Bangladesh							**India**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	0.006						s_t	0.005				
e_t	0.000	0.000					e_t	0.000	0.000			
i_t	-0.001	0.000	0.017				i_t	0.000	-0.001	0.118		
p_t	0.000	0.000	0.000	0.000			p_t	0.000	0.000	0.000	0.000	
y_t	0.000	0.000	0.000	0.000	0.003		y_t	0.000	0.000	0.000	0.000	0.002

Pakistan							**Sri Lanka**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	0.007						s_t	0.005				
e_t	0.000	0.000					e_t	0.000	0.000			
i_t	-0.010	0.001	0.225				i_t	-0.006	0.001	0.372		
p_t	0.000	0.000	0.000	0.000			p_t	0.000	0.000	0.001	0.000	
y_t	0.001	0.000	0.000	0.000	0.008		y_t	0.000	0.000	0.002	0.000	0.004

Source: authors’ calculations

functions and variance decomposition errors. Another way to check the robustness of the results with different identifying restrictions is to examine the correlation among the residuals. If the correlation among the residuals is found to be statistically significant, based on *t*-statistics, then different identifying restrictions influence the results, otherwise the results are not sensitive to changes in identifying restrictions. The residuals correlation matrix is given in Table 13. Correlations among the residuals of the variables are not only weak but also are statistically insignificant. These weak and insignificant correlations among the disturbance terms show that the model is not sensitive to the change in identifying restrictions.

Table 13

Residual correlation matrix

Bangladesh							**India**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	1						s_t	1				
	--							--				
e_t	-0.149	1					e_t	-0.343	1			
	(-2.080)*	--						(-5.030)*	--			
i_t	-0.070	-0.033	1				i_t	-0.009	-0.170	1		
	(-0.972)	(-0.459)	--					(-0.126)	(-2.382)*	--		
p_t	-0.035	-0.038	-0.022	1			p_t	-0.159	0.087	0.081	1	
	(-0.482)	(-0.527)	(-0.304)	--				(-2.221)*	(1.208)	(1.120)	--	
y_t	-0.003	0.128	0.062	0.100	1		y_t	0.142	-0.006	-0.029	-0.261	1
	(-0.034)	(1.784)**	(0.859)	(1.384)	--			(1.982)**	(-0.083)	(-0.393)	(-3.721)*	--

Pakistan							**Sri Lanka**					
	s_t	e_t	i_t	p_t	y_t			s_t	e_t	i_t	p_t	y_t
s_t	1						s_t	1				
	--							--				
e_t	-0.019	1					e_t	-0.060	1			
	(-0.265)	--						(-0.825)	--			
i_t	-0.265	0.165	1				i_t	-0.145	0.075	1		
	(-3.787)*	(2.307)*	--					(-2.014)*	(1.031)	--		
p_t	-0.001	0.213	0.050	1			p_t	-0.052	0.249	0.116	1	
	(-0.018)	(3.000)*	(0.691)	--				(-0.719)	(3.540)	(1.514)	--	
y_t	0.135	-0.108	-0.006	-0.171	1		y_t	-0.077	0.033	0.056	0.136	1
	(1.873)**	(-1.502)	(-0.079)	(-2.386)*	--			(-1.070)	(0.449)	(0.777)	(1.893)**	--

Note: * (**) indicates that the value is significant at 5% (10%) level.

Source: authors' calculations

CONCLUSION

The study investigates the interdependent causal relationship between stock prices and macroeconomic variables in four South Asian countries using time series data for the period 1997:07 to 2013:06. The macroeconomic variables used are exchange rate, interest rate, inflation and income. The estimated results show that all variables are stationary at their first differences and that long-term cointegration holds among variables. The Granger causality results show that in Bangladesh there is a unidirectional causality running from interest rate to stock prices and from stock prices to inflation. In India, there is a unidirectional causality running from stock prices to exchange rate, from stock prices to interest rate, and from inflation to stock prices. In Pakistan, there is a bi-directional causality between stock prices and exchange rate. Furthermore, there is also a unidirectional causality running from interest rate to stock prices and from output to stock prices. Finally, in Sri Lanka a unidirectional causality is running from stock prices to exchange rate. The results indicate that the South Asian stock markets are largely characterized by the phenomenon predicted under the 'portfolio approach'. In India and Sri Lanka, changes in stock prices lead changes in exchange rates, while in Pakistan either market can take the lead, i.e. there is feedback interaction between stock market and exchange rate market.

Impulse response analysis also indicates that stock prices and macroeconomic variables are correlated. It is found that exchange rate has more effect on stock market compared to other macroeconomic variables. Although there is a feedback interaction between stock market and exchange rate market, the results support the 'traditional approach' more than the 'portfolio approach', i.e. it is exchange rate that affects stock prices more than the other way round. The existence of such a relationship between exchange rates and stock prices is expected because South Asian countries are import-dominant countries, any fluctuations in exchange rate will have an impact on stock markets. The stock market also affects macroeconomic variables but it has more effect on income compared to other variables. These findings are also supported by variance decomposition analysis. All this indicates that stock prices and macroeconomic variables are basically interdependent.

The findings of this study have some important policy implications. The exchange rate market has a great impact on the stock market which indicates that the governments of South Asian countries are required to administer their exchange rates cautiously in order to prevent fluctuations in their stock markets. Furthermore, macroeconomic variables have different effects on stock markets in South Asia which can prove useful for portfolio diversification plans. Since interest rate affects stock prices, increasing interest rate, which would result in contractionary monetary policies, can reduce stock price fluctuations as people will have less money to purchase goods and stocks. This may also decrease speculative activities and the cascading effects on price rises. The relationship between stock market and macroeconomic variables also highlights the formulations and implementation of such policies which have an impact on macroeconomics because well planned and implemented policies may promote stock market stability in South Asia. Moreover, such an analysis could expose the structural channels by which stock prices and macroeconomic variables are inherently causal.

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APPENDIX: IDENTIFICATION

In the structural VAR model (SVAR), Amisano and Giannini (1997), suggested the following relationship between reduced form and structural shocks in the form of the AB-model.

$$\mathbf{A}\mathbf{e}_t = \mathbf{B}\boldsymbol{\mu}_t$$

where $\mathbf{e}_t$ is the observed (or reduced form) residuals, while $\boldsymbol{\mu}_t$ is the unobserved structural innovations. **A** and **B** are $k \times k$ matrices to be estimated. Without imposing some restrictions, the parameters of the SVAR model cannot be identified. The basic purpose of identification is to transform the correlated innovation of the reduced form model into uncorrelated and theoretically meaningful structural shocks. The simple rule of identification is given as: in the case of k variables, k^2 independent restrictions on the parameters of structural model are required for the system to be exactly identified. Out of total k^2 restrictions $k(k+1)/2$ restrictions are generated due to the inbuilt diagonal structure of the variance–covariance matrix. The rest of the $k(k-1)/2$ restrictions can be placed on the contemporaneous or the long-term properties of the system.

Generally, following Sims (1980), short-term identifying restrictions are imposed in the system. In literature, several short-term identification schemes have been developed which are classified into two broad categorized: triangular restrictions and non-triangular restrictions. The triangular or recursive approach to identification transforms $\mathbf{B}$ in the above equation to an n-dimensional identity matrix and $\mathbf{A}$ to a lower triangular matrix with unit diagonal. The recursive approach embraces a causal ordering of variables in a given model. In the case of k variables model, $k!$ total orderings are possible. On the other hand, the non-triangular scheme to identification allows us to impose restrictions that are econometrically feasible, that is, restricted matrices should be fully ranked. In this section non-triangular restrictions are imposed on the matrices in the AB-model. The restrictions are given as follows:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & 0 & a_{24} & 0 \\ 0 & 0 & 1 & a_{34} & 0 \\ 0 & 0 & a_{43} & 1 & 0 \\ 0 & a_{52} & a_{53} & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^s \\ e_t^e \\ e_t^i \\ e_t^p \\ e_t^y \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_t^s \\ \mu_t^e \\ \mu_t^i \\ \mu_t^p \\ \mu_t^y \end{bmatrix}$$

All of these restrictions are imposed on the basis of theoretically expected relationships between variables. Stock prices are affected by exchange rate, interest rate, inflation and income shocks. Exchange rate depends on stock price shock and inflation shock as stipulated by purchasing power parity. Inflation and interest rate are determined by each other as explained by the Fisher hypothesis. Finally, income is affected by exchange rate and interest rate shocks. Note that after the initial period, the variables in the system are allowed to interact freely. For instance, exchange rate shocks can affect stock prices in all periods after the first period in which the shock occurs.