

Macroeconomic Impact of International Reserves: Empirical Evidence from South Asia

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Abstract

In recent years, many emerging countries have been accumulating substantial amount of international reserves by outpacing traditional benchmark in response to a series of financial crises in the world. In this context, this paper constructs a dynamic macro model with new monetary policy rule to examine the implications of international reserve accumulation for macroeconomic outcomes such as economic growth and inflation. Such a macro model is empirically examined in the data of South Asian countries, namely Bangladesh, India, Nepal, Pakistan and Sri Lanka by using Panel VAR method for the period of 1990-2014. The empirical results show that increase in international reserves tends to cause higher economic growth in these countries but without significant impact on inflation. This implies that these countries can move further utilizing the accumulated international reserves productively which will enhance economic growth and maintain internal and external balances.

Key Words: International Reserves, Macroeconomic impact, South Asia

JEL Classification: C23, C61, F31, F41, F43

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I. INTRODUCTION

In recent years, many emerging countries have been accumulating substantial amount of international reserves by outpacing traditional benchmark in response to a series of financial crises in the world (IMF, 2010). In recent years, the international reserve accumulation¹ has accelerated rapidly, reaching 16.7 percent of global GDP in 2013 from 5.3 percent in 1990. The bulk of increase occurred in emerging market countries reaching as high as 28 percent of the GDP. Among them, Asian countries held about 64.2 percent of global reserves in 2013 compared to about 23.4 percent in 1990. China has been the largest reserve holder in absolute volume after 2006 (World Bank, 2015).

International reserves, indeed, play a vital role for smoothing both trade and capital flows in emerging and developing countries whose currencies are not used in international transactions. Holding international reserves is considered to be a rational response to mitigate the impact of fundamental uncertainty and different types of risks in international trade and capital flows. Experiences and evidence have shown that the current global financial system is prone to various types of risks such as currency crisis, capital flight, financial fragility, sovereign default and interplay among those risks (Gabel, 2003). Ocampo (2007) argues that foreign reserves act as a collective insurance against such risks. Feldstein (1999), Rajan (2008), and Banchs and Mollejas (2010) also view that holding of international reserves appears to be essential in the world of asymmetric monetary system for emerging and developing countries. This is because of the lack of a credible international lender of last resort and monetary cooperation at the regional level. More importantly, given that an IMF bailout cannot be guaranteed always and may not be adequate, building sufficiently large precautionary international reserves is felt to be essential for stability of currency, financial system and economy, and preventing balance of payment crisis. Hence, emerging countries hold a large buffer stock of international reserves in spite of significant opportunity costs of holding it (Rodrik, 2006).

Apart from the role of financial stability, accumulation of international reserves can have direct or indirect impact on macroeconomic outcomes of the country through various channels. First, the reserve accumulation alters the balance sheets of the central bank, financial institutions and other economic agents in the economy (Mohanty & Turner, 2006; Cruz & Walters, 2008, Shrestha, 2013). Second, holding international reserves helps stabilize the exchange rate. A sudden and substantial depreciation of the exchange rate usually has major disruptive impact on inflation and growth. Third, international reserves act as a barometer of financial health, helping developing and emerging economies to get access to international capital markets by increasing credibility of the country and confidence of investors (Drummond et al., 2009; Hviding et al., 2004). International reserves are, in fact, taken as collateral for both private and government's external borrowing (Aizenman & Turnovsky, 2002; Dooley, Folkerts-Landau & Garber, 2005). Fourth, international reserves can itself be used to import necessary capital goods and raw materials in developing countries. Fifth, accumulation of international reserves

¹ Including gold

increases the monetary base if not fully sterilized or used for imports, however. Such a rise in the monetary base expands money supply through money multiplier resulting in inflationary effect. More importantly, international reserve accumulation can be an end-result of export-led growth strategy by maintaining undervalued real exchange rate. By creating downward pressure on exchange rate through building up foreign exchange reserves, developing countries attempt to limit consumption and imports, and stimulate exports and investment, and thereby economic growth (Polterovich & Popov, 2003). Yet, the empirical examinations of impact of accumulation of international reserves on macroeconomic outcomes have been less explored. There are only a few studies directly related to this issue, such as Polterovich and Popov (2003), Elhiraika and Ndikumana (2007), Bar-Ilan and Marion (2009), and Ho and McCauley (2009). To our knowledge, no similar study has been carried out in the context of South Asian countries.

This paper, hence, aims to explore the trend of reserve accumulation and the impact of it on key macroeconomic variables, particularly output and inflation in South Asian countries namely Bangladesh, India, Nepal, Pakistan and Sri Lanka. We develop a dynamic macroeconomic model to study the impact of international reserve accumulation on macroeconomic outcomes. In developing a model, several key variables such as exchange rate, international reserves, capital flows, foreign interest rate and foreign exchange interventions are considered. The model is then empirically examined by using data from the selected countries over the period of 1990-2014 which corresponds to the period of rapid economic liberalization in South Asia. We use panel VAR method for empirical estimation.

Empirical results show that international reserve accumulation matters for economic growth in South Asian countries, but no significant impact on inflation. Although South Asian countries have (partial) control on capital account, international reserve accumulation is influenced by foreign interest rates. All of the selected countries observed trade deficit; however, remittance inflows have been contributing to build up foreign reserves in these countries.

The remaining part of the paper is structured as follows. Section 2 presents a brief literature review. Section 3 elaborates a dynamic macro model, which is followed by discussion on data and methodology in section 4 before presenting empirical analysis in section 5. Finally, section 6 ends the paper with conclusions.

II. REVIEW OF LITERATURE

There are various studies on different aspects of international reserves such as Heller (1966), Frenkel and Jovanovic (1981), Jeanne and Ranciere (2006), and Jeanne (2007) on the optimum size of currency reserves; Aizenman and Marion (2003), Aizenman and Lee (2007), Cheung and Ito (2009), and Obstfeld, Shambaugh and Taylor(2010) on the determinants of demand for reserves using various explanatory variables; Drummond, Mrema, Roudet and Saito (2009) on the motives for holding reserves; and Rodrik (2006), Bar-Ilan and Lederman (2007), Bar-Ilan and Marion (2009), Heller (1976), Khan (1979), Ho and McCauley (2009), Hviding, Nowak and Ricci (2004), Zhou (2009), and Banchs

and Mollejas (2010) on the various impacts of reserve accumulation including policy implications.

As the paper concentrates on the macroeconomic impact of international reserve accumulation, a few relevant studies are reviewed here. In a cross country regression of 92 countries, Polterovich and Popov (2003) show that the accumulation of foreign exchange reserves contributes to economic growth of developing countries by increasing both the investment / GDP ratio and capital productivity, even after consideration of other factors affecting economic growth over the period of 1960-99. Further, in a panel data estimation of 21 African countries over the period of 1979-2005, Elhiraika and Ndikumana (2007) examine the impact of reserve accumulation on the exchange rate, inflation and investment. They find that reserve accumulation tends to bring an appreciation of the exchange rate but no significant impact on current inflation. As per these authors, the monetary authorities have been successful in containing the expansionary impact of reserve accumulation. Moreover, both private and public investments increase with the accumulation of foreign exchange in the long run, though the short-run response remains weak (Elhiraika & Ndikumana, 2007). However, these studies lack concrete theoretical backup.

With regard to the impact on inflation, some earlier studies such as Heller (1976) and Khan (1979) find that an increase in international reserves causes inflation worldwide, consistent with the monetarist's view of inflation. However, Ho and McCauley (2009) find no strong evidence of inflation with large-scale reserve accumulation. Foreign currency accumulation leads to lower inflation in Pakistan (Chaudhry, Akhtar, Mahmood & Fardi, 2011). While Ho and McCauley (2009) argue that an absence of inflationary pressure may be due to sufficient excess labour and capacity to meet growing demand without exerting upward pressure on prices, Chaudhry et al. (2011) on the other hand, assert that developing and emerging countries have to rely on imports, so that a decline in the volume of foreign exchange reserves in turn reduces the imports of industrial and agricultural raw material ingredients, unleashing inflationary pressures via shortages in the market.

Given the very limited studies with conflicting results on the possible macroeconomic impact of reserve accumulation, this paper contributes to explore the pattern of international reserve accumulation and its macroeconomic implications for South Asian economies.

III. THE MODEL

This section presents a simple dynamic model with the aim of capturing key macroeconomic outcomes and policy behaviours of small open economies.

3.1 The Macroeconomy

Equation (1) represents open economy output dynamics. This equation is the standard open economy IS-relationship, as used in Proaño (2011).

$$y_t = \alpha_y y_{t-1} - \alpha_{yr} (i_t - \pi_t) + \alpha_{y\eta} \eta_{t-1} \quad \dots\dots\dots (1)$$

where y_t denotes the output gap defined as a log deviation of actual output from its potential level, i_t denotes the short-term nominal interest rate, assumed to be set by monetary policy, π_t is the inflation rate and η_t represents the log of real exchange rate (RER). A lagged output gap in the right side represents an acceleration effect. For export-led growth, a depreciation of RER will raise output by increasing aggregate demand for the economy.

For inflation dynamics, the model follows a standard backward looking Phillips curve as in Proaño (2011), and Bar-Ilan and Marion (2009), by extending it to make an open economy version by incorporating the impact of exchange rate on domestic inflation as in Ball (1999) and Svensson (2000). Hence, our inflation equation is

$$\pi_t = \alpha_{\pi y} y_{t-1} + \alpha_{\pi} \pi_{t-1} + \alpha_{\pi e} (e_t - e_{t-1}) \quad \dots\dots\dots (2)$$

where $\alpha_{\pi y}$ presents the slope of the Phillips curve, α_{π} denotes the degree of inflation persistence in the economy, $\alpha_{\pi e}$ is the exchange rate pass-through effect on inflation, e_t is the log of nominal exchange rate². Empirical studies such as Ho and McCauley (2003), and Ito and Sato (2008) have shown that the exchange rate is an important determinant of inflation in emerging economies. Moreover, Dua and Gaur (2009) find some empirical evidence of the output gap influencing inflation in some Asian economies.

3.2 Exchange Rate Dynamics

The model explicitly treats foreign exchange markets. The uncovered interest parity is the workhorse of exchange-rate determination in many theoretical models despite its consistently poor empirical backing (Reinhart & Reinhart, 2008; Baillie & Chang, 2011). Instead, the model constructed here follows a different approach and considers central bank interventions in the foreign exchange markets influencing the exchange rate. In practice, central banks are frequently engaged in sales and purchases of foreign currencies. Non-sterilized foreign exchange market interventions involve one-for one change in the central bank's net foreign assets and the monetary base. This leads to a change in the short-term interest rate through which exchange rate will eventually change. Central banks are, however, predominantly engaged in sterilized foreign exchange interventions, which leave the primary monetary policy instrument i.e. short-term interest rate unaffected.

Similar to the price impact function of Farmer and Joshi (2002), the model considers the exchange rate to be determined in the foreign exchange market through the interaction of demand and supply.

$$\dot{e}_t = e_t - e_{t-1} = \beta ED \quad \dots\dots\dots (3)$$

where e_t is log of spot exchange rate, ED denotes the excess demand for foreign currency, and β is the adjustment parameter, the value of which depends on the

² However, Ball (1999) considers the log of real exchange rate. But, in our view, the nominal exchange rate affects the inflation, not the real exchange rate.

perfectness of foreign exchange market. Excess demand is $D_t^{fc} - S_t^{fc}$ where D_t^{fc} is the demand for foreign currency and S_t^{fc} is the supply of foreign currency.

Excess demand results in from the trading decisions of foreign exchange market customers. There are two different groups of customers in the foreign exchange market (Grauwe & Grimaldi, 2006). The first group includes all agents who act as customers in the market e.g. fund managers, hedge funds, export and importing firms. They buy and sell currencies according to the needs of their clients. The second group consists of the market makers, normally banks and foreign currency dealers, who take up the excess demand of customers. These market makers ensure that all customers buying and selling orders are fulfilled in the market. More importantly, the central bank is an additional and important market player in the foreign exchange markets, which buys and sells foreign exchange with a view of stabilizing the exchange rate and international reserve accumulation.

Considering these features of foreign exchange markets, the demand for foreign currency is considered as a function of the interest rate differential, output, and the level of international reserves relative to a certain target. A higher interest rate differential will cause capital inflows which lowers demand for foreign currency and vice-versa. Moreover, a higher output level (here represented by the output gap) will increase imports for which more foreign currency will be demanded. As a novel idea, the model considers that investors in the foreign exchange markets also look at the level of international reserves, which would provide both **confidence and collateral** for all sorts of foreign investors. If a country has enough foreign currency reserves, there would be a lower country risk which encourages capital inflows and lowers the demand for foreign currency. Instead, declining reserves, on the other hand, will encourage investors to get the foreign currency back as quickly as possible because of likely default, putting pressure on the demand for foreign currency. Therefore, the demand function for foreign currency is modelled as

$$D_t^{fc} = -\alpha_{ei}(i_t - i_t^f) + \alpha_{ey}y_t - \alpha_{eR}(R_t - R^*) \quad \dots\dots\dots (4)$$

where i_t is the interest rate, i_t^f denotes the foreign interest rate, y_t represents the output gap, R_t is the foreign currency reserves, R^* denotes some sort of a minimum or a target level of international reserves.

The supply of foreign currency through the capital account is captured by the first part of the demand function in an opposite way. The supply side considers two sources of foreign currency – first is the supply of foreign currency from exporters. Since exports are generally considered to depend on the RER, this component of supply of foreign currency is assumed to be a positive function of the RER. Second source of the supply of foreign

currency is the central bank's intervention (I_t) (Almekinders, 1995; Grauwe & Grimaldi, 2006)³.

So, the supply of foreign currency in the foreign exchange market is modelled as

$$S_t^{fc} = \alpha_{e\eta}\eta_t + I_t \quad \dots\dots\dots (5)$$

where η is the log of RER, where I_t is the intervention, i.e. a sale of foreign currency.

Then, combining equation (3), (4) and (5) provides the equation for the exchange rate dynamics as

$$\dot{e}_t \approx e_t - e_{t-1} = \beta_e[-\alpha_{ei}(i_t - i_t^f) + \alpha_{ey}y_t - \alpha_{eR}(R_t - R_t^*) - \alpha_{e\eta}\eta_t - I_t] \quad \dots\dots\dots (6)$$

In this way, the foreign exchange interventions influence the market exchange rate which has theoretical and empirical supports⁴ (Disyatat & Galati, 2005; Dominguez & Frankel, 1993; Grauwe & Grimaldi, 2006; Mongkol, 2011).

In the efficient market model, only unsterilized interventions can influence the exchange rate by affecting the interest rate in money markets (Grauwe & Grimaldi, 2006). In practice however, central banks overwhelmingly use sterilized interventions, which also affect the exchange rate (Disyatat & Galati, 2005; Grauwe & Grimaldi, 2006; Mongkol, 2011). Aizenman and Glick (2008) find that the volume of sterilization has risen after the Asian financial crisis.

Since RER is $E \frac{P^*}{P}$, where E is nominal exchange rate, P* represents the foreign price level and P denotes the domestic price level, taking log and differentiating with respect to time generate the equation for RER as,

$$\log RER_t = \eta_t = \log E_t + \log P_t^* - \log P_t \quad \dots\dots\dots (7)$$

$$\dot{\eta}_t \approx \eta_t - \eta_{t-1} = \dot{e}_t + \pi_t^f - \pi_t \quad \dots\dots\dots (8)$$

³ Three important objectives of interventions, documented by Moreno (2005) are as follows: influencing the level of the exchange rate; dampening the volatility of exchange rate volatility; and accumulating foreign currency reserves.

⁴ Almekinders (1995) views that the sterilized interventions affect the exchange rate through the portfolio balance channel and Archer (2005) adds two additional channels - signaling or expectation, and the order flows. In the portfolio balance channel, portfolio reallocation changes relative prices in the process and one type of the relative price changes might be exchange rates (Mongkol, 2011). In the signaling channel, intervention influences the exchange rate by changing the perceptions of market participant about the future (Dominguez & Frankel, 1993). In the order flow channel, central banks can alter the order flow with their own orders in the market.

Replacing equation (6) in equation (8), we get

$$\eta_t - \eta_{t-1} = \beta_e [-\alpha_{ei}(i_t - i_t^f) + \alpha_{ey}y_t - \alpha_{eR}(R_t - R_t^*) - \alpha_{e\eta}\eta_t - I_t] + \pi_t^f - \pi_t \dots\dots\dots (9)$$

3.3 Reserve Accumulation Process

It is assumed that the central bank's reserve level varies primarily with foreign exchange interventions⁵. Through purchase interventions, the level of international reserves increases, but through sells interventions, such a reserve level declines. In order to maintain a competitive RER (and even a stable nominal exchange rate),⁶ central banks actively participate in the foreign exchange market. A competitive RER is considered as an important development strategy (Eichengreen, 2008), and the exchange rate stability is considered as a public good (Almekinders, 1995). Through interventions, central banks try to limit the fluctuations of the exchange rate around the fundamental trend line determined by the purchasing power parity in line with the fear of floating hypothesis of Calvo and Reinhart (2002) – avoiding appreciation due to competitiveness concerns and depreciation due to balance sheet effects (Rajan, 2010).

Following Almekinders (1995), foreign exchange interventions are modelled in terms of an intervention response function as $I_t = Fz_t$, where F is a row vector containing response coefficients, and z_t is a column vector of state variables⁷. Central banks, looking at the real exchange rate, intervene in the foreign exchange market - supplying and buying foreign currencies⁸. In the case of depreciation, central banks sell foreign currency (supplying foreign currency) and in the case of appreciation, central banks purchase foreign currency, to maintain the RER stable. If $\eta = 0$ i.e. RER = 1, there will be no interventions. This is similar to the exchange rate targeting rule of foreign exchange interventions. Under this rule, central banks intervene if the exchange rate deviates from its fundamental values. If $\eta = 0$, the spot exchange rate is at the fundamental level implied by the purchasing power parity.

⁵ In addition to foreign exchange intervention, the level of international reserves may vary due to valuation changes, income flows (e.g., accrual of interest), and debt operations of the central bank on behalf of other agents, particularly the government (Adler & Tovar, 2011).

⁶ One of the key findings of the open economy macro literature is that nominal exchange rates and real exchange rate move quite closely together, except in highly inflationary environment (Rodrik, 2008, 8)

⁷ Frenkel and Stadtmann (2001) show that intervention function can be derived from the minimization of the central bank loss function of $L_t = \alpha(s_t - s_t^*)^2 + \beta(I_t - I_t^*)^2$, where s_t denotes the log of the nominal exchange rate and I_t is the size of central bank intervention measured as a change in currency reserves. An asterisk represents the target level of respective variable and, α and β are the relative importance of the two objectives.

⁸ Almekinders (1995, 160) argues that promoting a stable exchange rate system is the part of commitment with the Articles of Agreement of the International Monetary Fund (IMF) as amended in 1992 to "counter disorderly exchange market condition".

There is also another rule mentioned in the literature, which is called a leaning-against-the-wind strategy, in which the central bank does not refer to any specific target value, but intervenes to counter the past exchange rate movement. Grauwe and Grimaldi (2006) find, through model simulations, that both rules are capable of eliminating the bubble and these rules ensure the exchange rate to better reflect the underlying fundamentals by reducing the role of chartists. In addition, incorporation of the level of foreign currency reserves (deviation from certain minimum or optimum level of it) is the novel aspect of the model. Consideration of maintaining a certain reserve level may also cause central banks to intervene in the foreign exchange market. Aizenman and Sun (2009) find the behaviour of central banks that reflects the fear of losing currency reserves in the aftermath of the global financial crisis of 2007.

Considering these facts, the model considers the foreign exchange intervention function as follows.

$$I_t = \beta_\eta \eta_t + \beta_R (R_t - R_t^*) \quad \dots\dots\dots (10)$$

Then, the reserve accumulation by the central bank is assumed to be through intervention in the foreign exchange market. A change in foreign currency reserves is simply equivalent to the amount of interventions. Since I_t is the sale of foreign currency in interventions, a change in the foreign currency reserves can be written as

$$\dot{R}_t \approx R_t - R_{t-1} = -I_t = -(\beta_\eta \eta_t + \beta_R (R_t - R_t^*)) \quad \dots\dots\dots (11)$$

When $\eta > 0$ i.e. undervaluation of the RER, a central bank sells foreign currency so that international reserves will decline. On the other hand, when $\eta < 0$, i.e. overvaluation of RER, a central bank purchases foreign currency so that international reserves will increase. Similarly, when $R_t > R^*$, a central bank wants to sell foreign currency, but when $R_t < R^*$, a central bank buys the foreign currency from the market. R^* tends to indicate a minimum or critical level of precautionary international reserves.

3.4 Monetary Policy Rule

The model considers sterilized interventions, leaving the short-term interest unaffected, so that monetary policy can set the short-term interest rate. In place of conventional Taylor rule, the model uses a modification of it, considering small open economies following the studies of Berument and Tasci (2004), Kato, Proano and Semmler (2009), and Shrestha and Semmler (2015a, 2015b) in which monetary policy reacts not only to the output gap and inflation, but also to the deviation of foreign currency reserves from its minimum (or optimum) level as,

$$i_t = i_0 + \phi_y y_t + \phi_\pi (\pi_t - \pi_0) - \phi_R (R_t - R^*) \quad \dots\dots\dots (12)$$

where i_t is the short term interest, which is monetary policy instrument, i_0 is a steady state nominal interest rate, π_0 represents a steady state inflation rate.

Combining equation (1), (2), (9), (11) and (12) makes the complete model. The model includes four state variables such as y_t, π_t, η_t, R_t , monetary policy variable i_t , exogenous variables such as i_t^f, π_t^f and steady state (or target) variables such as i_0, π_0, R^* . By replacing i_t with monetary policy rule in output equation and exchange rate equation, we get a system of four variables y_t, π_t, η_t, R_t as follow.

$$\begin{aligned} y_t &= \alpha_y y_{t-1} - \alpha_{yr}(i_t - \pi_t) + \alpha_{y\eta} \eta_{t-1} \\ \pi_t &= \alpha_{\pi y} y_{t-1} + \alpha_{\pi} \pi_{t-1} + \alpha_{\pi e}(e_t - e_{t-1}) \\ e_t - e_{t-1} &= \beta_e(-\alpha_{ei}(i_t - i_t^f) + \alpha_{ey} y_t - \alpha_{eR}(R_t - R_t^*) - \alpha_{e\eta} \eta_t - I_t) \\ \eta_t - \eta_{t-1} &= \beta_e[-\alpha_{ei}(i_t - i_t^f) + \alpha_{ey} y_t - \alpha_{eR}(R_t - R_t^*) - \alpha_{e\eta} \eta_t - I_t] + \pi_t^f - \pi_t \\ R_t - R_{t-1} &= -I_t = -(\beta_{\eta} \eta_t + \beta_R(R_t - R_t^*)) \\ i_t &= i_0 + \phi_y y_t + \phi_{\pi}(\pi_t - \pi_0) - \phi_R(R_t - R_t^*) \end{aligned}$$

IV. DATA AND METHODOLOGY

The above system shows the complex interrelationship among four variables namely output, inflation, exchange rate and international reserves. There is no straight forward way of hypothesizing the relationship between variables in the system. However, as briefly discussed in the first section, international reserves may have positive association with economic growth and inflation but negative with real exchange rate.

Further, although there is contemporaneous impact of variables in the above model, in practice it takes time to have impact by one variable on others because of several kinds of lags such as recognition, decision and implementation. Hence, the essence of the above model can be well represented by a reduced form VAR which is now well established in applied macroeconomics. Avoiding complexities and given the nature of data and their availability, the following VAR model is set up to capture the essence of the above theoretical model.

$$Y_{i,t} = \alpha_0 + B(L)Y_{i,t} + C(L)X_{i,t} + \varepsilon_{i,t} \quad \dots\dots\dots (13)$$

where $Y_{i,t}$ is a set of endogenous variables GDP growth (g), inflation (π), real exchange rate (rer) and international reserve as percentage of GDP ($resgdp$), and $X_{i,t}$ is a set of exogenous variable i.e. inflation ($usinf$) and interest rate ($ustb1y$) in the US. Instead of calculating output gap despite mentioned in the theoretical model, we take GDP growth since there is no unanimous method for calculating output gap. For the real exchange rate, we have computed the real exchange rate with the US dollar, which is still a major reserve currency. The rer is a real exchange rate index (2010=100). As an indicator for international reserves, we have taken the international reserves as a percentage of GDP⁹.

⁹ There are other ratios also observed and monitored in recent year such as the Guidotti-Greenspan's rule of covering short-term debts for 1 year, number of months of imports covered, and international reserves– broad money ratio, for detail Shrestha and Semmler (2015a).

$\varepsilon_{i,t}$ reflects the model's error term $\sim iid(0, \sigma^2)$. $B(L)$ and $C(L)$ are matrix polynomials in the lag operator.

We apply the Panel VAR technique which combines the traditional VAR technique with panel-data approach, which allows the capturing of unobserved individual heterogeneity (Love & Zicchino, 2002). Five South Asian countries – Bangladesh, India, Nepal, Pakistan and Sri Lanka have been selected for the panel study. Annual data for the period of 1990-2014 are used. This is the period of economic liberalization and opening up the economy in these countries. All data are collected from World Bank's World Development Indicators (WDI, December 2015), except one-year US treasury bill rate which is collected from Federal Reserve Bank's website¹⁰.

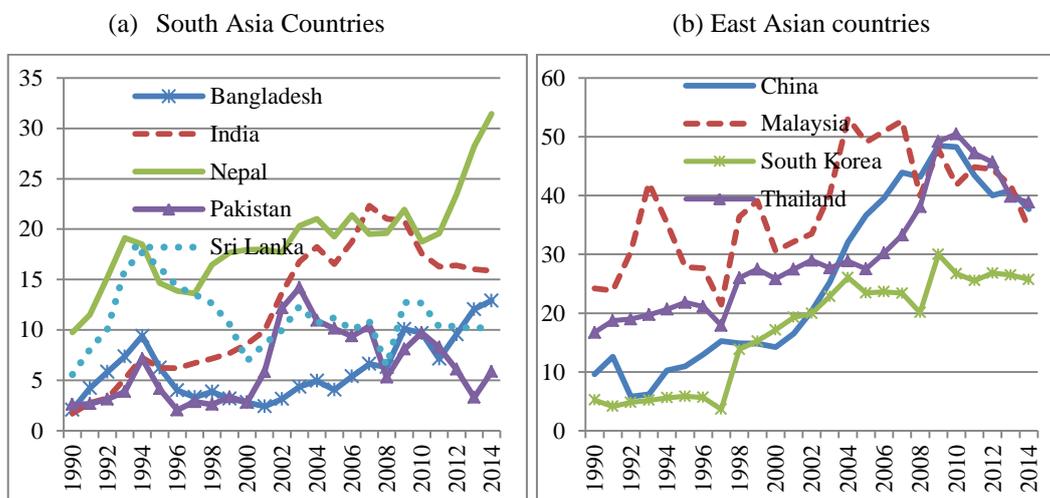
V. EMPIRICAL ANALYSIS

5.1 Trend of International Reserve Accumulation in South Asia

This section presents the pattern of international reserve accumulation in the selected South Asian countries. Figure 1, 2 and 3 present international reserve accumulation in these countries as a percentage of GDP, number of months of import of goods and services covered, and short-term debt as a percentage of international reserves respectively. Figure 1 shows that all of the selected countries observed rise in reserve accumulation in the first half of 1990s and witnessed a decline in the second half during which East Asian countries passed through the severe financial crisis. After 2000, all selected countries observed a substantial rise in international reserve accumulation despite some fluctuations. Such a rising trend continued with some break in 2008 in Nepal. India experienced a decline in international reserve accumulation after the global financial crises of 2007. International reserve accumulation registered a decline in Sri Lanka and Pakistan after 2003 until 2008. Despite some improvement in reserve accumulation in 2007 in Pakistan, this trend did not continue. But, Sri Lanka witnessed improvement after 2008. Gradual improvement in reserve accumulation was observed in Bangladesh after continuous decline until 2001. Except Pakistan, reserve accumulation in other countries in recent years is higher than what they had in the 1990s.

Except Nepal, the highest level of international reserve accumulation as a percentage of GDP (22.3 percent) was observed by India in 2007. On the other hand, after the East Asian crisis countries such as China, Thailand, South Korea and Malaysia continuously increased their reserve accumulation as seen in Figure 1(b). These East Asian countries accumulated international reserves above 50 percent of GDP, except South Korea until the global financial crisis. Despite some drop during the recent global crisis, reserve accumulation increased afterward before slightly declining in recent years. Still, the level of reserve accumulation in East Asian countries remained higher than that of in South Asian countries.

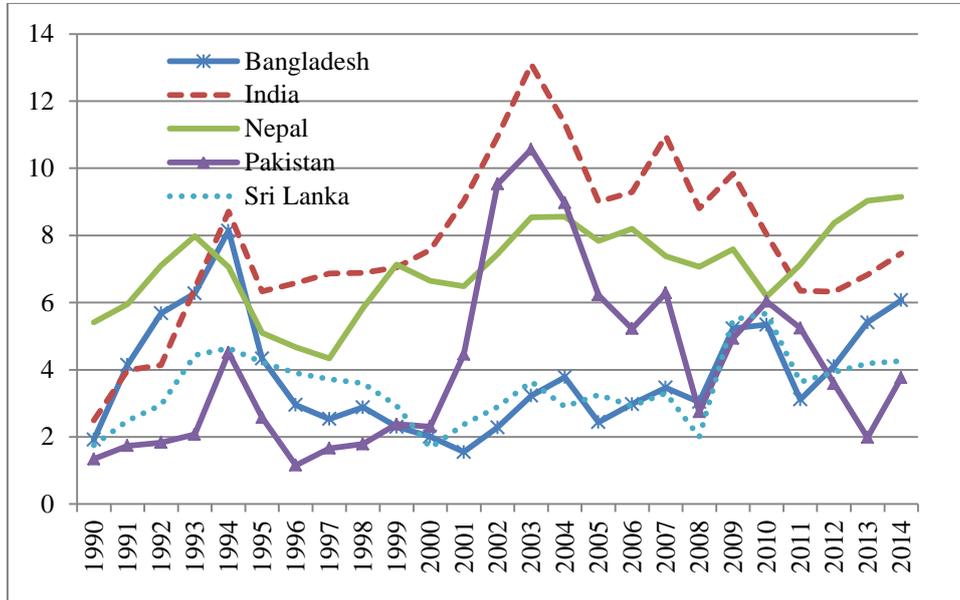
¹⁰ <http://www.federalreserve.gov/releases/h15/data.htm>

Figure 1: International Reserve Accumulation as % of GDP

Source: World Development Indicators, World Bank (December 2015)

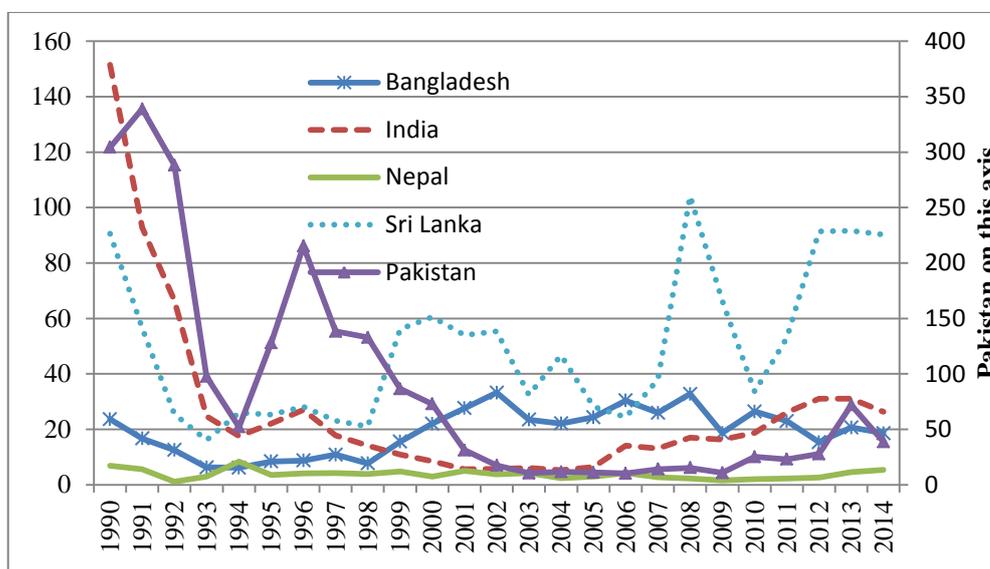
Another highly used indicator of international reserve accumulation is the number of months of imports of goods and service covered. As shown in Figure 2, all selected South Asian countries observed a rise in months of imports of goods and services in the first half of 1990s and a fall in the second half of 1990s. After 2000, India, Nepal and Pakistan witnessed a sharp increase in the number of months of imports covered until 2003, but Sri Lanka and Bangladesh recorded only a slight increase. After 2004, the number of months of imports covered declined sharply in India and Pakistan. This trend continues despite slight improvement in some years. However, the number of months covered in India has been higher than 6 months, while in Pakistan remained about 4 months in 2014. Interestingly, the number of months of imports covered in Bangladesh and Sri Lanka shows a similar pattern, i.e. a rise after the global financial crisis for the next two years, then decline in 2011, before slight improvement thereafter above 3 months of imports covered. Nepal observed a rising trend over the sample period, reached as high as 9 months in 2014.

Figure 2 : No. of Months of Import of Goods and Service Covered



Source: World Development Indicators, World Bank (December 2015)

Figure 3 shows the adequacy of international reserve accumulation from capital account perspective. People argue that traditional benchmark rule of 3 months of imports covered is inadequate from the perspective of sudden capital outflows as observed in East Asian countries in 1997 (Obstfeld, et al., 2010). Hence, the recent Greenspan-Guidotti rule argues that countries should have international reserves sufficient to cover short-term debt for one year (Jeanne & Ranciere, 2006). In 1990, India and Pakistan had international reserves not enough to cover all short-term debt. However, the situation improved thereafter observing sharp decline in short-term debt to international reserves ratio in all South Asian countries. However, Pakistan witnessed a sharp increase in short-term debt to international reserve ratio in 1995 and 1996, which has since declined. Sri Lanka also observed rise in a short-term debt to international reserves ratio in 1999 and 2000, and later in 2007 and 2008, again increased in 2012 and remained at that level till 2014. Likewise, India recorded a modest rise in this ratio in recent years. On the other hand, Bangladesh maintained the short-term debt to international reserve ratio below 40 percent throughout the sample period and witnessed a decline in recent years. Since capital account is not open in Nepal, the short-term debt to international reserve ratio has remained very low. From the point of view of Greenspan-Guidotti rule, the selected South Asian countries are in a comfortable position in international reserve accumulation because of (partial) control on capital account in recent years, except Sri Lanka who observed high volatility of this ratio because of more open capital account.

Figure 3: Short-term Debt as % of International Reserves

Source: World Development Indicators, World Bank (December 2015)

5.2 Macroeconomic Performance of South Asia

Before doing empirical analysis, this section describes the macroeconomic performance in the selected countries over the sample period. During 1990-2000, except Pakistan, other selected countries registered a growth of their economy close to 5 percent or more (Table 1). India grew at a comparatively higher rate of 5.6 percent on average. During that period, Malaysia grew by 7.4 percent¹¹ and China grew by 9.9 percent. Hence, economic growth in South Asia during 1990-2000 had remained moderate. Except Nepal and Pakistan, other South Asian countries improved their growth performance during 2001-2014 with India increasing its economic growth rate to 7.2 percent. Although China continued to maintain higher rate even after the East Asian crisis, economic growth in other East Asian countries decelerated, for example, Malaysia grew by 4.8 percent during 2001-2014 (Table 1).

¹¹ Average economic growth in Malaysia will go up if we remove the crisis period of 1997 and 1998.

Table 1: Economic Growth and Inflation (in %)

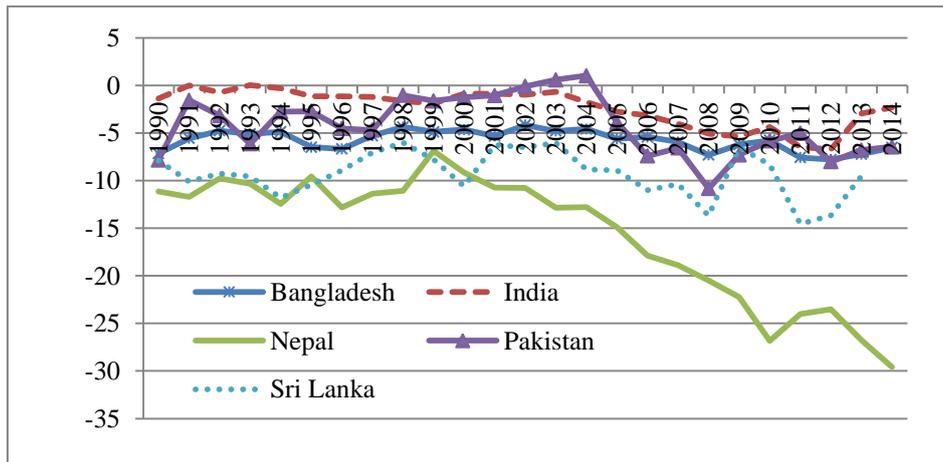
Countries	GDP Growth (g)		Inflation (π)	
	1990-2000	2001-2014	1990-2000	2001-2014
Bangladesh	4.8	5.8	5.38	6.81
India	5.6	7.2	9.04	7.08
Nepal	5.0	4.1	8.98	7.16
Pakistan	4.0	4.1	9.23	8.98
Sri Lanka	5.3	5.5	10.79	9.41
Malaysia	7.4	4.8	3.47	2.30
China	9.9	9.8	7.07	2.44

Source: World Development Indicators, World Bank (December 2015)

On the inflation front, the performance of South Asia remained relatively weak compared to East Asian countries. Except Bangladesh, other South Asian countries recorded inflation close to double digit during 1990-2000. However, these countries reduced their average inflation slightly during 2001-2014, which is still substantially higher than in Malaysia and China.

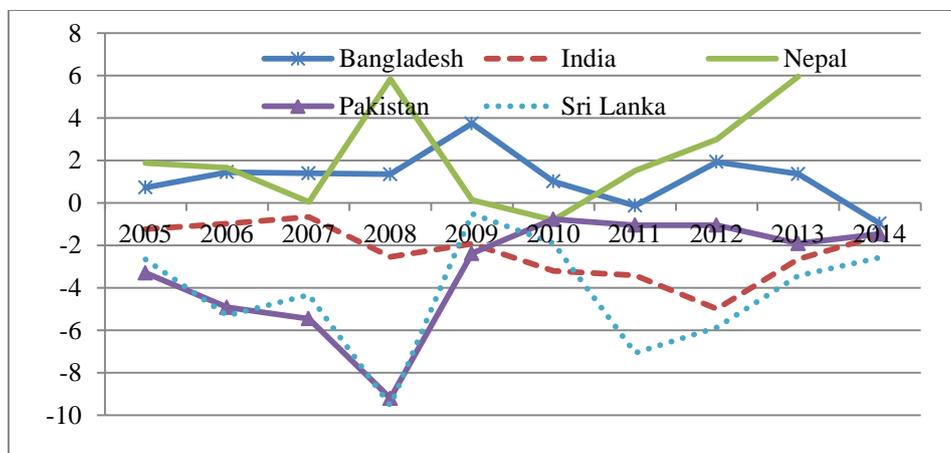
Figures 4, 5 and 6 show the external balance on goods and services, current account balance and remittance flows as a percentage of GDP in the selected countries. All selected countries in South Asia have a deficit in external balance on goods and services. Among them, such a deficit in Nepal has reached more than a quarter of GDP (Figure 4). However, due to inflows of substantial amount of remittance, current account has been in surplus in Nepal and Bangladesh (Figure 5). After 2001, remittance inflows started increasing in Nepal and Bangladesh. Remittance in Sri Lanka has also been increasing, which has now reached about 9 percent of GDP. Remittance inflows, in fact, contribute to accumulate international reserves in these countries.

Figure 4: External Balance on Goods and Services (% of GDP)



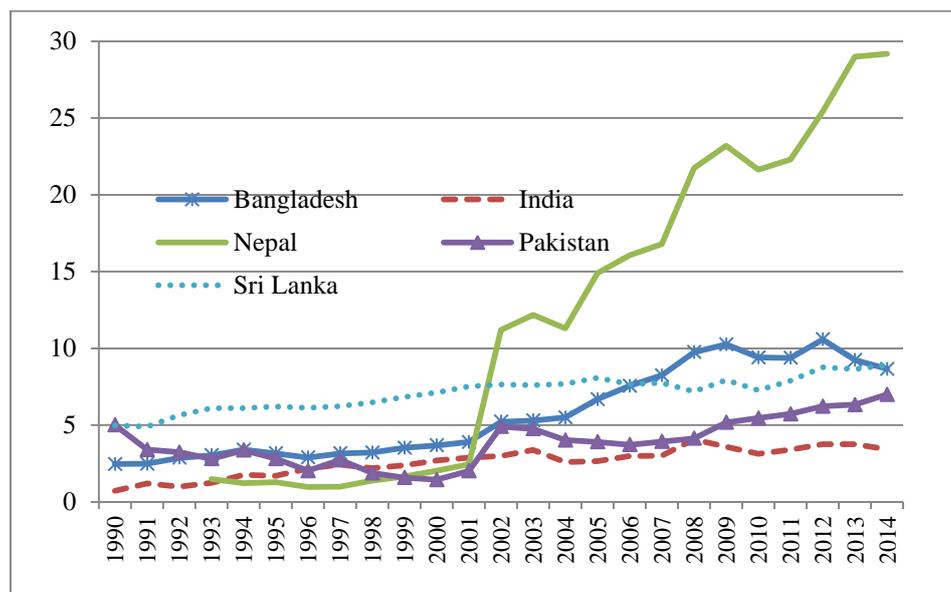
Source: World Development Indicators, World Bank(December 2015)

Figure 5: Current Account Balance (% of GDP)



Source: World Development Indicators, World Bank(December 2015)

Figure 6: Remittance Inflows (% of GDP)



Source: World Development Indicators, World Bank(December 2015)

5.3 Unit Root Tests

It is necessary to test for unit roots in time series data prior to statistical analysis for avoiding spurious results. The Levin and Lin Test, and Im, Pesaran & Shin W-Stat are utilized to test the null hypothesis of non-stationarity since VAR methodology requires variables to be stationary. Table 2 presents the test results for panel unit root. GDP growth (g) and inflation (π) are stationary, while $\log(rer)$ and $resgdp$ are

nonstationary in level, but stationary in first difference. Moreover, *usinf* is stationary but *ustb1y* is not; however, the first difference of *ustb1y* is stationary.

Table 2: Panel Unit Root Test (with intercept, lags selected by AIC)

Variables	Levin, Lin & Chu Stat	Prob.	Im, Pesaran & Shin W-Stat	Prob.
<i>g</i>	-6.50	0.00	-5.72	0.00
π	-4.85	0.00	-3.92	0.00
$\log(rer)$	0.86	0.81	0.93	0.82
$d\log(rer)$	-6.85	0.00	-5.13	0.00
<i>resgdp</i>	0.13	0.55	0.64	0.74
$d(resgdp)$	-7.32	0.00	-5.87	0.00
<i>usinf</i>	-4.20 (ADF stat)	0.00		
<i>ustb1y</i>	-1.83 (ADF stat)	0.35		
$d(ustb1y)$	-4.49 (ADF Stat)	0.00		

Source: Author's calculation

5.4 Panel VAR Estimation

5.4.1 Lag Selection

It is essential to select an appropriate lag for VAR estimation. Using the AIC criterion, we confirm that the number of lags to apply in the VAR is two (Table 3a). We also conclude that the VAR specification satisfies the stability conditions since all roots are inside the unit circle (Table 3b).

Table 3a: VAR Lag Order Selection Criteria

Endogenous variables: GDPG INF DLOG(RER) D(RES)

Exogenous variables: C USINF(-1) D(USTB1Y(-1))

Sample: 1990 2014

Included observations: 100

Lag	LogL	LR	FPE	AIC	SC
0	-520.36	NA	0.49	10.65	10.96*
1	-486.14	63.66	0.34	10.28	11.01
2	-467.82	32.60	0.33*	10.24*	11.38
3	-457.69	17.21	0.37	10.35	11.92
4	-436.15	34.90*	0.34	10.24	12.22

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Table 3b: Roots of Characteristics Polynomial

Endogenous variables: g π $d(\log(rer))$ $d(res)$
 Exogenous variables: c $usinf(-1)$ $d(ustbly(-1))$
 Lag specification: 1 2

Root	Modulus
$0.576596 - 0.177660i$	0.603345
$0.576596 + 0.177660i$	0.603345
0.500357	0.500357
$0.138661 - 0.467475i$	0.487606
$0.138661 + 0.467475i$	0.487606
$-0.352732 - 0.279001i$	0.449735
$-0.352732 + 0.279001i$	0.449735
-0.198499	0.198499

No root lies outside the unit circle.

VAR satisfies the stability condition.

Source: Author's calculation

5.4.2 Empirical Results

First, VAR model is estimated in the pool data ignoring the country heterogeneity. Detail results are in Table 4. Although the VAR estimates do not present the p-values for testing the corresponding parameters (in Eviews), based on each value of the t-statistics by using a critical point of $t_0 = 2$ or 1.96, we can determine whether or not a lagged variable has a significant adjusted effect on the corresponding dependent variable (Agung, 2009). Accordingly, it seems that except international reserves, other three variables are found to be affected by the past values and there is no any positive association between economic growth and inflation in the selected countries.

Although one year lag change in $\log(rer)$ has a positive effect as expected, albeit insignificant, two-year lag change in $\log(rer)$ has a significant negative impact on economic growth, which may be due to a significant import content in domestic production such as the high volume of petroleum products. Change in international reserves ratio ($resgdp$) is found to affect economic growth positively, although the first lag is insignificant, the second lag is statistically significant with a positive sign. As explained in section 3, international reserve accumulation can affect economic growth positively in various ways. The US inflation rate is also found to have significant negative effect on economic growth, which may be due to the impact on the real exchange rate. If we look at the third column of Table 4, inflation is found to be affected by its own past value only. In contrast to Khan (1979), reserve accumulation is not found to affect inflation as predicted by the quantity theory of money.

Table 4: Vector Autoregression Estimates

Sample (adjusted): 1992 2014
 Included observations: 110 after adjustments
 t-statistics in ()

	GDPG	INF	DLOG(RER)	D(RESGDP)
GDPG(-1)	0.304 (3.18)	-0.095 (-0.53)	-0.002 (-0.75)	-0.045 (-0.42)
GDPG(-2)	0.096 (1.02)	0.175 (1.00)	-0.001 (-0.55)	0.054 (0.51)
INF(-1)	0.082 (1.37)	0.446 (4.01)	-0.003 (-2.07)	-0.016 (-0.24)
INF(-2)	-0.091 (-1.65)	0.003 (0.03)	0.005 (3.01)	0.040 (0.65)
DLOG(RER(-1))	2.850 (0.74)	2.134 (0.29)	0.124 (1.18)	2.349 (0.54)
DLOG(RER(-2))	-10.161 (-3.04)	-12.071 (-1.93)	0.211 (2.30)	5.513 (1.45)
D(RESGDP(-1))	0.163 (1.88)	0.084 (0.52)	-0.009 (-3.92)	0.153 (1.56)
D(RESGDP(-2))	0.255 (2.81)	-0.004 (-0.03)	0.002 (0.60)	-0.130 (-1.26)
C	4.384 (4.76)	4.389 (2.55)	-0.049 (-1.96)	-2.264 (-2.17)
USINF(-1)	-0.519 (-2.40)	-0.182 (-0.45)	0.021 (3.60)	0.896 (3.65)
D(USTB1Y(-1))	0.185 (1.25)	0.524 (1.89)	-0.004 (-0.92)	-0.675 (-4.02)
R-squared	0.32	0.27	0.32	0.28
Adj. R-squared	0.26	0.19	0.25	0.21

Source: Author's calculation. Note: Significant coefficients are on bold letters.

Real exchange rate is significantly affected by change in inflation, negatively in one year lag as expected theoretically and positively in two-year lag. This shows the possibility of a complex effect in practice. However, the real exchange rate seems to respond to change in international reserves negatively as expected, which implies that with increase in reserve accumulation, domestic currency tends to appreciate. Similarly, as theory predicts, *rer* is found to depreciate with rise in US inflation.

In the last column of Table 4, coefficients of US inflation and treasury bill is found to affect reserve accumulation. With rise in the interest rate in US, foreign currency flows to South Asian countries tend to decline and vice versa. A rise in US inflation tends to overvalue the exchange rate which may encourage inflows of capital toward South Asian countries. Although capital account is not fully open in South Asia, dynamics of

international reserves is found to depend on the foreign interest rate, which seems plausible given the growing trend of globalization, development of information technology and growing role of remittance in these economies.

5.4.3 Residual Autocorrelation Test

Residual LM test has been performed on the above VAR estimation to examine if there is any serial correlation in residuals. Existence of serial correlation violates the OLS assumptions. Table 5 presents the VAR residual serial correlation LM tests. The LM – stat cannot reject the null hypothesis of no serial correlation up to lag lengths of three. Hence, the model satisfies the OLS assumptions.

Table 5: VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h
Sample: 1990-2014

Lags	LM-Stat	Prob
1	18.49	0.30
2	21.23	0.17
3	10.35	0.85

Probs from chi-square with 16 df.

Source: Author's calculation

5.4.4 Granger Causality Test

Because of the complicated dynamics in the VAR, Stock and Watson (2001) argue that statistics such as Granger-causality test, impulse responses and forecast error variance decompositions are more informative than VAR regression coefficients. In case of a reduced form VAR, *Granger-causality statistics* examine whether lagged values of one variable help predict another variable¹² (Stock & Watson, 2001). Table 6 summarizes the Granger-causality results. It shows the Wald test statistics with *p*-values for testing whether the relevant sets of coefficients are zero.

¹² Impulse responses and variance decomposition are typically calculated for recursive and structural VARs (Stock & Watson, 2001)

Table 6: Granger Causality Test

(p-value in parenthesis)

Regressor	Dependent Variable in Regression			
	g	π	$d\log(rer)$	$d(resgdp)$
g	0.0	1.05(0.59)	1.24 (0.54)	0.33(0.85)
π	3.06(0.22)	0.0	9.34 (0.01)	0.43(0.81)
$d\log(rer)$	9.24(0.00)	3.78(0.15)	0.0	3.05(0.22)
$d(resgdp)$	13.82 (0.00)	0.27 (0.87)	15.39(0.00)	0.0

Source: Author's calculation

Change in $\log(rer)$ and $resgdp$ help to predict economic growth at the 1 percent significance level, but inflation does not. None of the selected variables predict inflation, but inflation and change in $resgdp$ help to predict change in the real exchange rate. On the other hand, no any variables in the VAR system helps predict international reserve accumulation, which may be due to the fact that these countries have a deficit in external balance on goods and services.

5.4.5 Fixed Effect

Although all selected countries are in South Asia, normally affected by common external shocks and close to each other, and followed the economic liberalization over the sample period, they still differ in geography, culture and economic policies. For example, while Nepal has been following the pegged exchange rate with the Indian currency, other countries selected have followed managed floating systems. Moreover, selected countries are substantially different in economic size and population. Hence, there is some heterogeneity among these countries. To account heterogeneity among countries, fixed effect model has been estimated.

Results from fixed effect model in Table 7 are not much different from Table 4. After considering heterogeneity among countries, coefficient of one-year lag of $dustb1y$ also became significant at 5 percent in the first equation. It may work through a change in the real exchange rate by depreciating it. Although small changes, coefficient of two-year lag of $d\log(rer)$ and $d(resgdp)$, and one-year lag of $usinf$ are still significant in growth equation. Hence, the impact of international reserve accumulation on economic growth is seemed to be robust. In inflation equation, no substantial changes occur. In third equation, impact of $d(resgdp)$ on $d\log(rer)$ disappeared. There is no change in the fourth equation in terms of the significance of coefficients.

Table 7: Fixed Effect Estimation

(White cross-section standard errors & covariance (d.f. corrected))

	<i>g</i>	π	<i>dlog(rer)</i>	<i>d(resgdp)</i>
<i>g</i> (-1)	0.087	-0.07	-0.002	-0.06
<i>g</i> (-2)	-0.071	0.32	-0.003	-0.01
π (-1)	0.085*	0.38**	-0.003	-0.01
π (-2)	-0.082	-0.03	0.005*	0.04
<i>dlog(rer)</i> (-1)	1.450	0.04	0.117	2.55
<i>dlog(rer)</i> (-2)	-12.40**	-8.07	0.192	3.75
<i>d(resgdp)</i> (-1)	0.162	0.07	-0.010	0.15
<i>d(resgdp)</i> (-2)	0.245*	-0.03	0.001	-0.15
C	5.911	4.72	-0.043	-2.39
<i>usinf</i> (-1)	-0.376**	-0.34	0.021*	1.04**
<i>d(ustb1y)</i> (-1)	0.296*	0.47*	-0.004	-0.68**
<i>Adj. R</i> ²	0.39	0.20	0.24	0.22
F-stat (p-value)	5.66 (0.00)	2.91(0.00)	3.38(0.00)	3.15(0.00)

** 1 % level of significance, *5 % level of significance

Source: Author's calculation

VI. CONCLUSION

This paper has built a dynamic macro model by incorporating international reserve accumulation process and a new type of monetary policy rule to establish its linkage with macroeconomic variables. The macro model establishes inter-relationship between four macroeconomic variables such as economic growth, inflation, real exchange rate and international reserve accumulation by capturing many realistic features of policy behaviours in developing and emerging countries. Such an inter-relationship has been empirically examined in South Asian countries – Bangladesh, India, Nepal, Pakistan and Sri Lanka using a Panel VAR method.

South Asian countries, except Nepal, have not been accumulating international reserves as in East Asian countries, although they have been maintaining a traditional benchmark level of 3 months of imports of goods and services, and Greenspan and Guidotti rule of covering one-year of short-term debt liability in recent years. Empirical examinations show that international reserves accumulation can have significant impact on economic growth in the selected countries, but no impact on inflation. These results are similar to findings of Polterovich and Popov (2003), Elhiraika and Ndikumana (2007), Ho and McCauley (2009), and Chaudhry et al. (2011). Hence, international reserve accumulation matters for a higher growth in South Asian countries in the current global monetary system. The international reserve accumulation is so far driven mainly by remittance inflow, which is contributing to growth in these countries by providing necessary foreign exchange to imports capital goods. That enabled the selected countries to slightly accelerate their economic growth in the recent decade. Hence, for further economic growth, accumulated international reserve should be used in growth enhancing ways and

should follow a export-led growth strategy to maintain higher economic growth along with accumulating international reserves by maintaining competitive exchange rate through avoiding upward pressure on exchange rate. Moreover, the sensitiveness of international reserve accumulation with respect to foreign interest rate should be taken into account while formulating domestic policies.

Comparatively, economic growth is weak in Nepal in South Asia in recent decade despite having growing amount of international reserves on account of the elevated level of inflows of workers' remittances. Such accumulated international reserves can be used to enhance the productive capacity of Nepalese economy which will strengthen the resilience of Nepalese economy with both internal and external balances.

The research can be extended to compute the optimum level of international reserves in South Asia, and costs associated with the management of it.

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