*Research Article*

# Monetary Integration between India and Nepal

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**Abstract**

An open border, a pegged exchange rate regime and large trade with India offer Nepal some preconditions to satisfy monetary integration with its southern neighbour. In this study, investigation of the economic symmetry in the two countries is considered. A two-pronged empirical approach reveals inconclusive evidence to satisfy such integration. First, using a three-variable structural vector auto-regression showed a low and negative correlation in the supply shocks. Decomposing the structural shocks into regional and idiosyncratic components showed a favourable co-movement with the regional element only in Nepal's monetary shock. Second, the business-cycle analysis using state-space models of Nepal's GDP and its components showed evidence of co-movement with the regional element in some variables while others showed divergence.

**JEL: E2, E3**

**Keywords**

Exchange rate, monetary integration, structural shocks, state–space models

## Introduction

Nepal, with its pegged exchange-rate regime vis-à-vis India, faces a difficult choice of exchange-rate regime in light of an increasing trade deficit and a slowly growing economy. For the last five decades, the Nepalese authorities have basically chosen a peg arrangement with India as the nominal anchor for monetary policy, except for a brief interlude in the early 1990s when a currency basket was introduced. There is a growing recognition that the economy is overly dependent on income from remittances, which have so far financed an ever-increasing trade deficit. In the aftermath of the great recession, there was a decline in remittances. As a percentage of GDP, the current-account balance stood at 5.83 in 2008, but declined to –0.81 in 2009 as a direct consequence of this decline in remittances.

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The notion of adopting a proper exchange-rate regime in light of changing economic environment is a major policy issue to policy makers in Nepal as it is for many developing countries.

In practical terms, a purely flexible-exchange regime is perhaps not an immediate option. This is not only because India is Nepal's major trading partner, but also because the open border between the two countries risks creating destabilizing effects from daily volatility in the exchange rate. On the other hand, it appears that with an open border, huge bilateral trade and a pegged exchange-rate regime, Nepal already has a substantial degree of economic integration with India.

The central theme of this essay is to investigate whether the two economies share enough similarities to justify further monetary integration. In order to explore whether these economies meet some preconditions, this article applies two existing strands of investigation commonly cited in the literature. Both of them primarily analyze economic structure and transmission of policy effects. A suitable region for such integration will have economies with similar structures such that adjustment following shocks is generally synchronous in all countries. This is possible when the economies in the region share some common features. As a result, a common policy response is sufficient for restoring equilibrium in the entire region. The first of this approach is the structural-shocks analysis of the candidate countries using a structural vector auto-regression (SVAR) methodology. In this article, we complement this conventional investigation by identifying a region-wide common component in structural shocks using state-space models. Second, we undertake a comprehensive investigation of business-cycle synchronization by identifying a regional element using state–space models.

To the question of whether the two economies share similarities, the answer from this investigation is not conclusive. We have used different specification, several variables, and different indicators to analyze the possibility of further monetary integration, especially, from Nepal's point of view. While some indicators favour the proposition, other indicates dissimilar economic structures and therefore a costly outcome in a more integrated setting.

The rest of the article is organized as follows. In the second section, a review of the literature on monetary integration is offered with attention to their relevance in the Nepalese context. The third section gives details on each methodology, followed by a discussion of results in the fourth section. Some concluding remarks are offered in the fifth section.

## Brief Literature Review

This section begins with a brief discussion on the current exchange rate regime in Nepal and explores the need for alternatives to the current set up. It will then summarize the vast literature on the optimum currency area (OCA) on key aspects.

## *Exchange Rate Regime in Nepal*

As briefly noted in the Introduction, Nepal currently has a pegged exchange rate regime. The peg parity has remained unchanged for nearly two decades now. During this time, Nepal's economy has seen some significant changes. First, its economic performance has not shown any momentum. The average annual GDP growth rate has been below 4 per cent in the last decade. Second, Nepal's economy is now critically dependent on remittances. Nearly half a million people leave the country as migrant workers each year. With a stagnant domestic economy, remittances have been vital not only for poverty reduction and improvement in human development indicators, but it is also critical for macroeconomic stability.

The combined effect of slower economic performance and rising remittances has been reflected in conditions that show evidence of the Dutch-disease type effect in Nepal. In a recent study, Panday (2014) documents the overvaluation of the real exchange rate from 2000–2009. While Nepal is still able to finance its external obligations using remittances, it remains prone to external shocks that can hit the economy hard if there is persistent decline in remittance flows.

It is in Nepal's interest to look for sustainable alternatives to the current exchange rate system and use its exchange rate policy to help make its economy competitive. At the same time, Nepal and India share some pre-conditions through their historical relationship that satisfy formation of a monetary union. Therefore, a monetary integration between the countries can be a viable alternative to the current exchange-rate system in Nepal.

## *Specialization Versus Diversification*

In the first generation of the OCA literature (McKinnon, 1963; Mundell, 1961), a great deal of emphasis was placed on synchronized business cycles. This was interpreted as having correlated demand and supply shocks in the candidate countries. The second generation (Mundell, 1973) further argued by pointing out that the degree of risk sharing and financial integration are key requirements.[1] McKinnon (2001) points to Mundell's view that significant cross-country holdings of financial assets can mitigate the effects of asymmetric shocks by diversifying income sources, adjusting wealth portfolios and pooling foreign-exchange reserves.[2] In the same context, Krugman (1987) contradicts the idea of benefitting from synchronized business cycles or symmetry in structural shocks. The author points out that with the formation of a monetary union the stronger economic ties will eventually lead to condition—such as specialization in production—that would then create asymmetric business cycles/shocks. Some relevant data will shed light on these issues in the Nepalese context.

Table 1 presents correlation coefficients of business cycles for the two economies from 1975 to 2009 and two sub-periods. The full sample is split to highlight the fact that Nepal and India both underwent opening of their economies in the

**Table 1.** Business Cycle Correlation

| Variable | 1975–1992 | 1993–2009 | 1975–2009 |
|---|---|---|---|
| $Y$, $Y^f$ | 0.15(0.54) | 0.08(0.75) | 0.13(0.47) |
| $Y$, $IP^f$ | 0.52(0.03) | 0.22(0.39) | 0.4(0.02) |

**Source:** Author's calculation.

**Notes:** Business cycles calculated using HP-filtered data. P-values are given in the parenthesis. $Y$, $Y^f$ represent GDP in Nepal and India; $IP^f$ is India's industrial production.

**Table 2.** Trade, Production, and Expenditure (Average in Given Periods)

| Variable (Percent of GDP) | 1975–1989 | | 1990–1999 | | 2000–2009 | |
|---|---|---|---|---|---|---|
| | India | Nepal | India | Nepal | India | Nepal |
| Trade | 13.73 | 29.69 | 20.92 | 49.74 | 37.93 | 47.71 |
| Agriculture (v.a.) | 33.4 | 59.5 | 27.64 | 43.49 | 19.81 | 36.57 |
| Industry (v.a.) | 25.29 | 12.94 | 26.44 | 20.92 | 27.34 | 18.28 |
| Manufacturing (v.a.) | 16.57 | 4.91 | 16.29 | 8.77 | 15.42 | 8.24 |
| Services (v.a.) | 41.3 | 27.56 | 45.92 | 35.59 | 52.85 | 45.15 |
| HHexp | 69.63 | 80.23 | 65.89 | 79.24 | 59.93 | 79.8 |
| Govexp | 10.7 | 8.43 | 11.48 | 8.76 | 11.36 | 9.23 |
| GCF | 21.12 | 18.59 | 23.6 | 22.71 | 31.26 | 25.76 |

**Source:** WDI.

**Notes:** v.a. = valued added; HHexp is household final consumption expenditure; Govexp is general government final consumption expenditure; GCF is gross capital formation, formerly called gross domestic investment.

early 1990s. The correlation of the cyclical component of two GDPs fell in the latter period, while the correlation during the full-sample period (1975–2009) itself is quite low. In contrast, when the industrial production data from India is used, the correlation is significantly better.

This shows that, in general, India's industrial sector has had more linkages with Nepal's economy than the overall Indian economy. The level of correlation, however, fell by a significant degree in the latter period. One reason for this decline may be due to structural changes in the Indian economy, which is more diversified now with increasing contribution from the service sector.

To further understand the economic structure of the two countries, we present some relevant data in Table 2. The data in the table is presented for different time periods in order to help understand the evolving pattern of the two economies. As seen in the table, trade as a share of GDP, the openness indicators, shows that both economies are now more open and have an increasing share of trade in their respective economies. Increasing trade or the possibility of such, especially between major trading partners, is one reason to consider monetary integration. Next, the contributions of industry, manufacturing, and services to GDP are higher

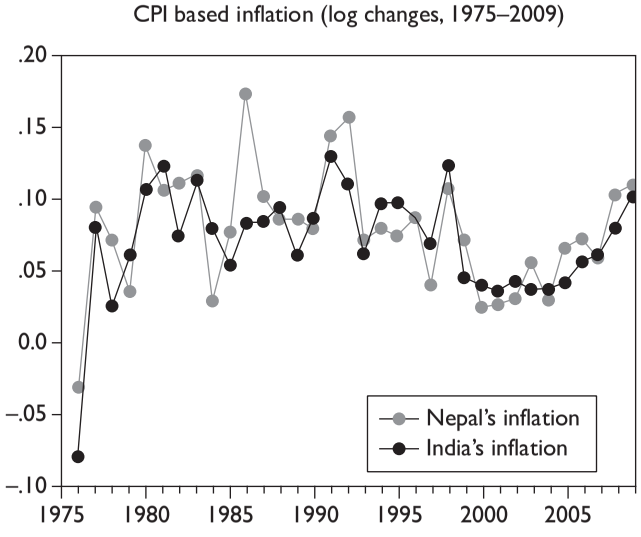
in India at all times, while agriculture dominates contribution to GDP in Nepal. Similarly, value added by manufacturing and industry is roughly constant in India, while there is some variation in contributions of these sectors in Nepal. Table 2 also shows a higher share of household consumption in Nepal, while the shares of government consumption and gross capital formation are higher in India.

In terms of inflation, Figure 1 shows a similar movement over time in the two countries. This is a likely outcome of pegged exchange-rate regime. Ginting (2007) and Yelten (2004) also suggest that prices in Nepal tend to be influenced by prices in India. The policy interest rate was higher in Nepal prior to 1991. The two interest rates have moved fairly closely in the last two decades. On the development and integration of the financial sector, India's economy is clearly much more integrated with the international market. Nepal remains relatively less connected. Apart from a few private investments in the financial sector, there are no significant private or public cross-holdings of financial assets and investments. In brief, it appears that the level of financial integration that is needed to diversify investments and share risk do not exist, at present, between the countries.

## *Endogeneity of OCA*

One important aspect of the OCA analysis is the argument that asymmetric economies may evolve over time into symmetric ones driven by the positive link between trade integration and income correlation. Frankel and Rose (1998) found evidence of this linkage and suggested it as the 'endogeneity of OCA hypothesis'. Countries in a monetary union gain reductions in trading costs in addition to the elimination of exchange-rate volatility. Increasing trade relations may evolve into greater economic and financial integration, which in turn may lead to synchronous business cycles. In a related study of the effects of a fixed exchange rate on trade, Klein and Shambaugh (2006) found that pegging the exchange rate substantially increased trade. Their estimate of the increase in trade is about 35 per cent. The authors make an interesting point that countries with an existing peg may not gain much in trade by forming a monetary union. Yet, as per them, countries that are facing difficulty in maintaining a peg may find salvage in a monetary union.

Some previous studies on the South Asian region have found that geo-economic relationship between the countries in the region offers evidence to support monetary integration. Banik, Biswas and Criddle (2009) look into different criteria to evaluate the possibility of this integration in South Asia. In particular, they look into (*a*) extent of trade; (*b*) symmetry of economic activity; (*c*) country characteristics; and (*d*) labour mobility and wage flexibility. The authors found that countries in this region share similar industry profiles, similar trade composition and close geographical proximity, all of which can help create interlinked industrial production. This article attempts to evaluate India–Nepal integration using trade and economic data through descriptive data. Assessing the symmetry of the two economies is central to this study. The historical ties and open border



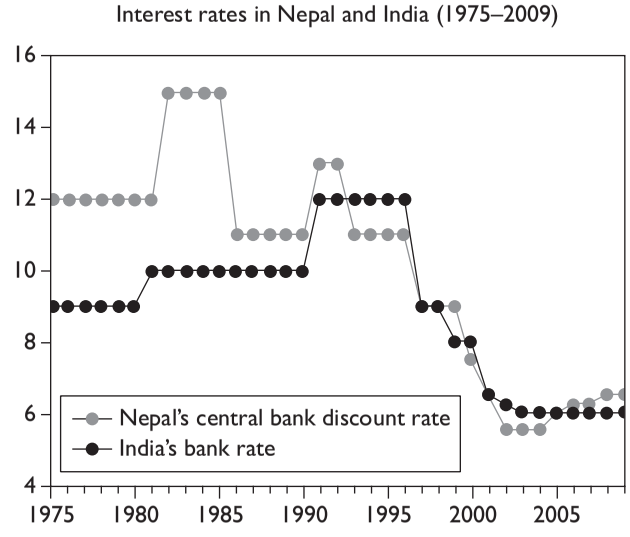




**Figure 1.** Nepal–India Inflation and Central-bank Interest Rates

**Source:** Author's calculation.

**Table 3.** Nepal's Bilateral Trade with India, and India's Share in Nepal's Total Trade

| Variable | 1975–1989 | 1990–1999 | 2000–2009 |
|---|---|---|---|
| Exports | NPR 14, 827.80 Mil (USD 952.94 Mil) | NPR 40,993.50 Mil (USD 836.26 Mil) | NPR 333,294.40 Mil (USD 4,577.6 Mil) |
| Imports | NPR 39,929.10 Mil (USD 2,566.14 Mil) | NPR 181,139.10 Mil (USD 3,695.21 Mil) | NPR 918,606.60 Mil (USD 12,616.49 Mil) |
| Total trade | NPR 54,756.90 Mil (USD 3,519.1 Mil) | NPR 222,132.60 Mil (USD 4,531.47 Mil) | NPR 1,251,901.00 Mil (USD 17,194.08 Mil) |
| Average trade share | 51.42% | 28.27% | 56.29% |

**Source:** Nepal Rastra Bank.

**Note:** The trade figures have been converted into dollar terms using the average exchange rate for each period.

allowing for free flow of goods and labour between the countries also suggest a reasonably high degree of economic mobility.

As discussed trade statistics can help us discern the pattern of bilateral trade. Data on bilateral exports/imports in Table 3 shows that Nepal is a net importer. Its average trade share with India is over 50 per cent for most of the period. According to central bank data, imports from India have exceeded exports in most of the major commodity categories for a long time. As already argued, despite huge bilateral trading, Nepal's business cycle shares a low correlation with India's. This indicates the possibility of specialization in the two economies. Interestingly, however, as Artis (2003) suggested, the endogeneity argument holds that trade between countries—specifically trade in 'components' as opposed to varieties—is likely to make shocks more common in the region. Indeed, Nepal's trade with India also involves a lot of inputs, especially low-end manufacturing goods (for example, raw materials in garments and textiles). This may explain the modest level of business-cycle correlation in the two.

Furthermore, some have argued that the speed of adjustment to shocks across countries is an equally important criterion.[3] Even when disturbances are asymmetric, faster adjustment to shocks may help mitigate the cost of relinquishing policy independence. Many of these issues are analyzed in this article.

## Estimation Methods

### *Structural-Shocks Analysis*

#### *Three-variable SVAR*

The structural-shocks analysis is based on an SVAR technique proposed by Blanchard and Quah (1989). Here, we consider their approach and others, namely, Bayloumi and Eichengreen (1994), Murray, Schembri and St-Amant (2003),

and Huang and Guo (2006). The idea behind using the SVAR technique is to impose assumptions about the structural relationships in the economy. Using a three-variable SVAR allows extracting supply shocks, pure demand shocks and monetary policy shocks (policy-induced demand shocks). By separating the two demand shocks, it is possible to identify the impact of policy changes, which otherwise could be attributed to fundamental reasons, such as tastes, preferences, etc. A detailed presentation of the SVAR methodology is given in the Appendix.

*Time Invariant State–Space Models*

The use of state–space models in OCA analysis is motivated by the fact that an unobserved regional element in the structural shocks can be extracted. This presentation closely follows Xu (2006) and Chamie, DeSerres and Lalonde (1994). First, the measurement equation shows observed variables as a function of unobserved state variables

$$\begin{bmatrix} S_t^1 \\ S_t^2 \end{bmatrix} = \begin{bmatrix} \alpha_{11} & 1 & 0 \\ \alpha_{22} & 0 & 1 \end{bmatrix} \begin{bmatrix} Z_{0t} \\ Z_{1t} \\ Z_{2t} \end{bmatrix}, \tag{1}$$

where $S_t^i = [\varepsilon_{dt}^i, \varepsilon_{mt}^i, \varepsilon_{st}^i]'$ represents the observed structural supply, demand, and monetary shocks obtained from SVAR for country $i$ at time $t$. The unobserved $Z_{0t}$ represents the region-wide common component, and $Z_{1t}$ and $Z_{2t}$ are the unobserved country-specific components of the structural shocks. Second, the state equation allows identification of the common and country-specific components using the Kalman filter.

$$\begin{bmatrix} Z_{0t} \\ Z_{1t} \\ Z_{2t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \omega_{0t} \\ \omega_{1t} \\ \omega_{2t} \end{bmatrix} \tag{2}$$

Since the structural shocks are assumed to satisfy the model specification in SVAR, each state equation is modelled as a white-noise process. The error terms are assumed to be serially uncorrelated. Two identifying restrictions are needed: (*a*) no cross-correlation in shocks, that is, shocks are orthogonal; and (*b*) the variance of the common shock is set to unity.

$$E[\omega\omega'] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \sigma_{11} & 0 \\ 0 & 0 & \sigma_{22} \end{bmatrix} \tag{3}$$

where $\sigma_{ii}$ is the variance of the country-specific shocks.

The coefficient $\alpha_{i1}$ in Equation 1 measures the sensitivity of structural shocks in country *i* to the common component in the region. Particularly, a positive (negative) coefficient implies that the common shock is symmetric (asymmetric) for that country. Further, in order to assess the relative importance of common shocks in a particular country, its share in total shocks is calculated. For instance, the variance of a demand shock affecting country 1 is the sum of the variances of its common and country-specific shocks.

$$Var(\varepsilon^1_{dt}) = (\alpha_{11})^2 + \sigma_{11}. \tag{4}$$

Since the two shocks are uncorrelated, the proportion of the variance of shocks explained by the common component is given by $\frac{\alpha^2_{11}}{\alpha^2_{11} + \sigma_{11}}$.

## *Business Cycle Synchronization*

Some commonly-used tools in the investigation of business cycles are considered here. Darvas and Szapáry (2008) use trended GDP and its components in the EU countries. We use data on GDP, consumption, investment, imports and exports. Additionally, we also consider sectoral data—agriculture, industry, manufacturing and services—from the two countries. The primary line of investigation is identifying a regional element in the cyclical components of all these variables. We also use some additional indicators to complete the analysis.

### *Correlation of Common Component with Nepal's Business Cycle*

GDP and its component series are trended using the Hodrick–Prescott (HP) filter and a band-pass (BP) filter. Using alternative filtering techniques is expected to mitigate sensitivity in results and keep our findings robust. After detrending, the cyclical series is standardized to have equal variance in both countries. Smaller economies tend to have more volatile business cycles and likely to dominate in the calculation of the common component.

The standardized cyclical series from the two countries are used to generate the unobserved regional (common) element using various state–space models. Once the regional element is identified, a simple pair-wise unconditional correlation coefficient is computed between the common component ($z_t$) and each business cycle. We use a five-year non-overlapping correlation coefficient to uncover the changing pattern of business-cycle synchronization over different time periods.[4] A brief note on the specification of state-space models is offered below. In Equations 5–7, we present the first model.

$$y_{it} = \beta_i z^c_t + \beta_j z^s_{it} + \varepsilon_{it}, \tag{5}$$

$$z^c_t = \gamma z^c_{t-1} + v_t, \tag{6}$$

$$z^s_{it} = \gamma_i z^s_{it-1} + v_{it}, \tag{7}$$

where ($^{i}/_{j}$ = 1, 2), $y_{it}$ is detrended logarithmic GDP (or its components), $\varepsilon_{it}$ is the error term in the observation equation assumed to follow a normal distribution $N(0, \sigma^2)$, and the common ($v_t$) and country-specific ($v_{it}$) shocks are also assumed to follow a normal distribution with a zero mean and a constant variance. Further, it is assumed that these unobserved stochastic terms are uncorrelated with each other, $cov(v_t v_{it}) = 0$, and not correlated with $\varepsilon_{it}$. The $\beta_s$ and $\gamma_s$ are the parameters to be estimated.

## Results

The main findings are divided into two sections. In the first section, we present results using SVAR models and the estimates of common component in structural shocks. Results from business-cycle investigation are presented in the next subsection.

### *Econometric Evidence using Structural Shocks*

#### *SVAR Estimates*

We have estimated several SVAR models to account for different monetary policy tools, namely, the money supply, the interest rate (discount rate), and domestic credit. Output is represented by real GDP. Additionally, we have considered industrial production to proxy India's output.[5] By offering different combinations of output and policy tools, we have tried to expand the scope of investigation and are hopeful that this will produce robust results.

Table 4 presents the estimated correlations of the structural shocks from various SVAR models. For instance, D1, M1, and S1 are the shock correlations from an SVAR that includes the money supply (M1) and prices (CPIs) as well as home GDP (Nepal) and industrial production (India). These correlations are calculated for the full-sample period (1975–2009) and two sub-periods (1975–1992 and 1993 onwards).

In Table 4, three out of four SVAR estimates suggest that there is a negative correlation in demand shocks in the full sample. Two estimates (D1 and D4) suggest that the economies became more asymmetric over time, especially in post-liberal era. D2 estimates show that the correlation turned from negative to positive, indicating increasing symmetry. The correlation is negative in the full sample. Finally, the correlation coefficients (D3) from an SVAR that uses the interest rate as a policy instrument are positive and have remained at a similar level in the two sub-periods and in the full sample.

The correlation coefficients in monetary shocks (M1 and M2) suggest asymmetry, while two other monetary shocks (M3 and M4) show a positive correlation suggesting symmetry in all periods. Three supply-shock correlation coefficients

**Table 4.** Correlation of Structural Shocks

| Structural Shocks | 1975–1992 | 1993–2009 | 1975–2009 |
|---|---|---|---|
| D1 | –0.1 | –0.23 | –0.19 |
| M1 | –0.45 | –0.37 | –0.49 |
| S1 | –0.17 | 0.07 | –0.08 |
| D2 | –0.49 | 0.18 | –0.17 |
| M2 | –0.21 | –0.58 | –0.38 |
| S2 | –0.17 | –0.08 | –0.12 |
| D3 | 0.39 | 0.33 | 0.29 |
| M3 | 0.33 | 0.75 | 0.54 |
| S3 | 0.04 | 0.09 | 0.05 |
| D4 | 0.17 | –0.2 | –0.01 |
| M4 | 0.46 | 0.32 | 0.34 |
| S4 | –0.07 | –0.25 | –0.12 |

**Source:** Author's calculation.

**Notes:** D1, M1, and S1 represent correlation coefficients based on a SVAR that uses Nepal's GDP growth and the growth in India's industrial production as well as inflation (CPI) and the growth of the money supply (M1) in the two countries.
D2, M2, and S2 represent correlation coefficients based on a SVAR that uses GDP growth, inflation and M1 growth rate in two countries.
D3, M3, and S3 represent correlation coefficients based on a SVAR that uses domestic and foreign bank rates (discount rate), GDP growth and inflation in two countries.
D4, M4, and S4 represent correlation coefficients based on a SVAR that uses domestic and foreign domestic credit, GDP growth and inflation in two countries.

(S1, S2 and S3) show increases in the symmetry over time, albeit at low levels. S1 turned positive from negative in the latter period, while S2 also improved from more asymmetry to less so. S3 indicates a decreasing correlation in the latter period. Taken together, an SVAR that uses GDP growth, inflation and the interest rate showed the most favourable correlation for all three types of shocks.[6] This result is treated as the base case for further discussion.

These results are within the range of findings in similar other studies. Bayoumi and Eichengreen (1994) found supply shocks in Western Europe between –0.39 and 0.68 and demand shocks between –0.21 and 0.65. Similarly, Murray et al. (2003) reported average supply-shock correlation of 0.23 between Canada and the regions of the US, while between Mexico and US regions, it was –0.03. The demand shock averaged between 0.22 and –0.13. Saxena (2005) found supply- and demand-shock correlations in South Asia between –0.41 and 0.29, and –0.21 and 0.65, respectively. Similar results are also reported in Xu (2006) and Buigut and Valev (2005).

In the literature, more emphasis is placed on the correlation of supply shocks because they indicate fundamental variation in structure of the economies. Supply

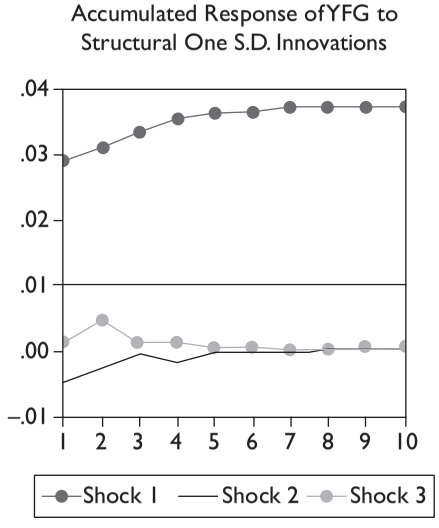
shocks are also less likely to respond to demand–management policies. From this view, the low correlation in supply shocks reported in Table 4 is not supportive of the idea of further monetary integration. It appears that the two economies have become less structurally similar in the post-liberal period. The earlier study by Saxena (2005) and this study both confirm low correlation in supply shocks. In a two-variable SVAR, the author reported a supply-shock correlation of 0.12 and 0.06 between India and Nepal for two periods (1973–2003 and 1995–2003), respectively. This study, however, also finds that the high correlation (0.57) in demand shocks reported in Saxena (2005) falls significantly once monetary shocks are incorporated. For the full-sample period, we find a coefficient of 0.29 in demand shocks.

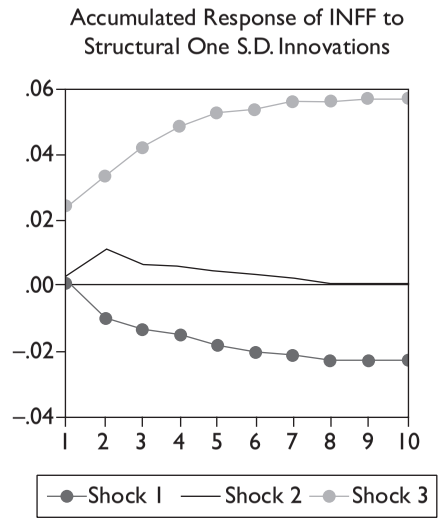
We now turn to impulse–response analysis using SVAR estimates considered in the base case. From the perspective of monetary integration, the larger the size of shocks the more disruptive it will be for the economy. Similarly, the slower the speed of adjustment after disturbances, the costlier it will be to coordinate policies. As seen in Figure 2, the output response to a supply shock is higher in India. It is more volatile in Nepal. A pure demand shock causes output to fall in both countries. The speed of adjustment is better in Nepal. Output recovers by the second period in Nepal, while output picks up in the third period in India. Response to monetary shock presents a stark difference in the two economies. Output responds positively to a monetary shock in India, but the effect goes away by the end of the third period. In Nepal, a monetary shock results in a loss of output, with adjustment and recovery by the end of the third period. The difference in the two policy responses is perhaps rooted in Nepal's supply-constrained economy (for example, infrastructure deficit and geography).

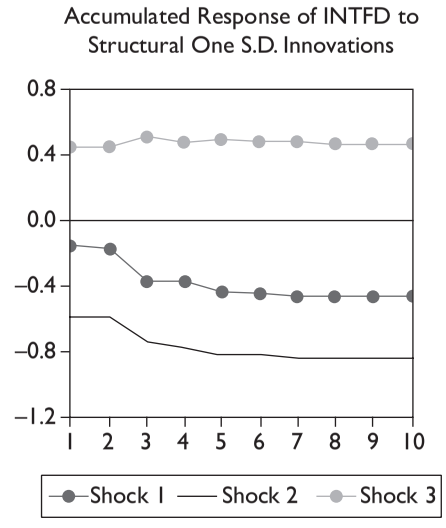
There is also divergence in how prices respond to a supply shock in Nepal and India. A supply shock raises prices in Nepal, with the peak effect near the third period. Prices fall persistently over time in India. However, prices respond similarly in both countries to a monetary shock. In both countries, prices rise persistently and display similar adjustment pattern over time. Finally, the interest rate falls in both countries in response to a supply shock. In Nepal, it fluctuates before settling in the sixth period, while it converges by the end of the fourth period in India. Likewise, the interest rate falls in response to a demand shock with similar speed and magnitude in both countries. In general, the impulse responses indicate some scope for similar adjustment in both countries.

### *Estimates of the Common Component in Structural Shocks*

Using the structural shocks from SVAR models, we estimated the state–space model outlined in Equations 1–3. In this specification, state equations are modelled as a white-noise process. During estimation, this model resulted in insignificant parameter estimates in all SVAR shocks. Therefore, as an alternative, a slightly different state–space model was estimated. In this specification state equations are set up as a stationary autoregressive process of order one. With this

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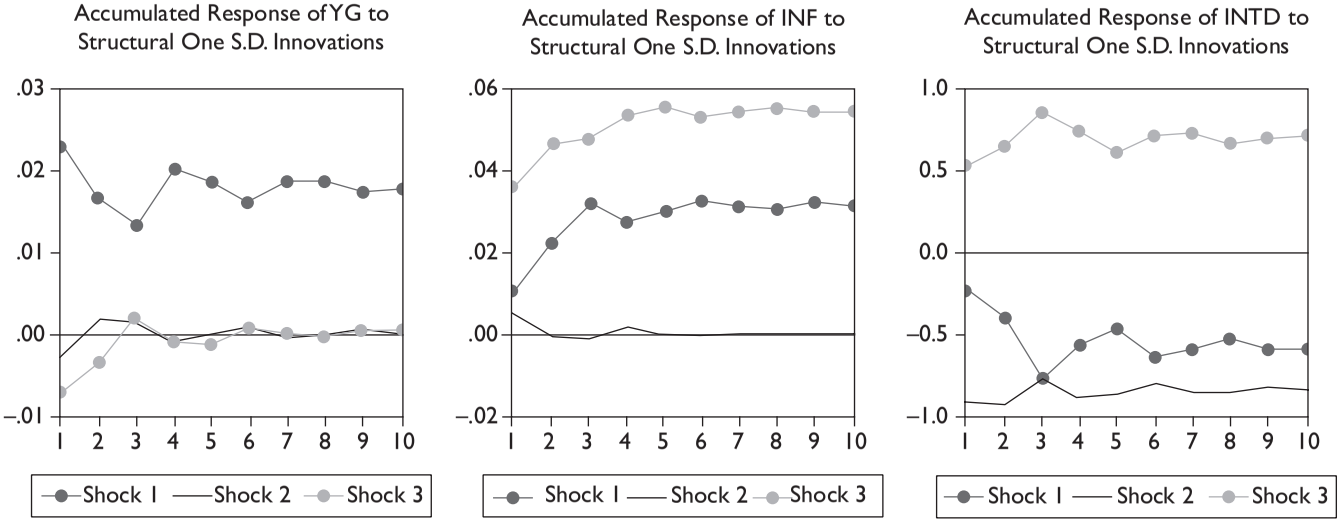


**Figure 2.** Various Impulse Responses to Different Shocks

**Source:** Author's calculation.

**Notes:** Upper panel-India; Lower panel-Nepal; First column: output response; Second column: inflation response; Third column: interest-rate response; Shock 1 = Output shock; Shock 2 = Inflationary shock; Shock 3 = Monetary shock.

**Table 5.** Estimates of the Coefficients of the Common Component and the Variances of Shocks (1975–2009)

| Structural shocks | $\alpha_{11}$ | $\alpha_{21}$ | $\sigma_{11}$ | $\sigma_{22}$ |
|---|---|---|---|---|
| Demand | | | | |
| D1 | 0.32 | –0.35 | 0.68** | 0.2 |
| | (0.32) | (0.33) | (0.27) | (0.25) |
| D2 | 0.27 | –0.36 | 0.66*** | 0.55** |
| | (0.23) | (0.24) | (0.2) | (0.26) |
| D3 | 0.29 | 0.79* | 0.67*** | 0.15 |
| | (0.19) | (0.45) | (0.19) | (0.67) |
| D4 | 0.23 | 0.21 | 0.59 | 0.73** |
| | (0.84) | (0.62) | (0.47) | (0.34) |
| Monetary | | | | |
| M1 | 0.63*** | –0.46*** | 0.27 | 0.4*** |
| | (0.19) | (0.15) | (0.19) | (0.13) |
| M2 | 0.46*** | –0.61** | 0.53*** | 0.29 |
| | (0.17) | (0.25) | (0.18) | (0.31) |
| M3 | 0.76*** | 0.57*** | 0.12 | 0.42*** |
| | (0.14) | (0.13) | (0.13) | (0.13) |
| M4 | 0.36** | 0.31 | 0.58** | 0.34 |
| | (0.18) | (0.29) | (0.25) | (0.24) |
| Supply | | | | |
| S1 | –0.0007 | –0.0009 | 0.79*** | 0.55*** |
| | (0.002) | (0.002) | (0.2) | (0.14) |
| S2 | 0.87*** | 0.11 | 0.005 | 0.77*** |
| | (0.12) | (0.17) | (0.04) | (0.19) |
| S3 | 0.08 | 0.06 | 0.75*** | 0.76*** |
| | (0.17) | (0.15) | (0.2) | (0.2) |
| S4 | 0.1 | –0.52 | 0.79*** | 0.21 |
| | (0.19) | (0.4) | (0.2) | (0.37) |

**Source:** Author's calculation.

**Notes:** *** 1%, ** 5%, and * 10% significance level.
$\alpha_{11}$ and $\sigma_{11}$ are estimates for Nepal; $\alpha_{21}$ and $\alpha_{22}$ are estimates for India.
See footnote in Table 4 for details on shocks definition.

several coefficients turned significant. The results are shown in Table 5. These estimates represent the coefficient for the common component in shocks and the variance estimates of idiosyncratic country-specific shocks.

In Table 5, a statistically significant positive value for $\alpha_{11}$ and $\alpha_{21}$ suggests that there exists a regional element (common component) in each country and that the shocks are symmetric in the two countries. Estimates of $\alpha_{11}$ suggest that the

unobserved common component is positively associated with Nepal's various structural shocks. Particularly, all of Nepal's monetary shocks show evidence of the regional element. However, only one supply shock (S2) has a significant regional component and none of the demand shocks show existence of a regional element. In India, the estimates, $\alpha_{11}$, suggests that D3 and M3 have statistically significant common components that are positively linked to structural shocks.[7]

To a large extent, the decomposition of structural shocks into unobserved regional and idiosyncratic components could not offer more evidence of commonality in the two economies. While one of Nepal's supply shocks was found positively associated with the regional element, there was no evidence of this in India. The positive association of Nepal's monetary shock with the regional element can be explained by the fact that Nepal has a pegged exchange-rate regime with India. To defend the peg, Nepal's policy makers are acting in tandem with changes in policy front in India. This is an evidence of policy spillover from India.

In the time-varying state–space models in Equations 13 and 14 in appendix, we are interested in the evolution of $\beta_t$, which is the coefficient of regression of Nepal's shock on shock from India. Figures 3 and 4 show this evolution for two monetary shocks (M1 and M2). We limit ourselves to the case of statistically

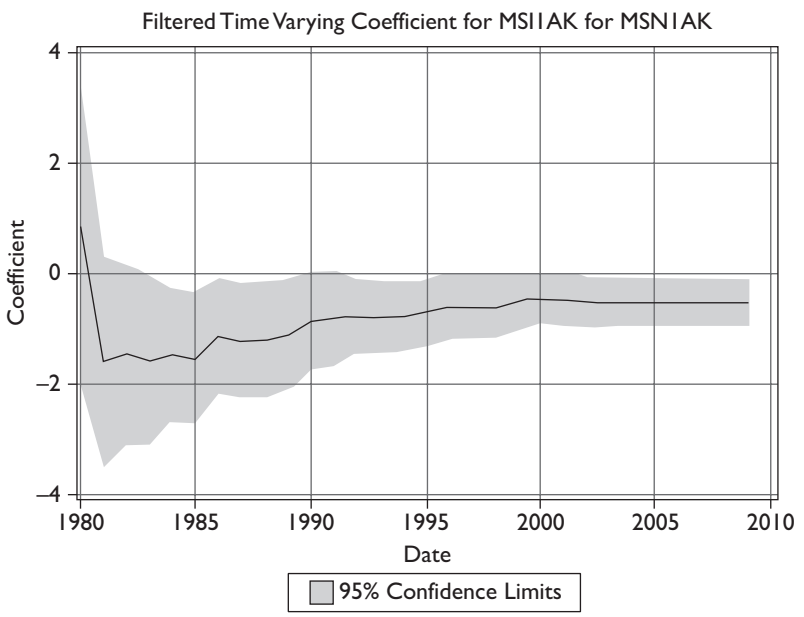


**Figure 3.** Time Varying $\beta_t$ Coefficient Using a Monetary Shock (Shock reported in Table 4 under M1)

**Source:** Author's calculation.
**Note:** Coefficient Using a Monetary Shock (Shock reported in Table 4 under M1).

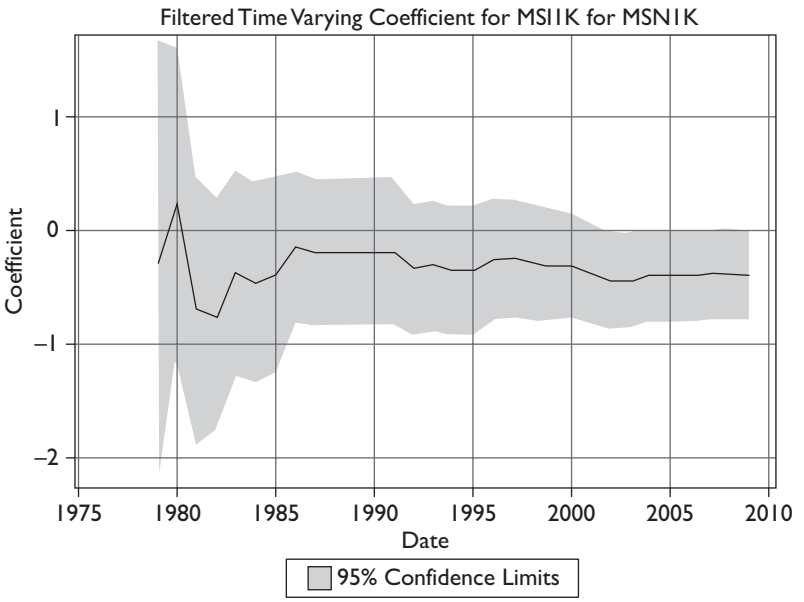


**Figure 4.** Time Varying $\beta_t$ Coefficient Using a Monetary Shock (Shock reported in Table 4 under M2)

**Source:** Author's calculation.
**Note:** Coefficient Using a Monetary Shock (Shock reported in table 4 under M2).

significant evolution of the coefficient. In Figure 3, $\beta_t$ rises slowly over time and converges under zero. There are some fluctuations in Figure 4, but the estimates eventually converge to below zero. Although these results are not an indication of a strong relationship in shocks formation, they do not indicate deterioration in the relationship, either.

## *Econometric Results from the Business-Cycle Investigation*

The estimates of common component used in calculating correlations coefficients in Tables 6 and 7 are based on models in Equations 5–7 and 15–17 (in appendix), respectively. Again, we limit our calculation of these coefficients to highlight synchronization of Nepal's business cycle with the regional element.[8] Some similar observations from estimates in the two tables are discussed below.

The first observation is that using BP-filtered data the cyclical correlation in GDP over time was found to be positive except in the 1990s. Second, the fluctuating correlation coefficients in exports do not indicate evidence of increased synchronization. Third, there is a high correlation in the cyclical component of investment in nearly all periods. Fourth, except in the early 1980s and 2000s,

**Table 6.** Correlation Coefficients using the Region-wide Common Component and Nepal's Business Cycle using the Model in Equations 5–7

| Variable | Filter | 1975–1979 | 1980–1984 | 1985–1989 | 1990–1994 | 1995–1999 | 2000–2004 | 2005–2009 |
|---|---|---|---|---|---|---|---|---|
| GDP | HP* | –0.26 | –0.55 | –0.56 | –0.08 | –0.3 | –0.96 | 0.05 |
| | BP* | | 0.2 | 0.63 | –0.07 | –0.12 | 0.91 | |
| Inv | HP* | 0.88 | 0.62 | 0.88 | 0.15 | 0.94 | 0.95 | 0.54 |
| | BP | | 0.48 | 0.92 | –0.2 | 0.29 | 0.85 | |
| Cons | HP* | 0.54 | –0.22 | 0.77 | 0.8 | 0.57 | –0.04 | 0.57 |
| | BP* | | –0.64 | 0.78 | 0.88 | 0.64 | 0.03 | |
| Exports | HP | 0.49 | 0.43 | –0.53 | –0.04 | 0.84 | 0.36 | –0.89 |
| Imports | HP* | –0.87 | –0.79 | –0.89 | –0.68 | –0.99 | –0.88 | –0.49 |
| Ag | HP | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.09 | 0.99 |
| | BP* | | –0.97 | –0.98 | –0.98 | –0.93 | –0.79 | |
| Ind | BP* | | 0.4 | 0.48 | 0.88 | –0.23 | –0.25 | |
| Manf | HP* | 0.06 | 0.28 | 0.97 | 0.73 | –0.5 | –0.41 | –0.7 |
| | BP* | | 0.99 | 0.99 | 0.99 | 0.85 | 0.99 | |
| Srv | HP* | –0.99 | –0.99 | –0.96 | –0.99 | –0.97 | –0.99 | –0.99 |

**Source:** Author's calculation.

**Notes:** HP: HP-filtered data; BP: BP-filtered data.
HP* and BP* indicate estimates based on the state-space model without the error term in the observation equation.
Using the Baxter and King (1999) method to get BP-filtered data led to a loss in observation at the beginning and the end of the sample. Three observations, each, at the beginning and end were lost.
Ag = agriculture; Ind = Industry; Manf = Manufacturing; Srv = Services; Cons = Consumption; Inv = Investment.

**Table 7.** Correlation Coefficients using the Region-wide Common Component and Nepal's Business Cycle using the Model in Equations 15–17 in appendix

| Variable | Filter | 1975–1979 | 1980–1984 | 1985–1989 | 1990–1994 | 1995–1999 | 2000–2004 | 2005–2009 |
|---|---|---|---|---|---|---|---|---|
| GDP | HP | 0.26 | 0.55 | 0.55 | 0.08 | 0.3 | 0.96 | 0.05 |
| | BP | | 0.2 | 0.63 | –0.07 | –0.12 | 0.91 | |
| Inv | HP | 0.88 | 0.62 | 0.88 | 0.15 | 0.94 | 0.95 | 0.54 |
| | BP | | 0.49 | 0.92 | –0.19 | 0.32 | 0.86 | |
| Cons | HP | 0.54 | –0.22 | 0.77 | 0.8 | 0.57 | –0.04 | 0.57 |
| | BP | | –0.44 | 0.78 | 0.88 | 0.64 | 0.03 | |

*(Table 7 Continued)*

*(Table 7 Continued)*

| Variable | Filter | 1975–1979 | 1980–1984 | 1985–1989 | 1990–1994 | 1995–1999 | 2000–2004 | 2005–2009 |
|---|---|---|---|---|---|---|---|---|
| Exports | HP | 0.89 | 0.26 | –0.47 | 0.13 | 0.46 | –0.2 | –0.4 |
| Imports | HP | 0.87 | 0.79 | 0.89 | 0.68 | 0.99 | 0.88 | 0.49 |
| | BP | | 0.57 | 0.76 | 0.31 | 0.74 | 0.8 | |
| Ag | HP | –0.01 | 0.33 | –0.6 | 0.37 | 0.18 | 0.16 | 0.5 |
| | BP | | –0.97 | –0.98 | –0.98 | –0.93 | –0.79 | |
| Ind | BP | | 0.4 | 0.48 | 0.88 | –0.23 | –0.25 | |
| Manf | HP | 0.06 | 0.28 | 0.97 | 0.73 | –0.51 | –0.41 | –0.7 |
| | BP | | –0.99 | –0.99 | –0.99 | –0.84 | –0.99 | |
| Srv | HP | 0.18 | 0.61 | 0.63 | –0.04 | 0.03 | 0.36 | 0.01 |
| | BP | | 0.8 | 0.52 | 0.1 | –0.05 | 0.47 | |

**Source:** Author's calculation.
**Note:** HP: HP-filtered data; BP: BP-filtered data.

there is a fairly high cyclical correlation in consumption. Fifth, a substantial negative correlation in agriculture is seen using BP-filtered data over time. Sixth, in industry and manufacturing, the synchronization was positive and increasing up until the mid-1990s, but then it turned negative for the rest of the period. Finally, it is to be noted that some estimates show sensitivity to either the model specification or to the data-filtering technique.[9] Yet it is also seen that some of the estimates are nearly identical using alternative specifications and insensitive to data filtering.

We now turn to economic discussion of some these findings. The high correlation in exports from 1995 to 2004 is likely to have captured the only period of export boom in Nepal, led by the exports of apparel, textile and carpets. India has been one of the leading exporters of these goods. It is possible that global demand is the source of increased synchronization. The other variable that showed a high correlation is investment. Infrastructure deficit is a priority area in developing countries. Investment in fixed capital is a likely source of synchronization in the two countries. This type of expenditure is often led by the state. Government spending makes a noticeable contribution to the economy. The correlation in consumption, which includes both household and government spending, may have possibly captured the effects of expansionary fiscal policy. Deficit financing in India and Nepal has been a regular feature of budgetary operations for a long time. By its nature, fiscal policy is idiosyncratic and country-specific circumstances largely govern its evolution. Household consumption, on the other hand, is an outcome of household income and wealth. While a reasonably high correlation over time suggests synchronization, this has to be taken with caution in light of changing country-specific conditions.

Next, the highly negative correlation in agriculture is surprising, although the result is sensitive to the choice of the filtering method. Weather and other factors can make agricultural outcome heavily dependent on country-specific conditions. Yet it is reasonable to expect some synchronization in agricultural output given geographic proximity and the fact that a majority of population in both countries still depend on agro-based economy. There is an interesting pattern in industry and manufacturing. The two economies shared similarity in the pre-liberalization era, but they became dissimilar in the post-liberalization period. Earlier the two countries shared similar industrial profile to some extent, mainly agriculture-related industries and low-end manufacturing. However, of late, India's industrial sector is diversifying with foreign investment and global brands. At the same time, Nepal's industrial sector has been severely affected for over a decade by conflict and political instability.

Other indicators of business-cycle synchronization—persistence and volatility—for selected variables are presented in Tables 8 and 9, respectively.

**Table 8.** Persistence of Business Cycles

| Variable | 1975–1992 | 1993–2009 | Variable | 1975–1992 | 1993–2009 |
|---|---|---|---|---|---|
| Ag | 0.34 | 0.08 | $Ag^f$ | –0.15 | –0.27 |
| | –0.13 | –0.31 | | –0.3 | –0.7 |
| Ind | 0.36 | 0.45 | $Ind^f$ | 0.24 | 0.66 |
| | 0.08 | 0.04 | | –0.07 | 0.33 |
| Manf | 0.55 | 0.62 | $Manf^f$ | 0.26 | 0.61 |
| | 0.3 | 0.18 | | 0.13 | 0.32 |
| Srv | 0.31 | 0.51 | $Srv^f$ | 0.54 | 0.63 |
| | –0.21 | –0.02 | | 0.14 | 0.17 |
| Inv | –0.1 | 0.46 | $Inv^f$ | 0.36 | 0.34 |
| | –0.42 | 0.08 | | 0.03 | 0.03 |
| M | 0.36 | 0.64 | $M^f$ | 0.56 | 0.56 |
| | –0.05 | 0.15 | | 0.22 | 0.35 |
| X | 0.53 | 0.48 | $X^f$ | 0.5 | 0.56 |
| | 0.08 | –0.19 | | 0.26 | 0.29 |
| Y | –0.04 | 0.2 | $Y^f$ | 0.13 | 0.62 |
| | –0.31 | –0.18 | | –0.22 | 0.26 |
| | | | $IP^f$ | 0.54 | 0.51 |
| | | | | –0.03 | 0.3 |

**Source:** Author's calculation.

**Notes:** Estimates for each variable uses HP data and BP in first and second rows. Variables with superscript 'f' represent India.

**Table 9.** Volatility of Business Cycles

| Variable | 1975–1992 | 1993–2009 | Variable | 1975–1992 | 1993–2009 |
|---|---|---|---|---|---|
| Ag | 0.001 | 0.0002 | $Ag^f$ | 0.002 | 0.0007 |
| | 0.0006 | 0.0002 | | 0.002 | 0.0006 |
| Ind | 0.005 | 0.0003 | $Ind^f$ | 0.0007 | 0.0009 |
| | 0.003 | 0.0002 | | 0.0005 | 0.0003 |
| Manf | 0.008 | 0.001 | $Manf^f$ | 0.0013 | 0.002 |
| | 0.003 | 0.0005 | | 0.0009 | 0.0007 |
| Srv | 0.0008 | 0.0004 | $Srv^f$ | 0.0003 | 0.0002 |
| | 0.0004 | 0.0002 | | 0.0001 | 0.00006 |
| M | 0.008 | 0.013 | $M^f$ | 0.02 | 0.014 |
| | 0.003 | 0.004 | | 0.007 | 0.004 |
| X | 0.01 | 0.018 | $X^f$ | 0.007 | 0.01 |
| | 0.005 | 0.007 | | 0.004 | 0.003 |
| Y | 0.0004 | 0.0001 | $Y^f$ | 0.0005 | 0.0004 |
| | 0.0004 | 0.0001 | | 0.0004 | 0.0001 |
| | | | $IP^f$ | 0.001 | 0.0008 |
| | | | | 0.0004 | 0.0004 |

**Source:** Author's calculation.

**Notes:** Estimates for each variable uses HP data and BP in first and second rows. Variables with superscript 'f' represent India.

Darvas and Szapáry (2008) suggest that an increase in the persistence of business cycles is an indication of diminishing role of country-specific shocks. There is variation in the level of persistence depending on data-filtering technique. Almost all of India's variables show a rise in the persistence using either data. Some of Nepal's variables also show increases in the levels of persistence using HP data. A majority of variables in both countries show roughly similar levels of persistence using HP data. Another indicator is the volatility of business cycle. In most of the variables, the variance of the cyclical component fell over time using either data. Yet the change in the level of volatility over time is minimal in both countries. Given most variables show a small decline or no significant changes, this may be taken as one more evidence of diminishing role of country-specific conditions. Finally, the impulse–response graph in Figure 5 shows response in Nepal's business cycle given a shock to the common component. Output rises in response to the shock with the peak effect near the end of the second period. The effect levels out by the end of the fourth period. When the business cycles are synchronized a positive shock to the common component results in similar cyclical changes in the candidate countries. This is observed in the impulse–response graph.

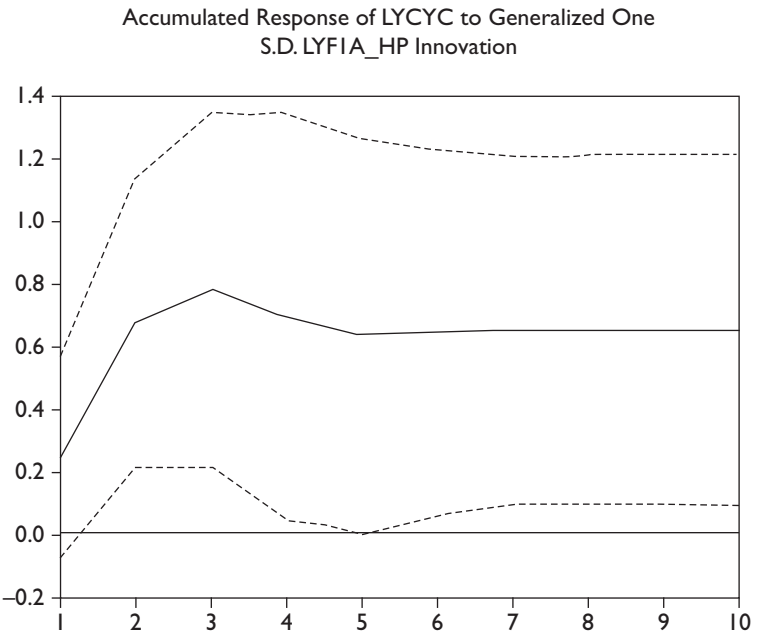


**Figure 5.** Response of Nepal's Business Cycle to a Common Shock from the Model in Equations 15–17 in appendix (Using HP data)

**Source:** Author's calculation.

## Conclusion

This article investigated the prospects for monetary integration by examining economic symmetry between India and Nepal. The issue is motivated by the fact that the current exchange-rate regime seems untenable in the long run given weak fundamentals. Moreover, there exist some pre-conditions, such as huge bilateral trade and easy flow of capital and labour due to the open border, that are favourable for such integration between the two. This essay analyzed economic symmetry by applying standard approach in the literature. All in all the results offer a mixed conclusion on whether the two economies share enough similarities to justify monetary integration.

Based on the correlation estimates of structural shocks in the two economies, it would be hard to say that they share similarity in shocks. The correlation was low and negative in supply shocks. However, there is evidence of policy spillover to Nepal in monetary shocks. Separating the structural shocks into the region-wide common component revealed significant estimates mainly for monetary shocks. They were found to be positively associated with the common component. In the business-cycle investigation, the results were sensitive to model specification and the use of de-trending method. The correlation between the common

component and Nepal's business cycle showed some variables with positive co-movement over time. Taken together, the results are not conclusive enough to support the idea of further monetary integration.

Further evaluation of monetary integration between India and Nepal may require assessment of additional criteria, such as the presence of a long-run relationship in the trend component of the GDP. The evidence of such a relationship was found in South Asia by Banik, Biswas and Saunders (2006). A future extension of this study may take a similar approach in order to arrive at a firmer conclusion.

### Acknowledgements

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## Appendix

## SVAR Model

In a VAR model a vector of variables is regressed upon lags of itself and other variables included in the system. A true model is represented by an infinite order moving average of a vector of variables.

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} \tag{8}$$

The matrix representation using a lag operator is $X_t = A(L)\varepsilon_t$. In Equation 1, $X_t = [\Delta Y_t, \Delta P_t, \Delta M_t]'$ and the corresponding structural error term $\varepsilon_t = [\varepsilon_{st}, \varepsilon_{dt}, \varepsilon_{mt}]'$. The endogenous variables included in the system are domestic real GDP, $Y_t$, the price level, $P_t$, and money supply (m1)/interest rate (discount rate)/domestic credit, $M_t$. The structural shocks in the system are assumed to be a domestic supply shock, $\varepsilon_{st}$, and a pure-demand shock, $\varepsilon_{dt}$, which is separated from the policy-induced demand effect, $\varepsilon_{mt}$. The coefficient matrix $\underset{(3\times 3)}{A}$ is the impulse response function that shows the impact of structural shocks on the endogenous variables. These innovations are assumed to be serially uncorrelated and orthonormal (that is, an identity covariance matrix). The following system of equations shows the dynamics of structural innovation in the model:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \\ \Delta M_t \end{bmatrix} = \begin{bmatrix} A_{11}(L) & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{st} \\ \varepsilon_{mt} \\ \varepsilon_{dt} \end{bmatrix} \tag{9}$$

A few assumptions are necessary to identify the system. First, it is assumed that the economy's long-run output is influenced only by supply-side factors, such as productivity growth. The cumulative effect of pure demand and policy-induced demand shock is nil:

$$\sum_{i=0}^{\infty} A_{12i} = 0, \tag{10}$$

$$\sum_{i=0}^{\infty} A_{13i} = 0. \tag{11}$$

The second assumption is necessary to separate the pure demand shock from monetary shock by assuming that only the latter can affect the long-run trend of inflation.

$$\sum_{i=0}^{\infty} A_{23i} = 0, \tag{12}$$

Using these assumptions, a reduced form VAR is estimated in order to recover the structural shocks in Equation 8.

## Time Varying State–Space Models

The state–space model presented in the third section does not elucidate the dynamic effects in the economy if the estimates parameters are time variant. Economic integration is an ongoing, evolutionary process. By incorporating dynamic changes in the economy, different patterns in shocks' behaviour over time can be observed. We use a time-variant state–space model for this purpose.

$$S_t^1 = \beta_t S_t^2 + \varepsilon_t, \tag{13}$$

$$\beta_t = \beta_{t-1} + \omega_t, \tag{14}$$

where $\varepsilon_t \sim N(0, 1)$ and $\omega_t \sim N(0, Q)$. $S_t^1$ represents the shocks from SVAR for Nepal and $S_t^2$ for India.

The time-varying parameter, $\beta_t$, is assumed to evolved as a random walk process, and its time path indicates the evolution of synchronization in shocks. In particular, it will measure if shocks in India affect shock formation in Nepal. A perfect synchronization would imply that the value of $\beta_t$ converges to unity.

## Business Cycle Synchronization

Below we present an alternative specification of the model presented in the third section through Equations 15–17 following Maza and Villaverde (2007).

$$y_{it} = \beta_t z_t^c + z_{it}^s, \tag{15}$$

$$z_t^c = \gamma z_{t-1}^c + v_t, \tag{16}$$

$$z_{it}^s = \gamma_i z_{it-1}^s + v_{it}, \tag{17}$$

The difference in this formulation is in coefficient restriction in the observation equation. This is based on the assumption that all variations not explained by the common element are attributed to the country-specific factors.

A few other indicators of business cycles are used to provide more information on symmetry of economies. The first one is the volatility of business cycles. As smaller economies tend to be volatile, policy coordination can be challenging within a more integrated setting. Second, along the lines of Darvas and Szapary (2008), we calculate persistence in business cycle using a first-order autocorrelation coefficient. Countries that are considering monetary integration are better served if they have a similar level of persistence. Knowing the degree of persistence helps in determining the scope and magnitude of policy response. As a final indicator of business-cycle synchronization, we present accumulated impulse responses of the cyclical component of GDP to a shock to the common component. The impulse response is based on a VAR that includes common component in business and individual-country business cycle.

## Notes

1. Cited from 'New Views on OCA' (Mongelli, 2002).
2. Cited from 'New Views on OCA' (Mongelli, 2002).
3. See Lee et al. (2003).
4. We limit our investigation to analyzing Nepal's case. Hence, we only calculate the correlation coefficient between the regional element and Nepal's business cycle.
5. Note that there is no industrial production data for Nepal.
6. In Table 4, these estimates are shown as D3, M3 and S3.
7. Although not shown here, further calculation of shares of variance of common component in total shocks for each country is not possible due to statistical insignificance of, at least, one parameter out of four for all types of shocks.
8. In general, the results presented here are for those variables where the convergence was achieved in applying the Kalman filter during estimation.
9. The sensitivity of the results is also documented in the literature.

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