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Is Inflation in India an Attractor of Inflation in Nepal?

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Is Inflation in India an Attractor of Inflation in Nepal?

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Authorized for distribution by Charles Kramer

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Abstract

The paper attempts to answer some important questions around the inflationary process in Nepal, particularly the transmission of inflation from India. Because the Nepali currency is pegged to the Indian rupee and the two countries share an open border, price developments in Nepal would be expected to mirror to those in India. The results show that inflation in India and inflation in Nepal tend to converge in the long run. Our estimates indicate that the pass-through of inflation from India to Nepal takes about seven months. The paper draws some implications for the conduct of monetary policy in Nepal.

JEL Classification Numbers: C51, E31, E37

Keywords: Nepal, India, Inflation

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I. Introduction

With Nepali currency pegged to the Indian rupee and the two countries share an open border[2], price developments in Nepal would be expected to reflect those in India. Inflation data for the last decade, however, suggest a somewhat mixed picture. Although comovements have been clearly observed in some periods, at times inflation in Nepal has deviated considerably from inflation in India. As stated in the Nepal Rastra Bank (NRB) act, one of the primary objectives of the NRB is to maintain price stability.

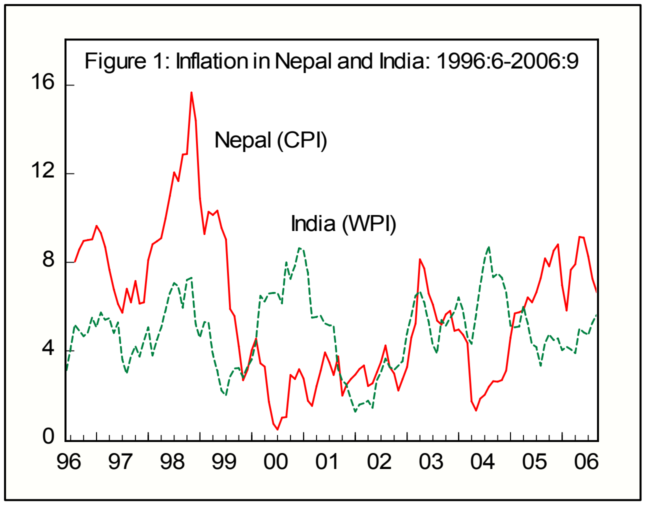

Figure 1: Inflation in Nepal and India: 1996:6-2006:9

This paper attempts to shed some light on the inflationary process in Nepal, as well as the scope for the control of domestic inflation. The transmission of inflation from India and its influence on the inflationary process in Nepal has important implication for monetary policy. As a backdrop, the paper reviews theoretical literature on international transmission of inflation in a small open economy (SOE). Central to the empirical approach adopted in this paper is the construction of alternative core inflation measures for Nepal and India. This approach makes it possible to examine the long- and short-term relationships, not only between headline inflation in Nepal and in India, but also between core inflation measures in the two countries.

The layout of the remainder of this paper is as follow. Section II provides a review of the main economic theories of inflation with a particular emphasis on price determination in a small open economy like Nepal. Section III develops core inflation measures for Nepal and India and then evaluates them using the necessary conditions for core inflation measures introduced by Marques, et al (2003). Section IV examines the long- and short-run relationships between various measures of inflation for Nepal and India. Section V and VI present policy implications and conclusions.

II. Theoretical Considerations

Economic theory offers several possible explanations for inflation. The Philips curve theories establish a simple trade-off between inflation and unemployment (Philips, 1958). Its primary implication is that unemployment can only be reduced by increasing inflation. Monetarist theories, on the other hand, stress the unique role of money as an independent and ultimate cause of inflation. As argued by Friedman (1966), inflation is always and everywhere a

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[2] Trade with in India accounts for about 65 percent of Nepal's total trade.

monetary phenomenon. Most of the early literature on inflation, however, was developed in the context of a closed economy. When the analysis is extended to a small open economy, the relevant variables driving the inflation process need to be extended beyond domestic money supply. The more open an economy, the greater the impact of foreign prices on domestic prices. Obviously, inflation dynamics are also highly dependent on the type of exchange rate regime adopted. There are two major frameworks for analyzing open economy inflation; the purchasing power parity (PPP) and the Scandinavian approach.

Purchasing Power Parity (PPP)

The starting point of PPP is *the law of one price,* which states that for any good *i*

$$p_t(i) = p_t^*(i) + s_t \tag{1}$$

where $p_t(i)$ is the log of domestic currency price of good *i* at time t, $p_t^*(i)$ is the analogous foreign currency price, and s_t is the log of relevant nominal exchange rate at time t. The premise underlying the law of one price is that, abstracting from tariffs and transport costs, trade should ensure identical price across countries. If the law of one price holds for every individual good, then it follows that it must also hold for any identical basket of goods. Absolute PPP requires:

$$p_t(CPI) = p_t^*(CPI) + s_t \tag{2}$$

where CPI denotes the basket of goods used in forming the consumption price index. However, unless the two countries have identical consumption baskets, equation (2) will not hold. To allow for a constant price differential between baskets, relative PPP can be derived as:

$$\Delta p_t(CPI) = \Delta p_t^*(CPI) + \Delta s_t \tag{3}$$

which requires that changes in relative price levels be offset by changes in the exchange rate.

The implication of (3) for an analysis of inflation in an SOE depends crucially on the exchange rate regime. If the nominal exchange rate is fixed ($\Delta s_t = 0$) and PPP holds, then under the assumption of price-taking behavior, foreign prices will lead domestic prices. In this case domestic influences over inflation are, at most, transitory (Kenny and McGettingan, 1999).

PPP is generally seen as a long-term relationship between relative prices and exchange rates. In the short run, it is subject to temporary offset rather than a continuously holding equivalence. The most common way to examine the presence of PPP is by using the cointegration test, which tests for the long-run relationship between economic variables. Many empirical studies have provided evidence in favor of PPP as a long-run hypothesis. But, the evidence to support PPP is easier to find across countries with fixed exchange rate (Froot and Rogoff, 1995). Kenny and McGettingan, 1997 also find that PPP is a valid long-run framework to analyze the evolution of Irish inflation.[3]

The Scandinavian Approach

Although the PPP approach has been accepted as an important long-run proposition for an SOE that operates under a fixed exchange rate regime, it ignores potentially interesting differences in the price determination process in the tradable and nontradable sectors of the economy. The Scandinavian model allows for a separate analysis of the price determination process in the two sectors (Aukurst, 1977 and Lindbeck, 1979). Accordingly, the sources of price inflation are decomposed into two sources:

$$\pi = \phi\pi^{T} + (1-\phi)\pi^{NT} \tag{4}$$

where π^T and π^{NT} are price inflation in the tradable and nontradable sectors, respectively, and ϕ is the share of the tradable sector in the output/consumption basket.

Under the assumption of smallness and a fixed exchange rate, tradable price inflation conforms to the implications of PPP. The smallness also implies that changes in domestic demand will play no role in determining tradable price inflation.

In the nontradable sector, the model assumes that no external constraint on price determination exists. Non-traded inflation is modeled as a markup over wage costs adjusted for productivity

$$\pi^{NT} = w^{NT} - q^{NT}, \tag{5}$$

where w^{NT} and q^{NT} are wage and labor productivity growth in the nontradable sector, respectively.

The model assumes a homogenous labor market and, hence, wage equalization across sectors $(w_t^T = w_t^{NT})$. The model also assumes a constant factor income share in the tradable sector and tradable wage growth is determined by growth in the price of tradable goods and productivity $(w^T = \pi^T + q^T)$. With these assumptions and (5), equation (4) can be transformed into:

$$\pi = \pi^{T} + (1-\phi)(q^{T} - q^{NT}) \tag{4a}$$

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[3] Ireland is a classic example of an SOE with a longstanding strict peg with sterling before joining the EMS.

Equation (4a) implies that, even under a fixed exchange rate regime, inflation in an SOE can differ from inflation in its tradable partners because of productivity growth differences in the tradable and nontradable sectors. Thus, a country with relatively large intersectoral productivity growth differentials will have a higher rate of inflation relative to its trading partners.

Kenny and McGettingan (1999) use the Scandinavian approach to analyze inflation behavior in Ireland over the period 1979:Q1−1995:Q3 and find that the data provide strong support for PPP in the case of tradable prices, but not for nontradable prices. Interestingly, the results for aggregate domestic prices and world prices are also consistent with PPP. Using a similar approach for larger countries, Degregorio, et al. (1994) examine price determination in 14 OECD countries over the period of 1970–1985. Their findings suggest that inflation in OECD countries has been driven predominantly by the nontradable sector.

Three key theoretical implications can be drawn from this review for a small open economy like Nepal. First, any change in the trading partners' traded prices will be transmitted one for one to domestic inflation. Second, even with a peg to the Indian rupee, the differential in productivity growth between tradable and nontradable sectors $(q^T > q^{NT})$ could give rise to deviation in the domestic rate of inflation from inflation in India. Finally, given capital controls, domestic monetary policy could also contribute to the deviation of domestic inflation and inflation in India through nontradable prices.

III. Inflation Measures For Nepal And India

For the conduct of monetary policy, the most commonly used price indicator in Nepal is the consumer price index (CPI) inflation. But, it is widely recognized that, at times, the CPI inflation can be a misleading indicator of the underlying inflation. Thus, many central banks have found it useful to monitor core inflation measures, which separate temporary shocks from the inflationary process and, hence, represent the underlying price movements more accurately.

Core inflation is useful in the conduct of monetary policy in two ways. First, since core inflation excludes temporary price fluctuations originated from supply disturbances (Roger, 1997), it could considered as a measure of inflation that is the outcome of policy and, hence, more controllable by the monetary authorities. Second, because monetary policy affects economic activity with long and variable lags, it is not a good tool for countering temporary price movements, so policymakers are more interested in the inflation outlook. To the extent that measures core inflation measures can isolate the underlying trend to which inflation will return, they could be a useful short-term guide for future projections of total CPI inflation.

Four core inflation measures for Nepal and India are developed here to allow us to analyze the underlying price movements. The analysis of core inflation measures will make it possible to determine: (i) whether or not, and to what extent, temporary shocks to inflation in

India translate to domestic inflation in Nepal; and (ii) whether the temporary shocks in Nepal are important sources of deviation from inflation in India.

A. Defining Core Inflation

Economic literature has documented many definitions of core inflation. Bryan and Cecchetti (1993) relate core inflation with price changes that are attributed to the growth rate of the money supply. Quah and Vahey (1995) identify core inflation as the component of measured inflation that has no medium to long-run impact on real output. Blinder (1997) and Marques, et al (2003) define core inflation as the persistent part of inflation. Despite differences in definition, all research on core inflation are motivated by the observation that inflation can be noisy and volatile as a result of temporary shocks, making it difficult to read true underlying inflationary developments. Thus, it is important to isolate the signal from the noise.

Inflation rate π_t at any given time period t can be broken down into two components (Marques, et al, 2003): a persistent component named core inflation π_t^{Core} and a temporary component represented by ν_t.

$$\pi_t = \pi_t^{Core} + \nu_t \qquad (6)$$

The persistent component is related to the fundamental driving force of inflation, such as excess demand for goods and monetary policy. Short-run movements in inflation are due to temporary supply shocks and tend to reverse fairly quickly. Therefore, if ν_t has zero mean, the core inflation measure captures the persistent component of inflation.

B. Core Inflation Measures for Nepal and India

Despite its prevalence, there is no agreed method of measuring core inflation. Literature provides two broad approaches: statistical and model-based. The most popular statistical approaches are exclusion-based measures and trimmed-based measures pioneered by Bryan and Cecchetti (1993). The model-based approach pioneered by Quah and Vahey (1995) attempts to develop core inflation measures by using a multivariate econometric model. This approach suffers from a number of drawbacks, including sensitivity to the assumptions underlying the model and sample changes, which limit the usefulness of these inflation measures. This paper will thus focus on the statistical measures of core inflation.[4]

Core inflation measures for Nepal are constructed for the period 1996:08–2006:09 using the National Urban Consumer Price Index (NUCPI), which is disaggregated into 33 components (Annex I, Table 1). For India, core inflation measures are computed based on the wholesale price index (WPI) for the period of 1996:06–2006:09. The WPI data used in this study are

[4] See Annex II for further discussion of methods to develop core inflation measures.

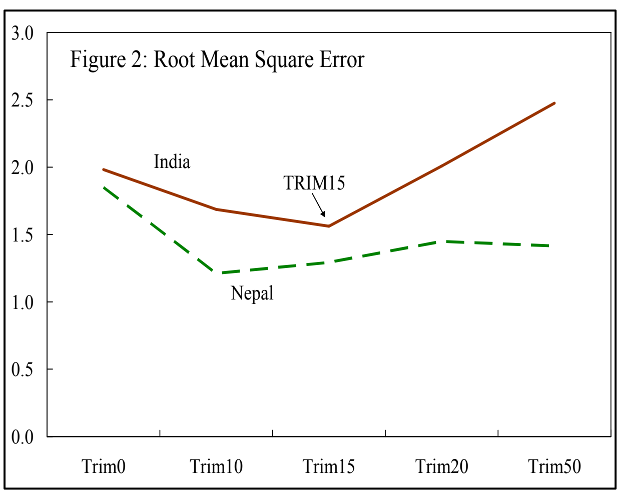
aggregated into 47 components (Annex I, Table 2). All core inflation measures are constructed using a 12-month price changes. Throughout the period, calculations are based on constant weights, 1995/96 for Nepal and 1993/94 for India.

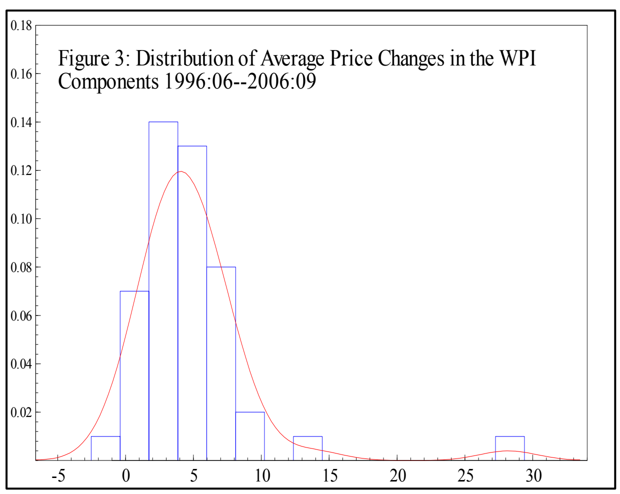
Two exclusion-based measures are constructed for Nepal and India. For Nepal, the first measure, CPIFE, excludes food, fuel and electricity, which account for about 50 percent of the total CPI weights. The second measure, CPI10, is developed based on the relative volatility of NUCPI components measured by their standard deviation over the sample period. Ten components (one-third of the total weight) with a standard deviation higher than the average (6.7) are excluded. For consistency, the same approach is used for India. The first measure, WPIFE, excludes food, fuel and electricity, which account for about 40 percent of total WPI weights. The second measure, WPI16, excludes 16 of the most volatile components of WPI with a higher than average standard deviation (10.8), accounting for about 21 percent of the total WPI weights.

Two trimmed-based measures are also constructed for Nepal and India. The first step in developing trimmed-based measures is to determine the size of the trim. In this paper, following Cecchetti (1996), an optimum trim is obtained by minimizing the root mean square error (RMSE) of each trimmed measure with respect to a reference measure of long-term inflation:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{N} (\pi_t^{Core} - \pi_t^{R})^2}{N}} \qquad (7)$$

where π_t^{Core} and π_t^{R}, respectively, are core inflation measures and long-term inflation proxied by a historical 36-month moving average of headline inflation. N is the number of observation.





For Nepal, TRIM10, a 10 percent trim on both sides of the distribution of monthly price changes of the CPI, minimizes the RMSE. For India, as shown in the chart, the distribution of monthly price changes in the WPI is skewed to the right. With this feature of the data, a symmetric trim approach tends to generate a biased estimate of core inflation. This problem is addressed by using an asymmetric trim. The TRIM15L20, which trims 20 percent and 10 percent, respectively, on the left and right end of the distribution, produces minimum RMSE. To shed further light on the cross-section distribution of price changes, a core inflation measure based on weighted median (WMED) is computed for both Nepal and India. If the distribution of price changes is asymmetrical, WMED is expected to diverge considerably from headline inflation. (All measures of core inflation are presented in Appendix I, Tables 3 and 4).

C. Evaluation of Core Inflation Measures

Two general criteria can be used to evaluate core inflation measures; practical and empirical. From a practical perspective, core inflation measures should be timely, credible, verifiable, and easy to explain to the public Roger (1998). On empirical side, Laffleche, et al (2006) suggest that core inflation measures should be evaluated based on the way they are derived and they propose three criteria: volatility, unbiasedness, and predictive power. Marques, et al (2003), however, argue that core inflation measures should not be evaluated on the basis that they are good predictor of inflation. By definition, a good predictor of future inflation must be able to account for short-run movements of the price level, but this feature cannot and should not be expected from core inflation measures. They introduce three testable necessary conditions for core inflation measures: (i) headline and core inflation should not exhibit a systematically diverging trend; (ii) core inflation should be an attractor of headline inflation, but (iii) headline inflation should not be an attractor of core inflation.

In this section, all core inflation measures are evaluated using volatility and unbiasedness criteria. Volatility is evaluated by comparing standard deviation for each measures. For unbiasedness, first it is evaluated by comparing the unconditional means of various core inflation measures with the headline inflation. Then, the property is explored more formally using necessary conditions for core inflation introduced by Marques, et al..

Volatility

The measures that exclude the influence of the most volatile components of the price index, by definition, will be less volatile than the headline inflation. Comparing volatility across various measures of core inflation will also help indicate whether they have excluded the right components that are influenced mostly by temporary shocks. One way to examine volatility is by comparing the standard deviation for each measure. For Nepal, all measures of core inflation are less volatile than the CPI (Table 1). For India, WPIFE is not less volatile than WPI (Table 2), suggesting that some WPI components, other than food and energy, are important sources of temporary shocks.

Table 1. Nepal: Statistical Properties of Various Measures of Core Inflation, 1996:08–2006:09

	CPI	CPI10	CPIFE	TRIM10	WMED
Mean	5.8	5.6	5.5	5.4	5.0
Median	5.7	5.4	4.7	5.1	4.6
Maximum	15.7	9.5	10.3	10.2	10.0
Minimum	0.5	2.2	2.4	0.8	1.1
Standard deviation	3.2	2.2	2.3	2.6	2.4
Skewness	0.6	0.3	0.6	0.1	0.5
Kurtosis	2.8	1.9	2.1	1.8	2.1

Source: Staff calculations.

Table 2. India: Statistical Properties of Various Measures of Core Inflation, 1996:06–2006:09

	WPI	WPI16	WPIFE	TRIM15L20	TRIM15	TRIM20	WMED
Mean	4.9	4.1	3.5	5.0	3.2	3.2	3.2
Median	5.1	4.1	3.1	5.0	3.4	3.4	3.4
Maximum	8.7	7.4	9.3	7.9	6.0	6.0	6.0
Minimum	1.3	1.4	-0.2	1.3	0.2	0.2	0.2
Standard deviation	1.6	1.2	2.1	1.4	1.3	1.3	1.3
Skewness	0.0	0.1	0.4	-0.3	-0.1	-0.1	-0.1
Kurtosis	2.7	2.9	2.5	2.8	2.4	2.4	2.4

Source: Staff calculations.

Unbiasedness

Over time, measures of core inflation and headline inflation should share the same long-term trend. A significant divergence between them would undermine the basic notion that core inflation represents the underlying trend of inflation. An absence of bias supports the claim that only temporary shocks are excluded from the core inflation measure. One simple way to examine unbiasedness is to compare the unconditional means of various core inflation measures with the headline inflation. As shown in Table 1, for Nepal the means of all measures of core inflation over the sample period fall within the same range as the CPI. For India, the means of WPIFE and WMED are significantly lower than the others.

Three Properties of Core Inflation

According to Marques, et al, a core inflation measure should satisfy three statistical properties:

1. Headline inflation π and core inflation π^{Core} should be cointegrated with unit coefficient, that is, $v_t = \pi_t - \pi_t^{Core}$ should be stationary with zero mean.[5] This condition essentially means that π and core inflation π^{Core} cannot exhibit a systematically

[5] Assume that the headline inflation and the core inflation measure are I(1).

nonvanishing difference in the long run. If ν_t does not have zero mean, then π^{Core} does not capture the persistent component of inflation. On the other hand, even if $\nu_t = \pi_t - \beta\pi_t^{Core}$ is stationary, but $\beta \neq 1$, the headline and core inflation measures tend to drift apart. One way to examine this property is by estimating the following regression:

$$\pi_t - \pi_t^{Core} = \alpha + (1-\beta)\pi_t^{Core} + \mu_t \quad (8)$$

and testing for the hypothesis $(\alpha, \beta) = (0,1)$.

2. Core inflation should be an 'attractor' of headline inflation. This condition formalizes the assumption that headline inflation converges to core inflation in the long run. This condition can be tested using:

$$\Delta\pi_t = \sum_{j=1}^{m} \phi_j \Delta\pi_{t-j} + \sum_{j=1}^{n} \varphi_j \Delta\pi_{t-j}^{Core} - \gamma(\pi_{t-1} - \pi_{t-1}^{Core}) + \varepsilon_t \quad (9)$$

This requires the existence of an error correction representation for π_t, which will be satisfied if the null hypothesis of $\gamma = 0$ is rejected. The implication of this condition is that headline inflation may diverge from core inflation in the short run, but comes back to it inflation in the log run.

3. Headline inflation should not be an attractor of core inflation. This condition ensures that condition 2 does not occur the other way around, which can be evaluated by using the error correction model for π_t^{Core}:

$$\Delta\pi_t^{Core} = \sum_{j=1}^{r} \delta_j \Delta\pi_{t-j}^{Core} + \sum_{j=1}^{s} \theta_j \Delta\pi_{t-j} - \lambda(\pi_{t-1}^{Core} - \pi_{t-1}) + \eta_t \quad \textbf{(10)}$$

This condition requires that the error correction term does not appear in (10) and that π does not Granger cause π^{Core}, which requires strict exogeneity, that is $\lambda = \theta_1 = ... = \theta_s = 0$.

According to the ADF test, inflation series for Nepal and India appear to be I(1) without a drift (Appendix III. Table 1). In this case, each core inflation measure must satisfy the three conditions discussed above. A single equation approach is used to evaluate these conditions and the results are presented in Table 3. The Johansen approach is also used for a robustness check (Table 4). The results from the Johansen approach are consistent with the results obtained from the single equation approach. Accordingly, we only discuss the results reported in Table 3 and Figures 1 and 2.

Table 3. Nepal and India: Necessary Conditions for Core Inflation, Single Equation Approach 1/

Variable	Condition 1		Condition 2	Condition 3		Conclusion
	ADF Test on $(\pi-\pi^{Core})$ 2/	$\alpha = 0$ given $\beta = 1$	$\gamma = 0$	$\lambda = 0$	$\theta_1 = \ldots = \theta_s = 0$ given $\lambda = 0$ 3/	
	(1)	(2)	(3)	(4)	(5)	(6)
Nepal						
CPI10	No P = 0.21	Yes P = 0.82	No** P = 0.02	Yes P = 0.73	No** P = 0.03	Fails condition 1a and 3b
CPIFE	No P = 0.11	Yes P = 0.76	No** P = 0.02	Yes P = 0.68	Yes P = 0.42	Fails condition 1a
TRIM10	Yes*** P = 0.00	Yes P = 0.17	No** P = 0.05	Yes P = 0.46	Yes P = 0.68	OK
WMED	Yes* P = 0.08	Yes P = 0.15	No** P = 0.04	Yes P = 91	Yes P = 0.10	OK
India						
WPI16	Yes** P = 0.02	No** P = 0.05	Yes P = 0.21	Yes P = 0.31	Yes P = 0.37	Fails condition 1b and 2
WPIFE	Yes* P = 0.09	No* P = 0.09	Yes P = 0.48	Yes P = 0.23	Yes P = 0.25	Fails condition 2
TRIM15L20 4/	Yes*** P = 0.01	Yes P = 0.93	No** P = 0.05	Yes P = 0.50	Yes P = 0.77	OK
WMED	Yes*** P = 0.00	No*** P = 0.00	Yes P = 0.16	Yes P = 0.47	No** P = 0.04	Fails condition 1b, 2 and 3b

Source: Staff calculations.

1/ *** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level.
2/ MacKinnon (1996) one-sided p-value for ADF test.
3/ Strict exogeneity is tested using the Wald coefficient restriction test.
4/ Asymmetric (with 20 percent trim in the lower end of the distribution).

Table 4. Nepal and India: Necessary Conditions for Core Inflation, Johansen Approach 1/

Variable	Condition 1		Condition 2	Condition 3		Conclusion
	Trace Statistic 2/	$\beta = 1$	$\gamma = 0$	$\lambda = 0$	$\theta_1 = \ldots = \theta_s = 0$ given $\lambda = 0$ 3/	
	(1)	(2)	(3)	(4)	(5)	(6)
Nepal						
CPI10	No P = 0.29	Yes P = 0.73	No** P = 0.03	Yes P = 0.92	Yes P = 0.03	Fails condition 3b
CPIFE	No P = 0.29	Yes P = 0.53	No** P = 0.02	Yes P = 0.91	Yes P = 0.83	Fails condition 1a
TRIM10	Yes*** P = 0.00	Yes P = 0.27	No* P = 0.06	Yes P = 0.10	Yes P = 0.89	OK
WMED	Yes** P = 0.05	Yes P = 0.36	No** P = 0.04	Yes P = 22	Yes P = 0.13	OK
India						
WPI16	Yes* P = 0.08	Yes P = 0.41	Yes P = 0.22	Yes P = 0.13	Yes P = 0.21	Fails condition 2
WPIFE	Yes* P = 0.59	No* P = 0.09	Yes P = 0.48	Yes P = 0.26	Yes P = 0.01	Fails condition 1b, 2 and 3b
TRIM15L20 4/	Yes*** P = 0.05	Yes P = 0.17	No** P = 0.01	Yes P = 0.77	Yes P = 0.68	OK
WMED	Yes*** P = 0.00	Yes P = 0.32	Yes P = 0.70	No** P = 0.02	No** P = 0.04	Fails condition 2 and 3

Source: Staff calculations.

1/ *** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level.
2/ MacKinnon-Houg-Michelis (199p) p-values.
3/ Strict exogeneity is tested using the Wald coefficient restriction test.
4/ Asymmetric (with 20 percent trim in the lower end of the distribution).

The first column of Table 3 presents the results of the test for condition 1. Following Marques et al, the ADF test including a constant term is employed to examine

$(\pi_t - \pi_t^{Core})$ and separately test for the conditions $\alpha = 0$ and $\beta = 1.$ The rejection of the null hypothesis of a unit root on $(\pi_t - \pi_t^{Core})$ provides evidence favoring statitionary μ_t and $\beta = 1$ in Equation (8). For Nepal, only TRIM10 and WMED satisfy this condition, whereas all core inflation measures for India meet this condition. For the second part— $\alpha = 0$ (column 2)—, the test suggests that, for Nepal, $(\pi_t - \pi_t^{Core})$ derived from all core inflation measures have zero means. For India, however, only TRIM15L20 meets this condition. Taken together, TRIM10, WMED (for Nepal) and TRIM15L20 (for India) satisfy condition 1, hence, they are unbiased estimators and capture the true persistent level of core inflation.

After establishing the stationarity property of each core inflation measure, we can proceed to test for condition 2. The results are reported in the third column of Table 3. The test is carried out by estimating equation (9) using a simple *t*-test to examine whether the null hypothesis of $\gamma = 0$ is rejected. The figures in the table are *p*-values of *t*-statistics. For Nepal, the null hypothesis of $\gamma = 0$ is rejected for all core inflation measures, suggesting that they are an attractor of headline inflation. For India, as expected, only TRIM15L20 attracts headline inflation.

The results of the test for the first part of condition 3 are shown in column 4. As in condition 2, a simple *t*-test is used to check for weak exogeneity $(\lambda = 0)$. The results suggest that all measures of core inflation satisfy this requirement. However, when strict exogeneity is imposed and tested using Wald test, CPI10 (for Nepal) and WMED (for India) fail to meet the condition (Table 3, column 5).

Overall, the results indicate that three indicators— TRIM10, WMEFD (for Nepal) and TRIM15L20 (for India)— satisfy all three conditions. All other indicators fail to meet at least one of the conditions. For exclusion-based measures (CPIFE, CPI10, WPIFE, and WPI16) this result may imply that the sources of temporary shocks change over the sample period. Hence, these measures, which exclude constant elements of the CPI over time, do not represent the true level of core inflation. In addition, for CPIFE and WPIFE, given their large weights, excluding all food items when only some seasonal components of food are more volatile could introduce bias to these measures. WMED, as discussed earlier, fails to capture the true level of core inflation for India because of an often asymmetrical distribution of the year-on-year price changes in the 47 WPI components.

IV. Long- And Short-run Relationship Between Inflation In Nepal And India

The tests for core inflation measures employed in the previous section are adapted to examine the long-and short-run relationships between inflation in Nepal and India. To test for long-run relationships, condition 1 is modified by replacing π with π^{NPL} (inflation measures for Nepal) and π^{Core} with π^{IND} (inflation measures for India). If $v_t^* = \pi_t^{NPL} - \pi_t^{IND}$ is stationary with zero mean, it implies that that inflation in Nepal and India do not exhibit a systematically non-vanishing difference in the long run. On the other hand, even if $v_t^* = \pi_t^{NPL} - \beta\pi_t^{IND}$ is stationary, but $\beta \neq 1$, the test suggests that inflation in Nepal tends to drift apart from inflation in India.

As in the previous section, the long-term relationships of inflation series is tested by estimating the following regression:

$$\pi_t^{NPL} - \pi_t^{IND} = \alpha + (1-\beta)\pi_t^{IND} + \mu_t \qquad (11)$$

and testing for the hypothesis $(\alpha, \beta) = (0,1)$.

Note that by invoking the PPP hypothesis, which implies that price inflation in the tradable sector is in line with inflation in India, π^T can be replaced with π_t^{IND}. Therefore, equation (4a) can be rewritten into:

$$\pi_t^{NPL} - \pi_t^{IND} = (1-\phi)(q^T - q^{NT}) \qquad (4b)$$

If there is no difference between productivity growth in the tradable and nontradable sectors, the term in the right hand side of Equation (4b) will turn to zero. The same is also true if $(\alpha, \beta) = (0,1)$ in Equation (11). Therefore, the Scandinavian model can also be examined by estimating (11) and testing for $(\alpha, \beta) = (0,1)$. The estimated value for $\alpha > 0$ will lend some support to the Scandinavian model.

To evaluate the short-run dynamic adjustment between inflation in Nepal and inflation in India, conditions 2 and 3 (equation 9–10) transformed into (12–13):

$$\Delta\pi_t^{NPL} = \sum_{j=1}^{m} \alpha_j \Delta\pi_{t-j}^{NPL} + \sum_{j=1}^{n} \beta_j \Delta\pi_{t-j}^{IND} - \gamma(\pi_{t-1}^{NPL} - \pi_{t-1}^{IND}) + \varepsilon_t \qquad (12)$$

$$\Delta\pi_t^{IND} = \sum_{j=1}^{r} \delta_j \Delta\pi_{t-j}^{IND} + \sum_{j=1}^{s} \theta_j \Delta\pi_{t-j}^{NPL} - \lambda(\pi_{t-1}^{IND} - \pi_{t-1}^{NPL}) + \eta_t \qquad \textbf{(}13\textbf{)}$$

where $\lambda = \theta_1 = ... = \theta_s = 0$ for strict exogeneity

The existence of an error correction representation in (12) implies that inflation in India is an attractor of inflation in Nepal. Equation (13) implies that the reverse is not true, inflation in India should not be attracted to inflation in Nepal.

To examine the long-and short-run relationships between inflation in Nepal and India, the ADF test run on ${}_t^{NPL} - \pi_t^{IND}$. Then equation (11) estimated to test for the presence of a drift. The short-run relationships between measures of inflation are examined by estimating equations (12–13). The estimations are based on monthly data from 1996:8 to 2006:9. The same tests for the headline and four core inflation measures examined in the previous section. With five inflation measures for each country, we need to run 25 set of tests, one set for each pair of inflation measures. The results are presented in Table 5 and Figure 3.

The test statistics reveal some support for the existence of a long-term relationship between inflation in Nepal and India. As shown in column 1, headline inflation in Nepal (CPI) and in India (WPI) is cointegrated at 10 percent level. For core inflation, the pair of measures that satisfy the three conditions tend to perform better statistically. WMED is cointegrated with WPI and TRIM15L20 at the 5 percent level. The pair of trimmed-based measures (TRIM10 and TRIM15L20), however, are only cointegrated at the 10 percent level. One could argue that the differences in the composition of the CPI and WPI, which contain less nontradable goods, may contribute to a weaker than expected long-run relationship between headline inflation in Nepal and India. This result could also attributed to the shocks coming from tradable goods originating from outside of India. However, some of these shocks would be temporary, and hence filtered out by the core inflation measures.

Table 5. India Inflation: Which One is the Attractor for Nepal Inflation? 1/

Variable	Condition 1: ADF Test on (π-π^{Core}) 2/ (1)	Condition 1: α = 0 given β = 1 (2)	Condition 2: γ = 0 (3)	Condition 3: λ = 0 (4)	Condition 3: θ_1 = …= θ_s = 0 given λ = 0 3/ (5)	Conclusion (6)
CPI and WPI	Yes* P = 0.06	No*** P = 0.00	No* P = 0.08	Yes P = 0.38	Yes P = 0.14	Fails condition 1b
CPI and WPI16	Yes** P = 0.02	No*** P = 0.00	Yes P = 0.33	Yes P = 0.82	Yes P = 0.42	Fails condition 1b and 2
CPI and WPIFE	Yes** P = 0.04	No*** P = 0.00	Yes P = 0.35	Yes P = 0.81	Yes P = 0.70	Fails condition 1b and 2
CPI and TRIM15L20 4/	Yes* P = 0.08	No *** P = 0.01	No** P = 0.05	Yes P = 0.87	No** P = 0.05	Fails condition 1b and 3b
CPI and WMED	Yes* P = 0.09	No*** P = 0.00	Yes P = 0.25	Yes P = 0.78	Yes P = 0.64	Fails condition 1b and 2
CPI10 and WPI	Yes** P = 0.05	No*** P = 0.00	Yes P = 0.12	Yes P = 0.52	Yes P = 0.92	Fails condition 1b and 2
CPI10 and WPI16	Yes* P = 0.10	No*** P = 0.00	Yes P = 0.14	Yes P = 0.22	No* P = 0.06	Fails condition 1b and 2
CPI10 and WPIFE	No P = 0.12	No*** P = 0.00	Yes P = 0.11	Yes P = 0.81	Yes P = 0.41	Fails condition 1a, 1b and 2
CPI10 and TRIM15L20 4/	Yes* P = 0.08	No*** P = 0.00	No** P = 0.03	Yes P = 0.57	Yes P = 0.35	Fails condition 1b
CPI10 and WMED	Yes* P = 0.10	No*** P = 0.00	No * P = 0.08	Yes P = 0.35	Yes P = 0.32	Fails condition 1b and 2
CPIFE and WPI	Yes* P = 0.08	No** P = 0.02	Yes P = 0.14	Yes P = 0.58	Yes P = 0.57	Fails condition 1b and 2
CPIFE and WPI16	No P = 0.15	No*** P = 0.00	No* P = 0.06	Yes P = 0.41	Yes P = 0.29	Fails condition 1a, 1b and 2
CPIFE and WPIFE	No P = 0.17	No*** P = 0.00	No* P = 0.06	Yes P = 0.42	Yes P = 0.54	Fails condition 1a, 1b and 2
CPIFE and TRIM15L20 4/	No P = 0.13	No** P = 0.02	No** P = 0.04	Yes P = 0.52	Yes P = 0.15	Fails condition 1a and 1b
CPIFE and WMED	No P = 0.13	No*** P = 0.00	No** P = 0.02	Yes P = 0.61	Yes P = 0.50	Fails condition 1a and 1b
TRIM10 and WPI	Yes* P = 0.06	Yes P = 0.15	No** P = 0.04	Yes P = 0.95	Yes P = 0.65	OK
TRIM10 and WPI16	Yes* P = 0.07	No*** P = 0.00	No* P = 0.10	Yes P = 0.88	Yes P = 0.44	Fails condition 1b and 2
TRIM10 and WPIFE	Yes** P = 0.05	No*** P = 0.00	Yes P = 0.15	Yes P = 0.82	Yes P = 0.44	Fails condition 1b and 2
TRIM10 and TRIM15L20 4/	Yes* P = 0.08	Yes P = 0.15	No** P = 0.03	Yes P = 0.55	Yes P = 0.46	OK
TRIM10 and WMED	Yes* P = 0.08	No*** P = 0.00	No* P = 0.10	Yes P = 0.97	Yes P = 0.57	Fails condition 1b
WMED and WPI	Yes** P = 0.02	Yes P = 0.76	No** P = 0.05	Yes P = 0.29	Yes P = 0.12	OK
WMED and WPI16	Yes** P = 0.02	No*** P = 0.00	No** P = 0.05	Yes P = 0.38	Yes P = 0.26	Fails condition 1b
WMED and WPIFE	Yes** P = 0.04	No*** P = 0.00	No** P = 0.05	Yes P = 0.85	Yes P = 0.15	Fails condition 1b
WMED and TRIM15L20 4/	Yes** P = 0.03	Yes P = 0.86	No** P = 0.04	Yes P = 0.44	Yes P = 0.30	OK
WMED and WMED	Yes** P = 0.03	No*** P = 0.00	No** P = 0.04	Yes P = 0.89	Yes P = 0.92	Fails condition 1b

Source: Staff calculations.

1/ *** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level.
2/ MacKinnon (1996) one-sided p-value for ADF test.
3/ Strict exogeneity is tested using the Wald coefficient restriction test.
4/ Asymmetric (with 20 percent trim in the lower end of the distribution) for India.

Another important element of the long-term relationship is the presence of a drift, which could prevent a full long-run convergence of the two inflation measures. The results of tests are presented in column 2. The estimation equation (11) for the pair of headline inflation measure suggests that the value of α is about 1, implying that during the sample period, on average, headline inflation in Nepal is about 1 percent higher than that in India. This finding provides tentative support for the Scandinavian model. However, when the same equation is estimated for the pair of unbiased core inflation measures such as TRIM10, WMED, and TRIM15L20, the coefficient of α become insignificantly different from zero. These results suggest that the temporary components of headline inflation are responsible for drift. Moreover, it is interesting to note that core inflation in Nepal (TRIM10 and WMED) also has a stable long-run relationship with India's headline inflation (WPI). This implies that the temporary shocks originating from Nepal contribute more to the deviation of headline inflation between Nepal and India.

Overall, while support for the PPP hypothesis for headline inflation measure is only tentative, stronger evidence emerges from the pair of the unbiased core inflation measures. These findings also provide some support for the claim that inflation in India (headline or properly defined core inflation) is an attractor of core inflation in Nepal. The tests for condition 2 (column 3) indicate the existence of an error correction term for TRIM10-RIM15L20, WMED-RIM15L20, and TRIM10-WPI. Core inflation in Nepal may diverge from core inflation in India in the short run, but will come back to the Indian level in the long run. The coefficient on the error correction term is 0.07, suggesting that when core inflation in Nepal deviates from core inflation in India, the adjustment to the equilibrium is about 7 percent a month.[6] This implies that half life of deviations from equilibrium is about seven to eight months. These pairs also satisfy condition 3, suggesting that inflation in Nepal is not an attractor of inflation in India.

Taken together, the results suggest that the exchange rate peg transmits price developments from India, but not in a straightforward way. The PPP paradigm is a valid long-run framework for analyzing inflation behavior in Nepal. However, stronger evidence to support PPP emerges only after the transitory components of the headline inflation in Nepal are isolated through development of unbiased core inflation measures. The analysis find some support for the deviation between headline inflation in Nepal and India, as suggested by the Scandinavian Model. However, further examination using unbiased core inflation measures rejects the case for persistent differences in inflation between the two countries. The deviation in the headline inflation appears to originate from domestic sources, particularly in the nontradable sector.

V. Policy Implications and Conclusion

The findings of the paper point to a number of policy implications:

- With the Nepali currency pegged to the Indian rupee and an open border between the two countries, price developments in Nepal are largely determined by the level of inflation in India. Therefore, monetary policy can play only a limited role in the long run.

[6] This speed of adjustment to the long-run equilibrium is comparable with a recent study conducted by the NRB—about 31 percent of short-run disequilibrium is corrected in one quarter.

- With capital controls in place, one could argue that domestic monetary policy could also contribute to the deviation of domestic inflation and inflation in India through nontradable prices. Therefore, monetary policy can be used to remove the deviation when it occurs. The study found some evidence to support the deviation of headline inflation between the two countries, but the deviation is mainly attributable to domestic temporary shocks. Because monetary policy affects economic activity with long and variable lags, it may not be an appropriate tool to address temporary domestic shocks. However, persistent deviation of core inflation in Nepal from an appropriately measured core inflation would suggest the need for monetary or other macroeconomic policy interventions.

- Given the importance of domestic temporary shocks in explaining the deviation of inflation between Nepal and India, it is essential that the NRB develop and monitor an appropriate measure of core inflation in Nepal. In this context, development of tradable and nontradable price indices would allow for a more accurate analysis of the long-and short-run relationships between inflation in Nepal and India.

To conclude, constructing core inflation measures for Nepal and India that satisfy empirical criteria is not straightforward. Measures of core inflation constructed by excluding fuel and energy are not good core inflation measures for Nepal and India. The measures computed using the trimmed method are empirically superior for both Nepal and India.

Is inflation in India an attractor to inflation in Nepal? The findings suggest that the exchange rate peg transmits price developments from India, but not in a straightforward way. The evidence emerges only after the transitory components of headline inflation in Nepal and India are isolated. In the long run, core inflation in Nepal converges with core inflation in India. When the two deviate in the short run, the speed of adjustment to the long-run equilibrium is about 7 percent per month, suggesting that the pass-through time period from India to Nepal is about seven to eight months.

Figure 4. Nepal: Deviation Between Headline Inflation and Core Inflation Measure

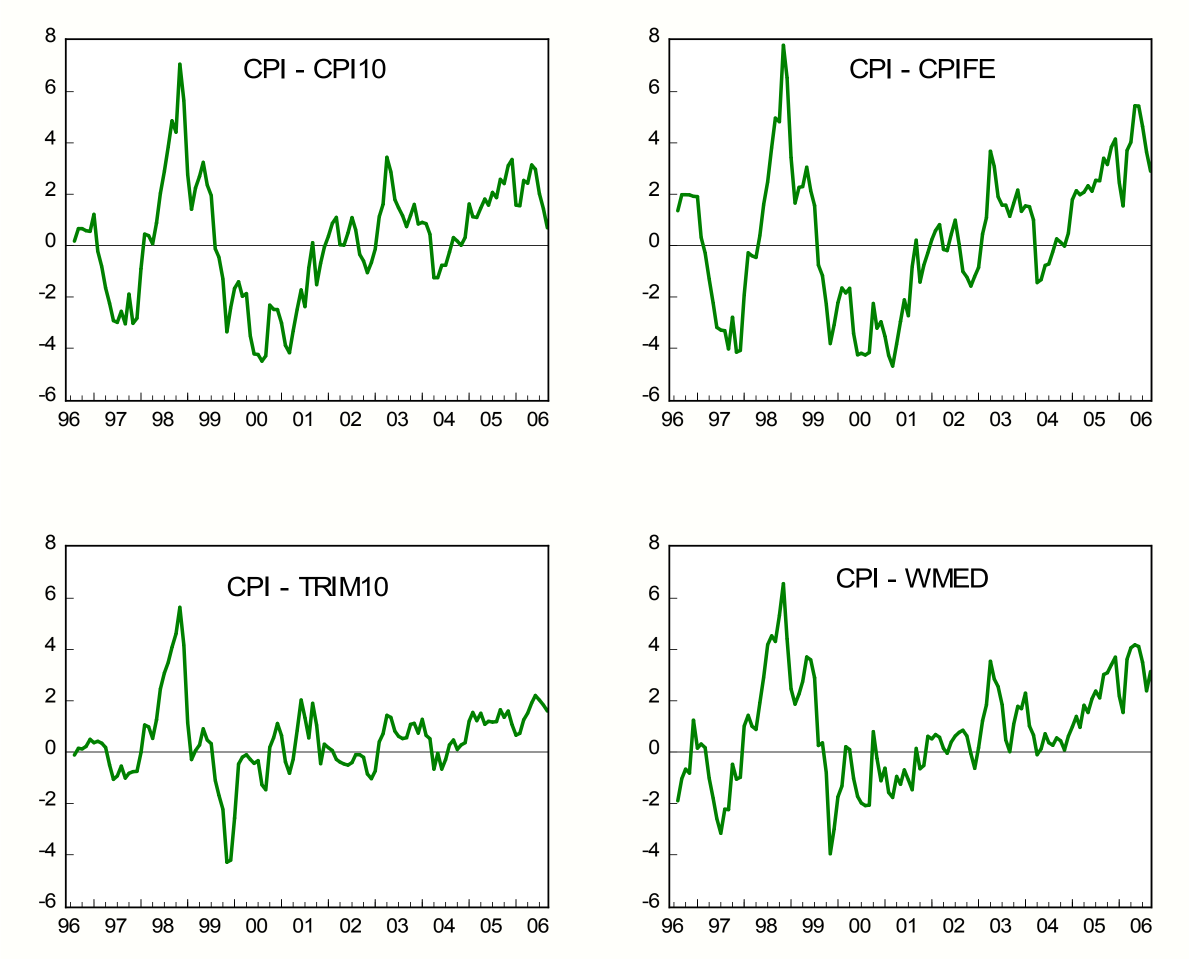


Figure 5. India: Deviation Between Headline Inflation and Core Inflation Measure

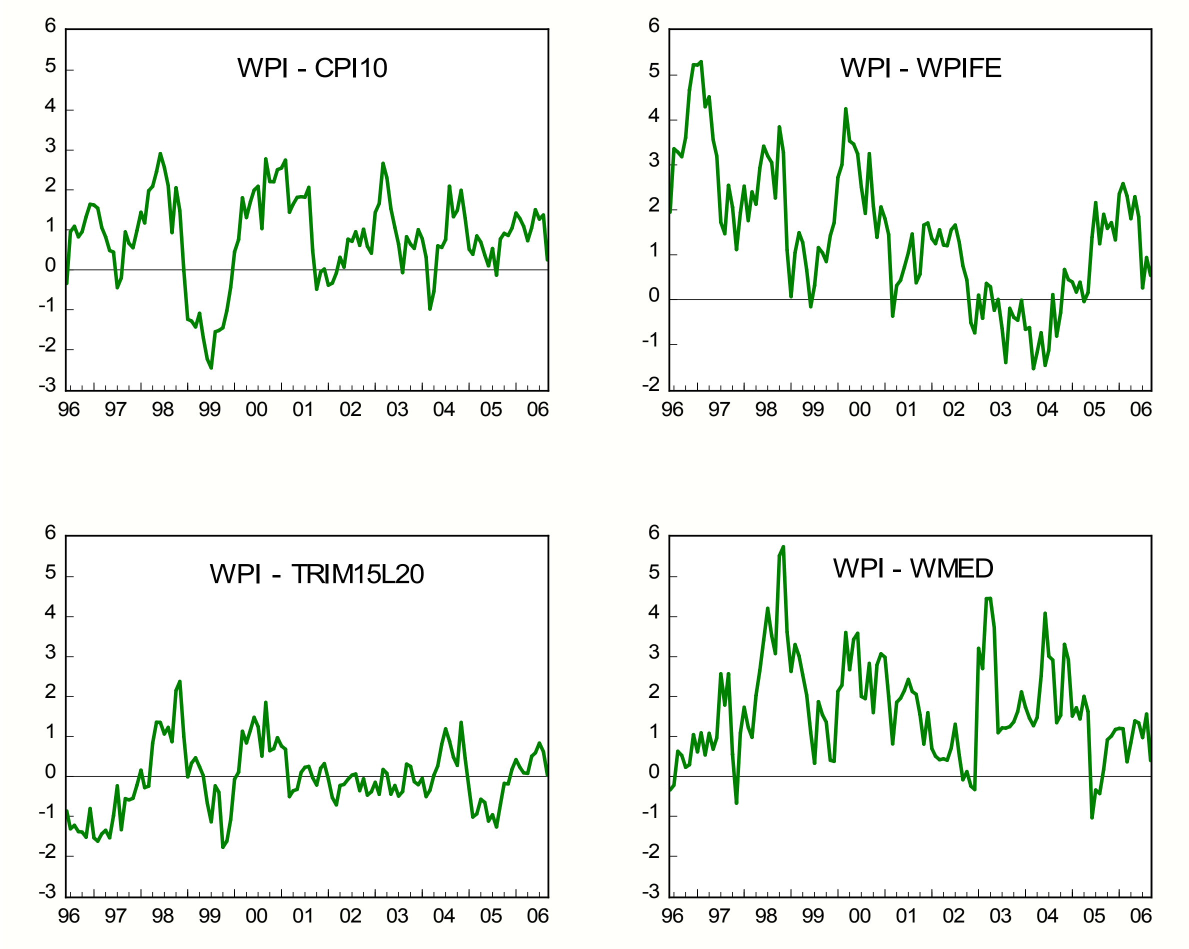
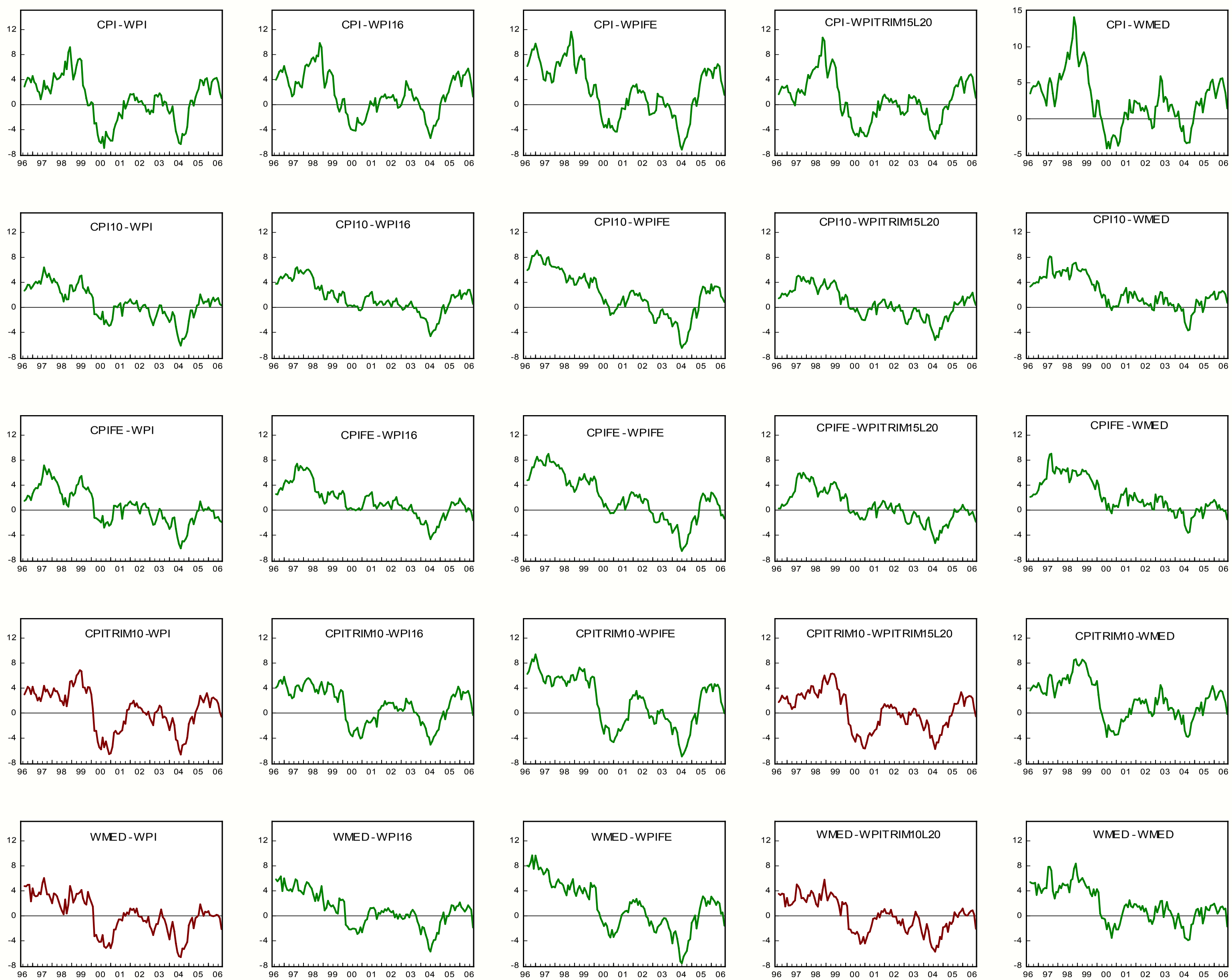


Figure 6. Deviation of Inflation Measures in Nepal and in India



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Appendix I

Table I.1. Nepal: Weights and Volatility of Components in CPI Basket, 1996:08¬2006:09

Item		Weight	Standard Deviation
1	House rent	0.9	4.2
2	House furnishing and household goods	1.6	3.5
3	Clothings	2.4	5.7
4	Cloths	2.7	2.3
5	Meat, fish, and eggs	2.7	5.2
6	Cleaning supplies	2.7	1.3
7	Medical care	2.9	6.2
8	Other grains and cereal products	2.9	2.0
9	Footwear	3.2	2.2
10	Personal care	3.4	1.8
11	Restaurant meals	3.6	6.9
12	Milk and milk products	3.8	4.1
13	Tobacco and related products	4.0	1.7
14	Sewing services	4.1	0.9
15	Private transport	4.1	1.1
16	Alcoholic beverages	4.2	1.5
17	Religious activities	4.6	0.7
18	Communication	5.0	0.4
19	Reading and recreation	5.3	1.6
20	Education	5.5	4.8
21	Nonalcoholic beverages	7.3	0.8
22	Pulses	7.7	2.7
23	Public transport	7.9	2.5
24	Spices 1/	8.9	1.8
25	Fuel, light, and water 1/	9.1	5.9
26	Sugar and related products 1/	9.5	1.2
27	Fruits 1/	10.3	1.6
28	Rice and rice products 1/	10.9	14.2
29	Wheat and wheat flour 1/	13.2	1.8
30	Nuts 1/	14.7	0.1
31	Oil and ghee 1/	15.4	3.1
32	Leafy green vegetables 1/	16.5	1.1
33	Vegetables without leafy green 1/	19.9	5.1

Sources: Nepalese authorities; and staff calculations.

1/ Excluded from CPI10.

Appendix I

Table I.2. India: Weights and Volatility of Components in CPI Basket, 1996:06¬2006:09

Item		Weight	Standard Deviation
1	Transport equipment	4.29	2.6
2	Dyestuffs and indigo	0.18	2.8
3	Rubber and plastic	2.39	3.5
4	Machinery	8.36	3.6
5	Cocoa, chocolate, sugar, and confectionary	0.09	3.8
6	Fertilizer and pesticide	4.16	3.9
7	Other nonfood primary products	1.95	3.9
8	Beverages, tobacco, and tobacco products	1.34	4.1
9	Matches, explosives, and others	0.94	4.1
10	Milk	4.37	4.6
11	Paints, vanishes, and lacquers	0.50	4.8
12	Dairy products	0.69	5.2
13	Textiles	9.80	5.4
14	Perfumes, cosmetics, and toiletries	0.98	5.5
15	Other manufactured food	0.15	5.6
16	Electricity	5.48	5.9
17	Other mineral	0.19	6.2
18	Bakery products	0.44	6.3
19	Nonmetallic mineral products	2.52	6.5
20	Paper and paper products	2.04	7.2
21	Nonferrous metals	1.47	7.3
22	Egg, meat, and fish	2.21	8.1
23	Cereals	4.41	8.3
24	Basic heavy inorganic chemical	1.45	8.3
25	Leather and leather products	1.02	8.5
26	Sugar, khandsari, and gur	3.93	8.7
27	Drugs and medicine	2.53	8.9
28	Basic metals and alloys	6.88	8.9
29	Pulses	0.60	10.2
30	Oil seeds	2.67	10.4
31	Turpentine and synthetic resins	0.75	10.6
32	Grain mill products 1/	1.03	11.0
33	Fruits 1/	1.46	12.1
34	Minerals oils 1/	6.99	12.1
35	Coal mining 1/	1.75	12.4
36	Condiments and spices 1/	0.66	13.0
37	Edible oils 1/	2.76	13.1
38	Nonfood fibers 1/	1.52	13.6
39	Oil cakes 1/	1.42	13.7
40	Processed fish 1/	0.05	15.0
41	Tea and coffee 1/	0.97	16.5
42	Wood and wood products 1/	0.17	18.0
43	Other food 1/	0.24	19.7
44	Basic heavy organic chemical 1/	0.45	19.8
45	Salt 1/	0.02	27.6
46	Vegetables 1/	1.46	40.6
47	Metallic minerals 1/	0.30	57.1

Sources: Indian authorities; and staff calculations.

1/ Excluded from WPI16.

Appendix I

Table I.3. Nepal: Alternative Measures of Inflation, August 1996¬September 2006

Month	CPI	CPIFE	CPI10	TRIM10	WMED	Month	CPI	CPIFE	CPI10	TRIM10	WMED	Month	HCPI	CPINRB	CPI10	TRIM10	WMED
Aug-96	8.0	6.7	7.9	8.2	9.9	Jan-00	4.0	6.3	5.7	6.6	5.8	Jun-03	6.6	4.9	4.8	5.8	4.0
Sep-96	8.6	6.6	7.9	8.4	9.6	Feb-00	4.6	6.2	6.0	5.0	5.9	Jul-03	6.1	4.5	4.6	5.5	4.2
Oct-96	9.0	7.0	8.3	8.8	9.6	Mar-00	3.4	5.3	5.4	3.6	3.2	Aug-03	5.4	4.2	4.2	4.8	4.9
Nov-96	9.0	7.0	8.4	8.8	9.8	Apr-00	3.3	5.0	5.2	3.4	3.2	Sep-03	5.2	4.4	4.5	4.6	5.2
Dec-96	9.0	7.1	8.5	8.5	7.8	May-00	1.7	5.1	5.2	2.0	2.7	Oct-03	5.6	4.4	4.5	4.6	4.5
Jan-97	9.6	7.7	8.4	9.3	9.5	Jun-00	0.7	5.0	4.9	1.2	2.4	Nov-03	5.8	4.1	4.2	4.7	4.0
Feb-97	9.3	9.0	9.5	8.9	9.0	Jul-00	0.4	4.6	4.7	0.8	2.4	Dec-03	4.9	3.7	4.1	4.2	3.2
Mar-97	8.7	9.0	9.5	8.3	8.5	Aug-00	1.0	5.2	5.5	2.3	3.1	Jan-04	5.0	3.6	4.1	3.7	2.7
Apr-97	7.7	9.0	9.3	7.5	8.7	Sep-00	1.0	5.2	5.3	2.5	3.1	Feb-04	4.7	3.5	3.9	4.1	3.7
May-97	6.8	9.0	9.0	7.3	8.6	Oct-00	2.9	5.2	5.2	2.7	2.1	Mar-04	4.4	3.8	3.9	3.8	3.7
Jun-97	6.1	9.3	9.0	7.2	8.7	Nov-00	2.7	5.9	5.2	2.2	3.0	Apr-04	1.7	3.4	3.0	2.4	1.8
Jul-97	5.7	9.0	8.7	6.6	8.9	Dec-00	3.2	6.1	5.7	2.1	4.3	May-04	1.3	2.8	2.6	1.3	1.2
Aug-97	6.8	10.1	9.4	7.3	9.0	Jan-01	2.8	6.3	5.8	2.1	3.4	Jun-04	1.8	3.1	2.6	2.5	1.1
Sep-97	6.2	10.2	9.2	7.2	8.4	Feb-01	1.8	6.0	5.6	2.1	3.3	Jul-04	2.0	3.3	2.8	2.3	1.7
Oct-97	7.1	10.0	9.0	8.0	7.6	Mar-01	1.5	6.2	5.7	2.4	3.3	Aug-04	2.4	3.0	2.6	2.1	2.1
Nov-97	6.1	10.3	9.2	6.9	7.2	Apr-01	2.4	6.2	5.7	2.7	3.4	Sep-04	2.6	2.8	2.3	2.2	2.1
Dec-97	6.2	10.3	9.0	6.9	7.2	May-01	3.1	6.1	5.6	2.3	4.4	Oct-04	2.6	2.8	2.4	2.5	2.2
Jan-98	8.1	10.0	9.0	8.1	7.1	Jun-01	3.9	6.0	5.7	1.9	4.6	Nov-04	2.7	3.0	2.7	2.4	2.6
Feb-98	8.8	9.1	8.4	7.8	7.4	Jul-01	3.5	6.2	5.9	2.1	4.6	Dec-04	3.1	3.1	2.8	2.7	2.5
Mar-98	9.0	9.4	8.6	8.0	7.9	Aug-01	2.9	3.7	3.8	2.4	4.4	Jan-05	4.6	3.5	3.0	3.4	3.6
Apr-98	9.1	9.5	9.0	8.6	8.2	Sep-01	3.8	3.5	3.6	1.8	3.6	Feb-05	5.7	4.0	4.6	4.2	4.3
May-98	10.0	9.6	9.1	8.7	8.1	Oct-01	2.0	3.4	3.5	0.9	2.6	Mar-05	5.7	3.6	4.6	4.5	4.8
Jun-98	11.0	9.4	9.0	8.5	8.1	Nov-01	2.5	3.2	3.2	2.9	3.0	Apr-05	5.8	3.6	4.4	4.3	4.0
Jul-98	12.1	9.6	9.2	9.0	7.9	Dec-01	2.7	3.0	2.8	2.4	2.1	May-05	6.4	3.8	4.6	5.3	4.9
Aug-98	11.7	7.8	7.8	8.2	7.1	Jan-02	2.9	2.7	2.6	2.8	2.4	Jun-05	6.2	3.7	4.6	5.0	4.1
Sep-98	12.9	7.9	8.0	8.8	8.6	Feb-02	3.2	2.6	2.3	3.1	2.5	Jul-05	6.6	3.7	4.6	5.5	4.3
Oct-98	12.9	8.1	8.5	8.3	7.6	Mar-02	3.3	2.5	2.2	3.6	2.8	Aug-05	7.3	4.3	5.4	6.1	5.2
Nov-98	15.7	7.9	8.6	10.0	9.1	Apr-02	2.4	2.6	2.4	2.8	2.3	Sep-05	8.2	4.4	5.6	6.5	5.2
Dec-98	14.4	7.9	8.8	10.2	10.0	May-02	2.5	2.7	2.5	3.0	2.6	Oct-05	7.8	4.2	5.4	6.5	4.7
Jan-99	10.9	7.5	8.1	9.7	8.4	Jun-02	3.0	2.6	2.5	3.5	2.6	Nov-05	8.5	4.2	5.4	6.9	5.1
Feb-99	9.3	7.6	7.9	9.6	7.4	Jul-02	3.5	2.5	2.4	3.9	2.9	Dec-05	8.8	4.3	5.5	7.7	5.1
Mar-99	10.3	8.0	8.0	10.2	8.0	Aug-02	4.2	4.2	3.6	4.3	3.5	Jan-06	7.0	4.2	5.4	6.3	4.8
Apr-99	10.1	7.8	7.4	9.9	7.4	Sep-02	3.3	4.3	3.6	3.4	2.4	Feb-06	5.8	3.9	4.3	5.1	4.3
May-99	10.3	7.3	7.1	9.4	6.6	Oct-02	3.0	4.2	3.6	3.2	2.3	Mar-06	7.7	3.7	5.1	6.4	4.0
Jun-99	9.5	7.4	7.2	9.1	6.0	Nov-02	2.2	3.8	3.3	3.1	2.3	Apr-06	7.9	4.0	5.5	6.4	3.8
Jul-99	9.0	7.5	7.1	8.7	6.1	Dec-02	2.7	3.9	3.4	3.8	3.4	May-06	9.1	5.0	6.0	7.2	5.0
Aug-99	5.9	6.7	6.0	7.0	5.6	Jan-03	3.3	4.1	3.4	4.0	3.1	Jun-06	9.1	5.3	6.1	6.9	5.0
Sep-99	5.6	6.7	6.0	7.3	5.2	Feb-03	4.6	4.1	3.5	4.2	3.4	Jul-06	8.3	5.4	6.3	6.2	4.8
Oct-99	4.2	6.5	5.5	6.4	5.0	Mar-03	5.2	4.2	3.6	4.5	3.4	Aug-06	7.3	5.2	5.8	5.4	4.9
Nov-99	2.7	6.5	6.0	7.0	6.6	Apr-03	8.1	4.5	4.7	6.7	4.6	Sep-06	6.6	5.5	6.0	5.0	3.5
Dec-99	3.2	6.3	5.6	7.4	6.2	May-03	7.7	4.6	4.9	6.4	4.9						

Sources: Data provided by the Nepalese authorities; and staff calculations.

Appendix I

Table I.4. India: Alternative Measures of Inflation, April 1995¬September 2006

Month	WPI	WPIFE	WPI16	TRIM15L20	WMED	Month	WPI	WPIFE	WPI16	TRIM15L20	WMED	Month	WPI	WPIFE	WPI16	TRIM10	WMED
Apr-95	11.0	13.2	11.4	12.5	12.3	Feb-99	5.3	4.2	6.6	5.0	2.0	Dec-02	3.5	4.3	3.1	3.4	3.9
May-95	10.8	13.6	11.3	12.5	11.3	Mar-99	5.3	3.8	6.7	4.8	2.3	Jan-03	4.8	4.7	3.4	4.3	1.6
Jun-95	9.6	12.5	10.3	11.0	8.6	Apr-99	3.9	2.6	4.9	3.6	1.3	Feb-03	5.5	5.9	3.9	5.1	2.8
Jul-95	9.6	12.3	10.5	10.7	8.7	May-99	3.1	2.5	4.8	3.1	1.1	Mar-03	6.5	6.1	3.8	5.4	2.0
Aug-95	8.7	11.1	9.7	10.0	8.7	Jun-99	2.2	2.4	4.4	2.9	1.1	Apr-03	6.7	6.4	4.4	5.7	2.2
Sep-95	9.0	10.9	9.6	10.1	9.1	Jul-99	2.0	1.7	4.4	3.1	1.7	May-03	6.2	6.4	4.7	5.6	2.5
Oct-95	8.4	9.8	8.4	9.0	9.5	Aug-99	2.8	1.7	4.4	3.1	1.0	Jun-03	5.3	5.3	4.3	4.8	4.2
Nov-95	7.8	8.8	8.2	8.1	8.3	Sep-99	3.2	2.2	4.7	3.6	1.7	Jul-03	4.3	4.9	3.6	4.2	3.1
Dec-95	6.3	7.1	6.9	6.6	6.0	Oct-99	3.2	2.4	4.7	5.0	1.9	Aug-03	3.9	5.3	4.0	3.7	2.7
Jan-96	4.8	5.9	5.9	5.1	3.4	Nov-99	2.8	1.4	3.8	4.4	2.4	Sep-03	5.4	5.6	4.6	4.5	4.1
Feb-96	4.6	5.0	5.6	5.3	3.6	Dec-99	3.3	1.5	3.7	4.3	2.9	Oct-03	5.1	5.5	4.5	4.3	3.8
Mar-96	4.4	3.5	5.1	5.4	4.3	Jan-00	3.6	0.9	3.2	3.7	1.5	Nov-03	5.5	5.9	5.0	4.9	3.9
Apr-96	3.8	2.4	4.0	4.3	4.1	Feb-00	4.4	1.4	3.6	4.3	2.1	Dec-03	5.7	5.8	4.7	5.2	3.6
May-96	3.8	2.1	3.9	4.2	4.0	Mar-00	6.5	2.2	4.7	5.4	2.9	Jan-04	6.4	7.1	5.6	5.7	4.7
Jun-96	3.1	1.2	3.5	4.0	3.5	Apr-00	6.2	2.7	4.9	5.4	3.6	Feb-04	5.8	6.4	5.5	5.5	4.4
Jul-96	4.1	0.7	3.1	5.4	4.3	May-00	6.6	3.1	4.9	5.4	3.2	Mar-04	4.6	6.2	5.6	4.3	3.4
Aug-96	5.2	1.9	4.1	6.4	4.6	Jun-00	6.6	3.4	4.6	5.1	3.0	Apr-04	4.3	5.5	4.9	3.6	2.8
Sep-96	4.9	1.7	4.1	6.3	4.4	Jul-00	6.6	4.1	4.5	5.4	4.6	May-04	5.6	6.3	5.0	4.6	3.1
Oct-96	4.7	1.1	3.7	6.1	4.4	Aug-00	6.1	4.2	5.1	5.6	4.2	Jun-04	7.0	8.4	6.4	5.3	2.9
Nov-96	4.8	0.2	3.5	6.3	4.5	Sep-00	8.0	4.7	5.2	6.1	5.2	Jul-04	8.1	9.3	7.4	6.2	5.1
Dec-96	5.5	0.3	3.9	6.3	4.5	Oct-00	7.3	5.2	5.0	6.6	5.7	Aug-04	8.7	8.6	6.6	7.0	5.8
Jan-97	5.1	-0.2	3.5	6.6	4.5	Nov-00	7.8	6.4	5.6	7.2	5.0	Sep-04	7.3	8.1	6.0	6.0	6.0
Feb-97	5.7	0.4	4.2	7.4	4.6	Dec-00	8.6	6.6	6.1	7.7	5.6	Oct-04	7.5	7.8	6.0	6.4	6.0
Mar-97	5.4	1.1	4.3	6.8	4.9	Jan-01	8.6	6.8	6.0	7.8	5.6	Nov-04	7.3	6.6	5.3	5.3	4.0
Apr-97	5.5	1.0	4.7	6.8	4.4	Feb-01	7.5	6.1	4.8	6.8	5.5	Dec-04	6.7	6.2	5.4	5.2	3.8
May-97	4.8	1.2	4.3	6.3	4.1	Mar-01	5.5	5.9	4.1	6.0	4.7	Jan-05	5.1	4.7	4.6	4.2	3.6
Jun-97	5.3	2.1	4.8	6.3	4.3	Apr-01	5.5	5.2	3.9	5.9	3.7	Feb-05	5.1	4.9	4.7	4.6	3.3
Jul-97	3.6	1.9	4.1	3.9	1.1	May-01	5.6	5.2	3.8	5.9	3.6	Mar-05	5.1	4.7	4.3	4.6	3.7
Aug-97	3.0	1.5	3.2	4.3	1.2	Jun-01	5.2	4.5	3.4	5.1	3.1	Apr-05	6.0	6.1	5.3	5.3	4.0
Sep-97	3.8	1.2	2.8	4.3	1.2	Jul-01	5.2	4.1	3.3	4.9	2.7	May-05	5.3	5.1	4.9	4.7	3.6
Oct-97	4.2	2.2	3.6	4.8	3.7	Aug-01	5.1	3.7	3.1	4.9	3.0	Jun-05	4.3	2.9	4.2	4.1	5.3
Nov-97	3.7	2.6	3.2	4.3	4.4	Sep-01	3.2	2.8	2.7	3.2	1.1	Jul-05	4.2	2.0	3.6	4.0	4.5
Dec-97	4.4	2.5	3.4	4.7	3.4	Oct-01	2.7	2.1	3.1	2.9	1.1	Aug-05	3.3	2.1	3.5	3.2	3.8
Jan-98	5.1	2.5	3.6	4.9	3.3	Nov-01	2.5	0.8	2.5	2.3	1.7	Sep-05	4.3	2.4	3.6	3.5	4.2
Feb-98	3.8	2.0	2.6	4.1	2.6	Dec-01	1.8	0.1	1.8	1.5	0.2	Oct-05	4.8	3.2	3.8	3.7	3.8
Mar-98	4.5	2.1	2.5	4.8	3.5	Jan-02	1.3	-0.1	1.7	1.3	0.6	Nov-05	4.5	2.8	3.6	3.5	3.5
Apr-98	5.0	2.9	3.0	4.2	3.0	Feb-02	1.6	0.3	1.9	2.1	1.1	Dec-05	4.6	3.2	3.5	3.7	3.4
May-98	5.8	2.9	3.4	4.5	3.2	Mar-02	1.6	0.1	1.7	2.4	1.2	Jan-06	4.0	1.7	2.6	2.8	2.8
Jun-98	6.6	3.2	3.7	5.3	3.2	Apr-02	1.8	0.5	1.4	2.0	1.3	Feb-06	4.2	1.6	2.9	3.0	3.0
Jul-98	7.1	3.9	4.5	6.0	2.9	May-02	1.4	0.2	1.4	1.6	1.0	Mar-06	4.1	1.8	3.0	3.1	3.7
Aug-98	6.9	3.9	4.8	5.7	3.4	Jun-02	2.7	1.1	1.9	2.7	2.0	Apr-06	3.9	2.1	3.2	2.9	3.1
Sep-98	5.9	3.7	5.0	5.1	2.9	Jul-02	3.0	1.4	2.3	3.0	1.7	May-06	5.0	2.7	3.9	3.6	3.6
Oct-98	7.2	3.4	5.1	5.0	1.7	Aug-02	3.7	2.4	2.7	3.6	3.1	Jun-06	4.8	3.0	3.3	3.3	3.5
Nov-98	7.3	4.0	5.8	4.9	1.5	Sep-02	3.3	2.5	2.7	3.6	3.4	Jul-06	4.7	4.5	3.4	3.3	3.7
Dec-98	5.2	4.1	5.2	4.2	1.6	Oct-02	3.1	2.7	2.1	3.2	3.0	Aug-06	5.3	4.3	3.9	4.0	3.7
Jan-99	4.6	4.5	5.8	4.6	2.0	Nov-02	3.3	3.8	2.7	3.8	3.6	Sep-06	5.6	5.1	5.4	4.9	5.2

Sources: CEIC; and staff calculations.

APPENDIX II: MEASURES OF CORE INFLATION

Exclusion-based measures

Exclusion-based measures are derived by permanently excluding certain components that are considered to be particularly volatile from the price index. The measure is computed by giving zero weight to the excluded components. The remaining weights are rescaled, which implicitly gives more weight to the components of price index that are less subject to shocks. The resulting measures of core inflation can be considered a practical quantification of persistent or generalized element of inflation (Roger, 1998).

Economic theory calls for exclusion of certain components, since they are likely to be more affected by supply shocks. The standard exclusions are food and energy. The exclusion of seasonal food items is based on the observation that their supply is heavily influenced by changes in weather conditions. Given their relatively low elasticity of demand, a shift in supply can cause relatively large changes in prices and consequently in aggregate inflation. The case for excluding energy is less clear cut. Although volatility in energy prices is driven by temporary global oil supply, conditions provide a valid reason for exclusion, persistent global demand conditions will likely also have a significant influence on the prices of these commodities. Therefore, energy prices may contain useful information about core and underlying inflation.

Food and energy are not always the most volatile components of the price index. In some countries all food prices are excluded even when only some seasonal components are more volatile (Cutler, 2001). Another approach is to exclude the most volatile components of the price index based on historical data rather than excluding standard items such as food and energy. The selection for exclusion can be based on empirical work to assess the volatility of all components of the price index and their longevity. One important weakness of this approach is that the appropriate components to exclude may change over time.

The advantage of the exclusion-based measures is that they are timely and easy to calculate and explain to public. The composition of the underlying basket is unchanged in each period, so it can be consistently compared over time. The adoption of such standard exclusions used in many countries has the advantage that the authorities are not perceived to be manipulating the target. However, in this approach the shocks and transient components of inflation are often defined as sector-specific and, hence, efforts to separate this component can lead to the removal of the sectors. Mohanty and others (1999) suggest that exclusion-based measures are inadequate for developing countries for three reasons. First, a large number of commodities show price volatility over time and it would not be appropriate to exclude them all. Second, the basket of volatile commodities shifts over time due to structural transformation. Finally, primary commodities form a sizeable part of the basket and are crucial in the formation of price expectation.

Limited influence estimators

Bryan and Cecchetti (1993) develop a limited influence estimator approach (also called order statistics) to address the possibility that the appropriate subcomponents for exclusion may change over time. This approach does not require a priory judgment concerning which components of price changes are included or excluded permanently. The measures are calculated by excluding a certain percentage of the largest and smallest (weighted) price changes in the components of the index.

Ball and Mankiw (1994) provide some theoretical support for limited-influence measures of core inflation. Based on the observation of nonnormal cross-section distribution of price changes and a static model with menu costs, they show that idiosyncratic supply shock will lead to temporary increases in the mean of inflation. They suggest that supply shocks can lead to a skewed distribution of price changes and that the values in the tail of the cross-sectional distribution represent temporary shocks and, hence, contain less information about current underlying price pressures than those further toward the centre of the distribution.

The limited-influence measures are computed by first ordering cross-section price changes. Then the cumulative weight $W_{i,t}$ is calculated for each sorted price changes to define

$$I_{\alpha} = \{i : \frac{\alpha}{100} < W_{i,t} < 1 - \frac{\alpha}{100}\}$$

The formula used to compute α percent trimmed-mean inflation can be expressed as follows:

$$TRIM_{t}(\alpha) = \frac{1}{1 - 2(\alpha / 100)} \sum_{i \subset I_{\alpha}} w_{(i),t} \pi_{(i),t}$$

Where $TRIM_{\alpha}$ is the trimmed measure, $\pi_{(i),t}$ and $w_{(i),t}$ are ordered components of price changes data and their associated weights, and α denotes the size of a trimmed subcomponent from each tail of the distribution. For α = 0, the trimmed-mean inflation would equal the weighted sample mean. In the case of α = 50, the formula (2) will calculate the weighted median.

Like exclusion-based measures, trimmed-based measures are also timely and can be easily computed and verified. However, these measures have two main disadvantages. First, it is more difficult to explain changes over time with these measures compared with exclusion-based measures. To understand monthly changes, it is necessary to keep track of which components are excluded in that month. Second, trimmed-based measures may be sensitive to changes in the degree of nonnormality of the cross-sectional distribution of price changes. Therefore, they may not be less volatile than headline inflation if there are substantial changes to the shape of the distribution price changes each month.

Appendix III

Table III. Augmented Dickey-Fuller Test Statistics

Variable	Level (t-statistic)	First Difference (t-statistic)
Nepal		
CPI	-0.96	-8.92
CPI10	-0.85	-11.12
CPIFE	-0.93	-10.57
TRIM10	-1.09	-10.83
WMED	-1.71	-12.01
India		
WPI	-0.62	-9.54
WPI16	-0.44	-9.78
WPIFE	-0.67	-9.33
TRIM15L20	-0.49	-9.81
WMED	-1.14	-13.00

Source: Staff calculations.

1/ The critical value for the ADF test with 123 observations (model without constant) are -2.58 for a 1 percent test and -1.94 for a 5 percent test (MacKinnon, 1996).