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Business Cycle Asymmetry and Seasonal Fluctuations: Some Stylized Facts from the Indian Economy

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Abstract

This paper tests for business cycle asymmetry in Indian macroeconomic time series using data at annual and sub-annual frequencies. We find evidence of asymmetry in industrial production only in sub-annual frequency data, and even this vanishes upon seasonal adjustment using seasonal dummies.

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Consumer price index and bank rate, on the other hand, exhibit asymmetry in annual data, but not in data at higher frequencies. This suggests that seasonal fluctuations are complex in nature.

1 Introduction

The behaviour of several macroeconomic variables is asymmetric over phases of the business cycle. Over the past two decades, this aspect has been studied empirically for several countries. Without exception, such studies are confined to data from developed countries; no attempt appears to have been made to examine the behaviour of business cycles in developing countries. This paper, in contrast, focuses exclusively on the business cycle dynamics of Indian macroeconomic data. The question we address is as follows: Are there asymmetries in behaviour of Indian macroeconomic variables over different phases of the business cycle?[3]

Frequently, empirical studies related to business cycles have been conducted using seasonally adjusted data. This has been done under the assumption that seasonal cycles are both regular and devoid of any economic information. However, current research has shown[4] that neither of these two assumptions may be correct. Indeed, it has been found that seasonal adjustments distort the data in several ways and this may lead to misleading inferences in the studies which use seasonally adjusted data. Further, seasonal fluctuations contain important information related to the working of

[3]Though Sinha and Kumawat (2000) present a number of stylised facts related to the business cycles in the Indian economy, the question of business cycle asymmetry is ignored altogether in that study. In this sense, the present note is complementary to that study.

[4]A brief review of the relevant literature is presented in Kumawat (2003).

the economy and this information would be lost if one worked with seasonally adjusted data.

In view of this, we study data at multiple frequencies: annual, quarterly and monthly. While using sub-annual frequency data, we consider both the seasonally adjusted (for deterministic seasonality) and unadjusted data. The difference between results from annual and seasonally unadjusted sub-annual frequency data provides information about the behaviour of the variable over seasonal cycles. The difference between the results from seasonally unadjusted and adjusted sub-annual frequency data, on the other hand, provides information about the nature of seasonal cycles. For instance, if the results from seasonally unadjusted sub-annual frequency data are similar to those from annual frequency data, it indicates that seasonal fluctuations are predominantly deterministic in nature.

We find that there is evidence of asymmetries in the dynamics of certain Indian macroeconomic data over phases of the business cycle. However, there are substantial differences in the nature of asymmetries in annual and sub-annual frequency data. Also, adjustment for deterministic seasonality alters the evidence regarding asymmetries.

The rest of this paper is organised as follows. Section 2 discusses alternative types of business cycle asymmetries and the methodology used to test for these. Section 3 applies these methodologies to Indian macroeconomic data and highlights the results obtained. The final section concludes.

2 Methodology

Let $\{y_t : t = 1, 2, \ldots\}$ be a certain data series that is annual in frequency. This series can be decomposed into three components:

$$y_t = \tau_t + c_t + \epsilon_t, \tag{1}$$

where τ_t is the non-stationary trend component of the series, c_t is its cyclical component, and ϵ_t is the irregular component, satisfying three standard properties: $E(\epsilon_t) = 0$, $E(\epsilon_t^2) = \sigma_\epsilon^2$, and $E(\epsilon_t \epsilon_s) = 0$, $\forall\ t \neq s$. If the data series $\{y_t : t = 1, 2, \ldots\}$ are at sub-annual frequencies, then (absent seasonal adjustments), the following decomposition is valid:

$$y_t = \tau_t + c_t + s_t + \epsilon_t, \tag{2}$$

where s_t represents the seasonal component of the series. When examining asymmetries, we concentrate on the cyclical component of y_t (that is, c_t).

Sichel (1993) terms a series as exhibiting (negative) *deepness* asymmetry in case it shows the following two features: (1) it remains above the trend for longer periods than below the trend, and (2) the cyclical troughs are normally further below trend (in absolute level) than the cyclical peaks are above trend. Thus, the concept of deepness is associated with an asymmetry in the reflection of the series in the horizontal plane around the mean of the series.

When a series displays signs of (negative) deepness asymmetry, the series will be skewed negatively about its non-stationary trend, with more observations above trend than below. Therefore, (negative) deepness asymmetry can be tested by checking for negative skewness in the cyclical component of the series, the sample measure for which is given by:

$$D(c) = \frac{\sum(c_t - \bar{c})^3}{T[\sigma(c)]^3}. \tag{3}$$

Sichel's test for deepness asymmetry proceeds in three steps. In the first step, corresponding to observation t, we construct the variable $z_t \equiv [(c_t - \bar{c})^3]/[\sigma(c)]^3$. Here, $\bar{c}$ is the sample mean of c_t, T is the sample size, and $\sigma(c)$ is the standard deviation of c_t.[5] In the second step, we regress z_t on a constant. The estimated coefficient of the constant term is equal to the statistic given in equation (3). Given the possibility of serial correlation in the errors, the standard error of this statistic is obtained using the method suggested by Newey and West (1987)[6]. In the third step, the ratio of the statistic $D(c)$ to its standard error is computed. This follows the student's t distribution.

Another dimension of asymmetry emphasised by Sichel (1993) is the *steepness* of a series. A series is said to exhibit (negative) steepness asymmetry if contractions are steeper and shorter-lived than expansions. The concept of steepness is related to *changes* in the value of the cyclical component. A series with (negative) steepness asymmetry shows the following pattern: the negative values of change will be fewer in number but larger in magnitude than the positive values of change.

When a series displays signs of (negative) steepness asymmetry, changes in the cyclical component will be negatively skewed. Therefore steepness can be tested by checking for skewness in the difference of cyclical component,

[5] The cyclical component, c_t, is extracted from the original series by detrending using the Hodrick-Prescott filter.

[6] It has been found that results are highly sensitive to the number of lags used for computing the serial correlation robust standard errors. For this exercise, we have used 14 lags for annual data, 60 lags for quarterly data and 170 lags for monthly data.

the sample measure for which is given by:

$$S(c) = \frac{\sum(\Delta c_t - \Delta\bar{c})^3}{T[\sigma(\Delta c)]^3}. \tag{4}$$

Here, Δc_t is $(c_t - c_{t-1})$, $\Delta\bar{c}$ is the sample mean of Δc and $\sigma(\Delta c)$ is the standard deviation of Δc_t. Again the test proceeds by constructing a variable $z_t' \equiv [(\Delta c_t - \Delta\bar{c})^3]/[\sigma(\Delta c)]^3$, regressing it on constant, and finally computing the t-statistic for the estimated coefficient of the constant term using the standard error suggested by Newey and West (1987).

3 Results

In total, twelve variables have been considered in this study. These are the index of industrial production, (IIP); three price variables (the consumer price index, CPI; the wholesale price index, WPI; and the share price index, SPI); three monetary variables (total money supply, MS; credit from the Reserve Bank of India, CRRB; and domestic credit, DOMC); two interest rates (inter-bank call money rate, CMR; and bank rate, BKR); and three variables related to the external sector (total exports, X; total imports, M; and the exchange rate, EXR). The data have been taken from the IMF International Financial Statistics. The data series for the variables correspond to different sub-periods of the 1960-2003 period.

We first test for deepness and steepness asymmetry of the aforementioned series using *annual data*. The results obtained are given in table 1. With annual data, none of the variables show significant deepness asymmetry; however, CPI and BKR show significant positive steepness asymmetry.

What happens when we test for asymmetries with *quarterly data*? The left panel of table 2 shows the results obtained when the series are used in unadjusted form. In contrast, the right panel shows the results obtained once the seasonal components have been removed from the series (using a regression of the series on seasonal dummies)[7]. With unadjusted quarterly data, IIP and CPI show significant negative steepness asymmetry; however, the evidence in favour of asymmetry vanishes once seasonal adjustments are made.

Finally, table 3 shows what is obtained when the frequency of the data is increased further to *monthly*. With unadjusted monthly data, IIP shows positive deepness asymmetry and negative steepness asymmetry. Again, this evidence vanishes once we use the data with seasonal components removed. Note also that the evidence for asymmetry in CPI found in annual and quarterly data (refer to tables 1 and 2) disappears in monthly data.

4 Conclusions

There is evidence of asymmetries in the behaviour of certain Indian macroeconomic variables over different phases of the business cycle. However, this evidence varies across different data frequencies. We also note that results obtained depend critically on whether the data used are seasonally adjusted or not.

[7]Specifically, each HP-filtered series was regressed on seasonal dummies to obtain the seasonally adjusted series.

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Table 1: Measures of asymmetry for annual data

Variable[1]	**Deepness**		**Steepness**	
	Coef	p-value[2]	Coef	p-value
IIP	-0.0424	0.889	0.0880	0.514
CPI	0.1630	0.528	0.1123	0.014*
WPI	-0.0046	0.986	-0.1935	0.411
SPI	0.2251	0.273	-0.2471	0.168
MS	-0.2476	0.379	0.3463	0.181
DOMC	0.1777	0.143	-0.3114	0.152
CRRB	-0.5888	0.137	0.2830	0.267
CMR	-0.5179	0.424	-0.1415	0.662
BKR	0.1481	0.569	0.6264	0.008**
EXR	-0.0182	0.857	0.1615	0.455
X	-0.0293	0.0885	0.0302	0.833
M	0.4869	0.155	-0.2622	0.241

[1] IIP is the index of industrial production, CPI is the consumer price index, WPI is the wholesale price index, SPI is the share price index, MS is the money supply, DOMC is domestic credit, CRRB is credit from the Reserve Bank of India, CMR is the call money rate, BKR is the bank rate, EXR is the exchange rate, X is total exports, and M is total imports.

[2] The standard errors used in computing the p-values are serial correlation-robust.

* Significant at the 5 percent level.

** Significant at the 1 per cent level.

Table 2: Measures of asymmetry for quarterly data

Variable[1]	Unadjusted[2]				Adjusted[3]			
	Deepness		Steepness		Deepness		Steepness	
	Coef	p-value[4]	Coef	p-value	Coef	p-value	Coef	p-value
IIP	-0.0369	0.792	-0.4126	0.019*	-0.1224	0.337	-0.0661	0.284
CPI	0.0780	0.629	-0.1915	0.014*	-0.0681	0.663	0.0483	0.643
WPI	0.0974	0.597	0.0699	0.428	-0.0213	0.922	0.0558	0.405
SPI	0.1894	0.183	0.0314	0.744	0.1988	0.163	-0.1176	0.237
MS	0.0880	0.396	-0.5134	0.147	0.1472	0.332	-0.8002	0.194
DOMC	-0.1256	0.334	-0.0702	0.373	-0.0830	0.510	0.0451	0.748
CRRB	-0.2388	0.269	0.0231	0.721	-0.2081	0.316	-0.1410	0.267
CMR	-0.0111	0.941	-0.1546	0.285	-0.1119	0.570	-0.4049	0.198
BKR	-0.1329	0.451	0.0425	0.888	-0.0954	0.571	0.0287	0.920
EXR	0.0945	0.634	0.5788	0.091	0.1982	0.169	0.5769	0.118
X	0.1223	0.339	-0.0013	0.990	0.1561	0.153	-0.0340	0.795
M	-0.0151	0.900	-0.1884	0.055	0.0845	0.455	-0.0567	0.590

[1] IIP is the index of industrial production, CPI is the consumer price index, WPI is the wholesale price index, SPI is the share price index, MS is the money supply, DOMC is domestic credit, CRRB is credit from the Reserve Bank of India, CMR is the call money rate, BKR is the bank rate, EXR is the exchange rate, X is total exports, and M is total imports.

[2] "Unadjusted" means that seasonal components have not been removed from the series.

[3] "Adjusted" means that seasonal components have been removed from the series (using a regression on seasonal dummies).

[4] The standard errors used in computing the p-values are serial correlation-robust.

[*] Significant at the 5 percent level.

[**] Significant at the 1 per cent level.

Table 3: Measures of asymmetry for monthly data

Variable[1]	Unadjusted[2]				Adjusted[3]			
	Deepness		Steepness		Deepness		Steepness	
	Coef	p-value[4]	Coef	p-value	Coef	p-value	Coef	p-value
IIP	0.3679	0.000**	-0.2666	0.029*	-0.2189	0.054	0.0878	0.427
CPI	0.1648	0.397	0.0751	0.414	0.0128	0.936	0.0993	0.175
WPI	0.0736	0.729	0.0425	0.612	0.0029	0.990	0.0967	0.068
SPI	0.2790	0.088	0.1811	0.271	0.2354	0.100	0.0856	0.430
MS	0.2378	0.066	0.0248	0.737	0.2171	0.247	-0.0005	0.990
DOMC	-0.1213	0.340	0.0125	0.896	-0.2053	0.083	-0.0237	0.784
CRRB	-0.5256	0.201	0.2993	0.218	-0.3279	0.221	0.2663	0.220
CMR	0.2247	0.144	0.3569	0.154	0.2088	0.202	0.1570	0.191
BKR	-0.0935	0.532	-0.1079	0.891	-0.1330	0.359	-0.1951	0.793
EXR	0.2372	0.127	1.2775	0.171	0.2793	0.082	1.2845	0.178
X	-0.0162	0.919	0.0844	0.277	0.101	0.212	0.1980	0.002**
M	0.2456	0.106	0.0279	0.740	0.1502	0.197	0.0871	0.179

[1] IIP is the index of industrial production, CPI is the consumer price index, WPI is the wholesale price index, SPI is the share price index, MS is the money supply, DOMC is domestic credit, CRRB is credit from the Reserve Bank of India, CMR is the call money rate, BKR is the bank rate, EXR is the exchange rate, X is total exports, and M is total imports.

[2] "Unadjusted" means that seasonal components have not been removed from the series.

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