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Changing Pattern of Seasonality in Prices and Industrial Production in India

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The changing pattern of seasonality reflects the changing structure of the economy. The analysis of the seasonal factors of the select variables has shown that overall seasonality has undergone a downward shift in almost all the selected economic variables. This is an indication that the economy is becoming less susceptible to the shocks during the year. Decreasing seasonal variations in prices indicate better supply management. Seasonal patterns of industrial production broadly reflect the busy and slack seasons. It is also observed that the seasonal variations in one industry are transmitted to other related industries through supply and demand channels. The pattern reflects the synergies across the industry groups.

JEL Classification: E 32, C 22

Keywords: Seasonality, Industrial Production, Prices.

Introduction

Background

The changing pattern of seasonality reflects the changing structure of the economy, technological improvements, changes in business environment due to increasing openness of the economy, changes due to maturity of the markets in the light of liberalisation and increase in competition from both domestic and foreign players. While seasonality of some of the variables is expected to decrease as an effect of these changes, the variation in some others might increase. Monthly seasonal factors for select macroeconomic time series are

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being regularly published in the Reserve Bank of India Bulletin (RBI, 2004) since 1980. These articles essentially present the seasonal factors estimated on the basis of 10 years of monthly data for over 60 variables.

Objective of the Study

This study focuses on two major aspects, namely, prices and industrial output, at different levels of disaggregation, viz., WPI - All Commodities, Food Articles, Manufactured Products; Index of Industrial Production - General, Basic Goods, Intermediate Goods, Capital Goods and Consumer Goods. An attempt is made to analyse the variations in seasonality in these variables. Data on both these variables are available for a sufficiently long period, with reasonably similar concepts and methodology across the time period. The seasonal patterns of WPI and its sub-groups and IIP are analysed for a period of two decades from 1982-83 to 2002-03. IIP - Use Based data series spans a period from 1990-91 to 2002-03. There are several methods for estimating the seasonal factors. A brief description of commonly used methods is provided in Annex I. In the present study, US Census Bureau's X-12 ARIMA method, which is one of the most popular one, is used.

The paper is organised in subsequent 4 sections. Section I provides a survey of relevant literature. Seasonal patterns in prices are discussed in Section II. Section II provides the seasonal patterns in industrial production. Concluding observations are given in Section IV.

Section I
Review of Literature

Rationale for Seasonal Adjustment

Time series is typically thought to be consisting of four components, viz., i) trend component, ii) seasonal component, iii) cyclical component and iv) error component. Of these, cyclical components have long periodicity ranging from 5 to 7 years. These components are attributed to business cycles in the economy and such other cyclical factors. Seasonal components reflect the fixed effects due to specific time of the year. The factors responsible for these components are thought to be, demand / supply patterns due to weather conditions, festivals, holidays and other events with fixed annual schedule. Although the seasonal effects are often referred to as fixed effects, they are in fact known to change gradually over the period. Error components, as the name suggests, are random in nature.

According to Bell and Hillmer (1984), traditionally the reasons given for seasonally adjusting data have been rather vague but they have broadly followed three themes: (i) to aid in short-term forecasting, (ii) to aid in relating the time series to other time series, external events and policy variables and (iii) to achieve comparability of time series values from month to month. They have given a possible justification for seasonally adjusting time series as: "Seasonal adjustment is done to simplify the data so that they may be more easily interpreted by statistically unsophisticated users without significant loss of information."

For the purpose of forecasting using ARIMA etc., and other rigorous econometric analysis, generally it is possible to take care of seasonality in the data by way of various econometric procedures. Thus, in such cases, it may not be essential to obtain the seasonally adjusted data. In fact, some authors have noted that it will be more appropriate to use the seasonal adjustment as part of the model rather than adjusting the time series externally. On the other hand, the use of time series data by the policy makers and administrators gets greatly facilitated, if seasonally adjusted data are used. This is because; it is the non-seasonal component of the time series, which may be possible to be controlled by government's intervention. The seasonal components are sticky, at least in the short run, due to peculiarities of the seasonal and institutional structures.

Even in respect of forecasting, it is to be noted that in spite of availability of sophisticated statistical techniques for forecasting, several users with little or no statistical training find seasonally adjusted data more convenient for forecasting. Bell and Hillmer

(1984) have provided further justification for seasonal adjustment, by treating the problem as a signal extraction problem. They contend that if there is reason to believe that the observed data are generated as a combination of seasonal and non-seasonal components, and if we are interested in separately analyzing either one or both these components, then it is appropriate to estimate them. The only question then remains is how best to estimate these components.

Presenting a time series from which the seasonal movements have been eliminated allows the comparison of data between two months or quarters for which the seasonal pattern is different. Also seasonal effects on non-adjusted or original data make it difficult to make valid comparisons over time using these data, particularly for the most recent period. Presentation of data on a seasonally adjusted basis allows the comparison of the evolution of different series, which have different seasonal patterns, and is particularly pertinent in the context of international comparisons since countries may be in different seasons at identical periods of the year for example Australia and Europe (OECD, 1999).

Policy-maker often needs information about the economic trends in the short-run. Since the short-term variability of economic time series often exhibit seasonal patterns and is greatly influenced by them, it is only by removing seasonal factors that turning points can be promptly identified; they cannot be readily identified either by changes over the previous period calculated on the raw data (which are affected by seasonal factors) or by changes over the corresponding period of the previous year, which reveal turning points long after they have occurred, since they are affected by developments over the whole year (Sabbatini, 2003).

Sources of Seasonal Variation

Traditionally, seasonal fluctuations have been considered to be of not much welfare consequence and are not thought to be associated with policy issues. In general, reducing the amplitude of the seasonal fluctuations was considered to be desirable. However, research in the field of business cycles brought forth a view that seasonal fluctuations are caused by technological change and shifts in preferences and hence they may represent efficient response to the these changes.

Braun and Evens (1994) and Chatterjee and Ravikumar (1992) extended real business cycle theory to the seasonal cycle. These authors showed that, by allowing seasonal shifts in tastes and technology, a real business cycle model produces seasonal variations consistent in many respects with the fluctuations observed. Exogenous shifts in technology may induce reallocation of production away from low productivity periods. Some commentators have suggested that policies to dampen the seasonal fluctuations might reduce welfare, as these would shift the economy from optimality to sub-optimal choices (Miron, 1990). The main idea of this approach is that concentration of economic activities may be due to synergies across agents, rather than to shifts in tastes or technologies.

Interaction of seasonal fluctuations with some distortions increases the effects of these distortions. Where these interactions are quantitatively important, stabilizing seasonal fluctuations might be an appropriate policy (Miron, 1990). Higher degree of seasonal fluctuations is also associated with high levels of unused capacity during the off-seasons. By stabilizing the seasonal variation in demand, the extent of under-utilization of resources could be reduced. Such policy can have desirable effects on output and welfare.

Seasonality also occurs due to synergy of various economic agents to concentrate activity at particular seasons, even when there is no significant variation in these seasons in terms of factors such as weather. This type of seasonality is not associated external factors such as shifts in preference or technology. Best example of such endogenous seasonality is the weekend. While such synergies tend to produce optimality in use of resources across the economic agents, the bunching may sometimes be excessive and might put strain on general capacities such as electricity, transport systems, over-crowding of holiday destinations etc.

Rather than relying solely on large shifts in technology or preferences, it may be more accurate to explain the magnitude of the seasonals as the result of relatively small seasonal shifts in preferences or technology combined with increasing returns or other synergies. These synergies can arise through a number of mechanisms. It may be desirable to produce at the same time as an upstream or downstream firm in order to avoid stockpiling raw materials or holding inventories of work in progress and finished goods. Firms may choose to close down completely so that maintenance or retooling can take place (Cooper and Haltiwanger 1996).

Empirical Observations in Other Countries

Beaulieu and Miron (1990a) have shown that seasonal dummies explain a large fraction of variation in aggregate output, suggesting that seasonal movements are highly correlated across sectors as well. They also showed that the seasonal patterns in consumption, investment, government expenditure, exports and imports, were strikingly similar to those in overall GDP, in the US economy.

Beaulieu and Miron (1990b) have studied seasonal cycles across several industrialized countries of northern and southern hemisphere. They demonstrate that there is a key role of the December retail sales in the production cycles across the countries. Last quarter peak and first quarter trough observed throughout the sample countries indicate that the role of weather is significantly less compelling in producing these seasonal cycles. They suggest that the synergies and increasing returns are the key factors that explain the seasonal variations. They also observe that output movements across sectors are highly correlated and nominal money moves together with the real output in these countries.

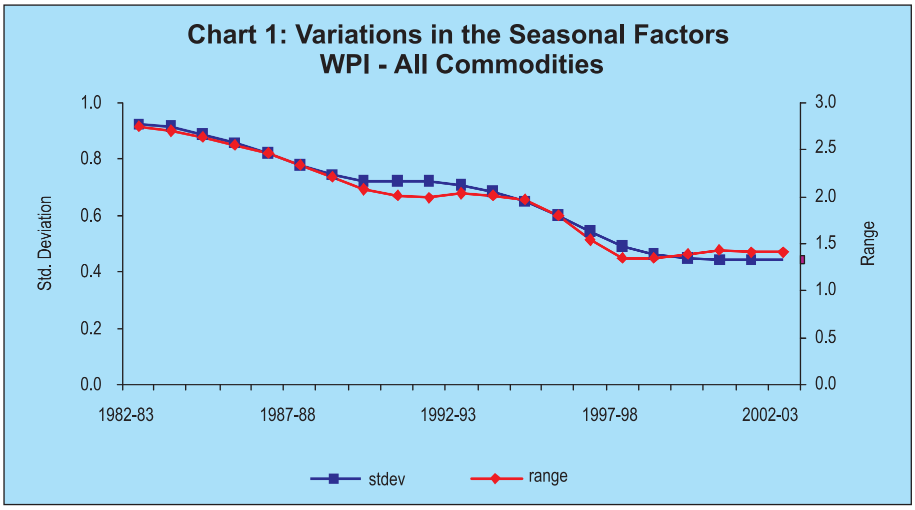
Blasio and Mini (2000) analysed the seasonal fluctuations of manufacturing production in Italy using 20 years data. The authors showed that seasonal fluctuations in manufacturing output in Italy are extremely high when compared to its two most important trade counterparts - France and Germany. The authors also showed that the Italian seasonal pattern was characterised by a dramatic slowdown in August followed by a full recovery in September. They found similar pattern across different manufacturing indicators. A large part of seasonality is attributed to the synergies or strategic interactions. However, whether the high seasonality and the resulting excess capacity is too much or too little as compared to socially optimal level needs further empirical exploration according to Blasio and Mini. They have observed that the Italian seasonal patterns are fairly homogeneous across industries and across time series such as production, sales, orders, yet it is extremely high compared to the economies with similar fundamentals like France and Germany.

As seen from the literature there are two types of seasonality, viz., exogenous and endogenous. Exogenous seasonality is the seasonality resulting from changes in underlying technology and preferences. Endogenous seasonality represents the changes in economic activities that arise because of synergies across agents that make it optimal to concentrate activity in a particular season. Endogenous seasonality is potentially actionable by policy.

Section II
Seasonal Patterns in Prices

WPI - All Commodities

The seasonal variations of WPI- All commodities has been consistently declining over the past two decades (Chart 1). The seasonal variation (measured as standard deviations of the seasonal factors during the year), declined consistently from 0.92 in 1982 to 0.72 in 1990. From 1992 onwards the decline in the seasonal variations gained momentum and it reached the levels of 0.44 in the latter half of the 1990s. The seasonal variations have stabilized at this level in the past 5 years.

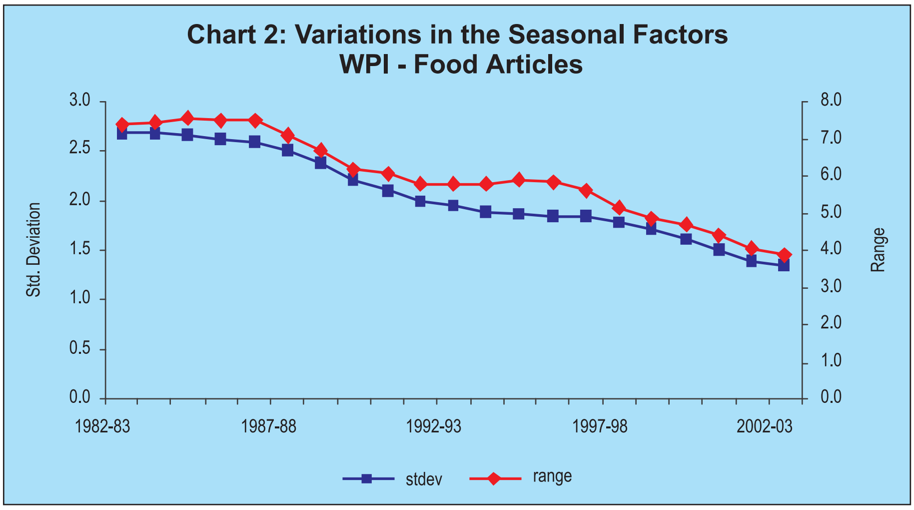


The peak period of the seasonal factors of WPI has been August or September during the years 1982 to 1996. As a result of stabilization in the seasonal variations in the seasonal factors, the peak period has shifted to October, although the seasonal values for this month remained at these levels for almost two decades. A clear picture, which has emerged in this case, is that in the post 1997 period all the months between April and November have the seasonal factors at above 100 levels, whereas, months between December and March witness a fall in these values. The seasonal factors during December to March remain below 100. The trough period of the seasonal factors of this series had been March during 1982 to 1997. From 1998 onwards there has been a shift in the trough month from March to February.

The low variations in the seasonal factors of WPI in recent years, also, indicate better supply management and proactive measures undertaken in the economy to prevent the supply shocks from translating into price rise.

WPI - Food Articles

The prices of Food Articles in India are prone to vagaries of rainfall. Seasonal variations of WPI- Food Articles, are in general higher than overall WPI, however, these variations have also been consistently declining (Chart 2). The seasonal factors of WPI-Food Articles varied



between 96.82 and 104.2 in the initial period. This range has, over the years, narrowed to 97.83 - 101.73. This indicates that even during off-seasons, the prices are stable, rather than rising gradually to a peak prior to the next crop. The drop in prices in the peak production season is to be expected, but this has also been moderated, due to better marketing opportunities as a result of reforms. The fact that the trough value of seasonal factor is moving close to 100 indicates that the producers are in a position to realize the price, which they had expected at the time of deciding to produce a particular crop.

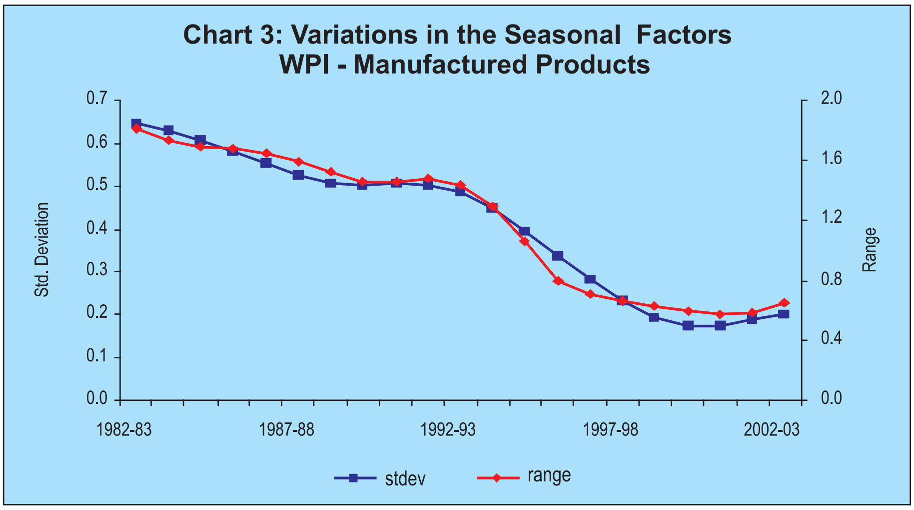
In general it shows that the production / import of food articles is available throughout the year to adequately meet the demand, without sharp fluctuations in prices. Such factors indicate improved welfare of both the producer and the consumer, by reducing the levels of distress sales and shortages.

Peak month, of the seasonal factors, shifted from August to October, in 1999. The seasonal factor for August has consistently declined from above 104 to nearly 100 in the last 20 years, whereas the seasonal factor for October has remained stable in the range of 101-102. In this series also, in the recent years all the months from April to November remained at 100 or above, while December to March months witnessed a fall in the seasonal factors to levels below 100. In the initial years March remained the trough month. In fact the values of March and April were very close up to 1991. The trough month in the recent years has either been February or March.

WPI - Manufactured Products

The seasonal variations of the WPI - Manufactured products have been low and these variations moved in the narrow range of 0.17 to 0.65, during the period under study (Chart 3). These variations after declining in the initial period remained stable at 0.50 during 1988 to 1991. Seasonal variations started declining further in the 1990s and have stabilized at a reasonably low level of 0.20 since 1998-99.

The peak of seasonal factors, in the case of prices of manufactured products, is not sharp. Seasonal factors of other months close to the peak months are also more or less the same. Therefore the peak month during the sample period has fluctuated between August and September. In a few cases the months- May, June and July also witnessed the peak values of the seasonal factors. Overall, the initial 7 months, viz., April to October, witnessed seasonal factors above 100, whereas November to March recorded values between 99 and 100. The trough months have been December and February. In most cases February has been the trough month. Overall, the prices of the manufactured products after a high in August/September start a downward movement from November onwards and reach the trough in February.



Relationship Between Inflation and Seasonal Variations

One of the major objectives of monetary policy is to have low and stable inflation rate. Low inflation rate indicates that there is low aggregate variation in prices, at least when compared with the corresponding period of the previous year. Although in theory, low inflation does not preclude high seasonal variation in prices, it is generally expected that in the time of low inflation, the demand - supply imbalances are on the lower side. With equilibrium situation in the commodity market, in the event of lower inflation rate, the transition in prices between seasons is also expected to be smooth resulting in relatively lower seasonal variation. This phenomenon can be observed in the following table (Table 1) where the inflation rate and the measure of seasonal variation have moved in tandem.

Empirical investigation of this relationship is presented in the form of equations below, which indicate that with the reduction in overall inflation rate over the years, the seasonal variations have also decreased considerably. The equations have been estimated

Table 1: Seasonal Variations and Inflation

Year	Inflation (%)			Seasonal Variations		
	AC	FA	MP	AC	FA	MP
1991-92	13.7	20.2	11.3	0.72	1.98	0.50
1992-93	10.1	12.4	10.9	0.71	1.94	0.49
1993-94	8.4	4.9	7.8	0.68	1.88	0.45
1994-95	12.5	12.7	12.2	0.65	1.86	0.40
1995-96	8.1	8.4	8.6	0.60	1.83	0.34
1996-97	4.6	12.4	2.1	0.54	1.83	0.28
1997-98	4.4	3.0	2.9	0.49	1.78	0.23
1998-99	5.9	12.7	4.4	0.46	1.71	0.19
1999-00	3.3	3.8	2.7	0.45	1.61	0.17
2000-01	7.2	3.0	3.3	0.45	1.50	0.17
2001-02	3.6	-0.8	1.8	0.45	1.40	0.19
2002-03	3.4	1.1	2.6	0.45	1.35	0.20

AC : All Commodities. FA : Food Articles. MP: Manufactured Products.

for WPI Overall, WPI - Primary Articles and WPI - Manufactured Products.

Equation 1: Seasonal Variation in WPI - AC (SVWAL) and overall inflation (OVP)

$$SVWAL = 0.3639 + 0.0268\ OVP \qquad \ldots 1$$
t- values 9.22 5.35
$R^2 = 0.74$, DW = 1.82

Equation 2: Seasonal Variation in WPI - FP (SVWFP) and Inflation - FP (FPP)

$$SVWFP = 1.5167 + 0.0263\ FPP \qquad \ldots 2$$
t- values 23.34 4.00
$R^2 = 0.61$, DW = 1.57

Equation 3: Seasonal Variation in WPI - MP (SVWMP) and Inflation - MP (MPP)

$$SVWMP = 0.1316 + 0.0288\ MPP \qquad \ldots 3$$
t- values 4.00 6.14
$R^2 = 0.79$, DW = 1.80

Thus in all the three cases it is observed that periods of low price rise seem to be associated with less seasonality.

Seasonality in Prices - Policy Relevance

Developing countries experience high volatilities in prices and production due to structural rigidities in the economy. In India it is observed that the structural aspects related to supply shocks have eased over the years. This, in turn, has led to a phase in the Indian economy characterised by stability in overall price level with low seasonal variations. Monetary policy formulations in the scenario of stable inflation and low seasonality in price variables has certain advantages. The uncertainties over achieving the set targets become minimal with the incidence of reduced seasonality in prices.

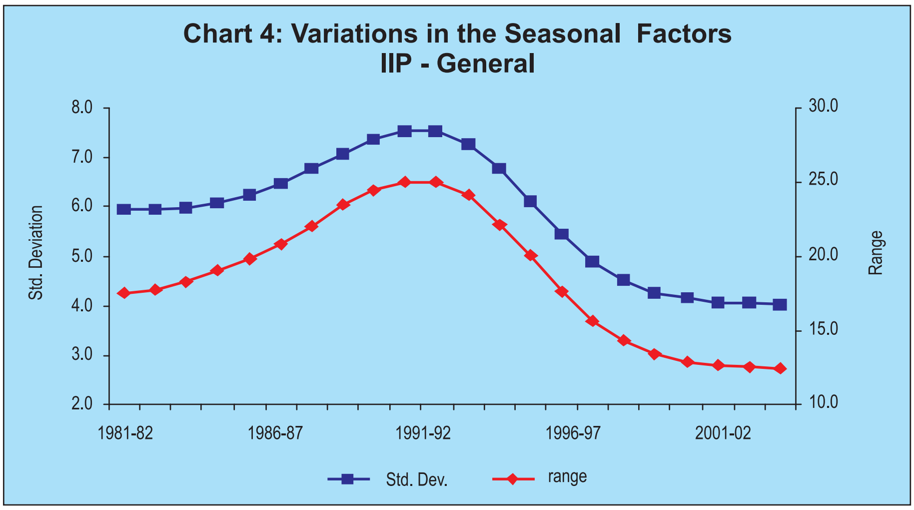
Section III

Seasonal patterns in Industrial Production

In India the industrial production is greatly influenced by the performance of the agricultural sector. The impact works through both the supply and demand channels. Substantial part of the industry depends on agricultural output for its input needs. The income generated in the agricultural sector influences the demand for manufactured goods particularly consumer goods and agricultural capital goods. These factors affect the seasonality in the production series. The industrial production normally picks up after the harvest of Kharif crop. The seasonal variations in this series and its sub-groups are analysed in this section.

Overall -IIP

The seasonal variations in the industrial production rose during the 1980s. This reflected the changing pattern of production in the Indian economy. However, after reaching the peak in 1991-92 the seasonal variations started declining. This perhaps could be attributed to gradual liberalization of foreign trade in the post economic reforms period.



The peak month of the seasonal factors remained unchanged throughout the reference period as March. The trough month in the last decade remained as June. However, in the years before 1993, troughs in the seasonal factors were observed in the months of August, April and May.

An interesting pattern observed in the seasonal factors was that after remaining at low levels during April-October, it showed a steep rise in the months of November and December. The seasonal factors remained stable during January, but declined in February before rising to its peak level in March.

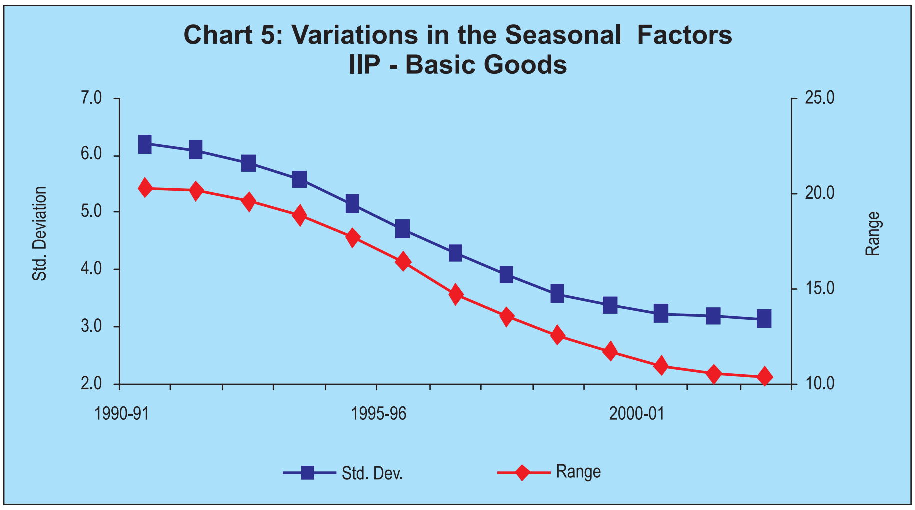
Another point worth noting is that, the seasonal factors after reaching the peak levels in March decline steeply in April. The fall is generally more than 10 per cent. Thus a smooth transition in the seasonal factors is not observed in the production series. Such steep declines are also found in other countries in their industrial production, as noted in Section II. While the pattern of seasonal variations has remained unaltered, the amplitude of seasonal cycles has been declining consistently since 1990-91.

In the following paragraphs the seasonal patterns of various industry groups are discussed. As these data are available since 1990, the discussion is restricted to the sample period. In general a consistent decline in the seasonal variations during the period under study is observed for all the industry groups.

IIP-Basic Goods

This group comprises of most of the infrastructure industries. Therefore, it is one of the important groups influencing the future course of overall production. The seasonal variations of this group have been worked out from 1990-91 onwards. It can be seen from the Chart below that the seasonal variations have declined from 6.18 in 1990-91 to 3.1 in 2002-03.

The movements in the seasonal factors are in-line with the movements in the IIP-General. March witnessed the peak values of

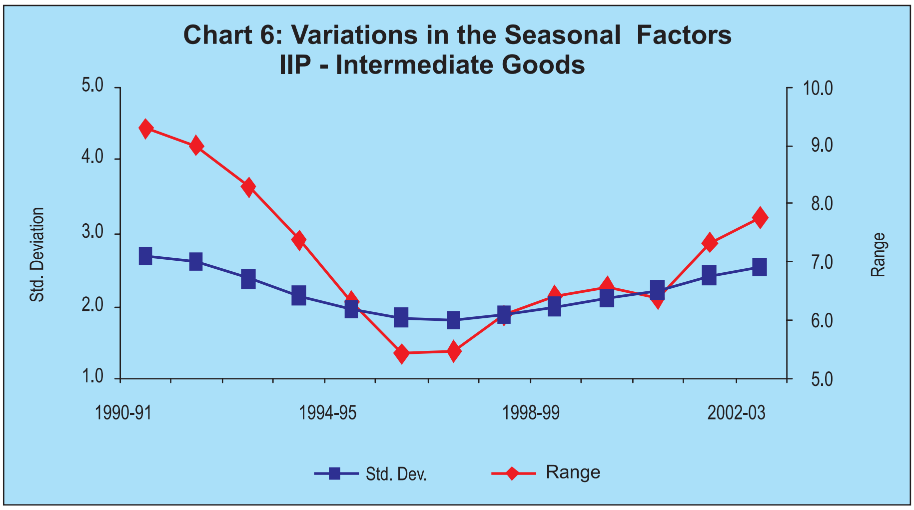


the seasonal factors of this series also. This was followed by a trough in April. Overall, reduction in seasonal factors in this category indicates consistent demand for the basic goods throughout the year.

IIP-Intermediate Goods

This group is most stable in terms of seasonal variation. Slight increase in the seasonality in the recent years is observed (Chart 6).

The peak levels of the seasonal factors were observed in the month of March. This observation is consistent with the pattern



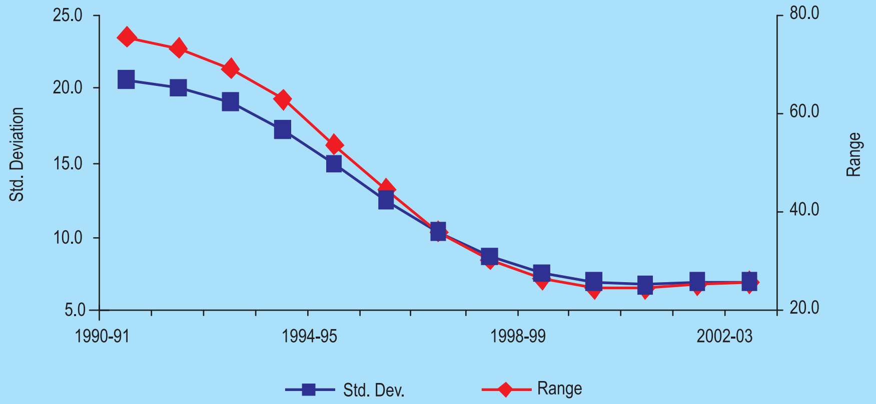
depicted by the overall IIP and IIP-Basic Goods. However, the transitions in the seasonal factors of this series appear to be different than the other two series mentioned above. The troughs were observed in the months of November and February. That is in the last five months of the financial year, high fluctuations are observed in the seasonality of this series.

IIP-Capital Goods

The series was highly seasonal in early 1990s. Substantial reduction is observed in the seasonal variations over the last decade (Chart 7).

The trough was as low as 82 in the initial years of 1990s and the corresponding peak was more than 150. In the year 2002-03, the corresponding values are 95 and 120 respectively. The troughs in the seasonal factors of this series were observed in the months of May, April or June. Thus virtually the first three months observed low seasonal levels. The production of capital goods also follows the same pattern as that of overall IIP, however the fluctuations in seasonality is higher in the case of former.

Chart 7: Variations in the Seasonal Factor
IIP - Capital Goods



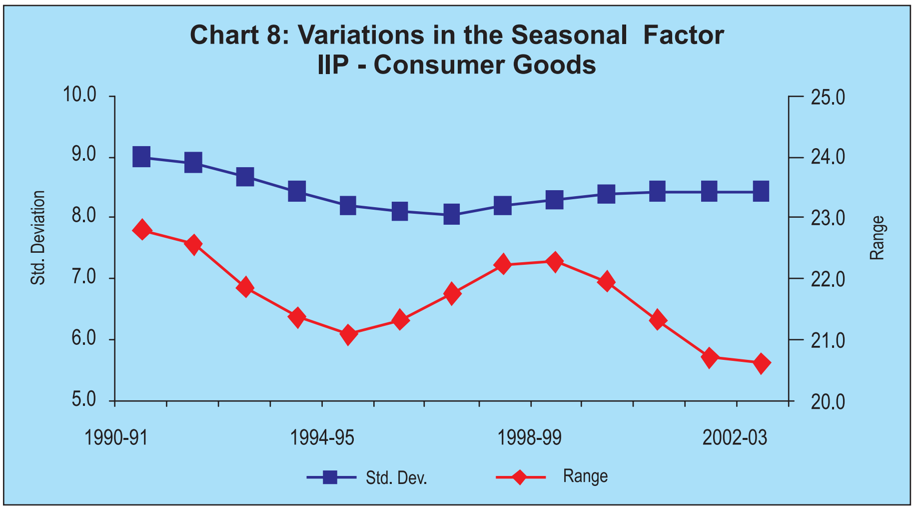
IIP-Consumer Goods

The production of consumer goods is expected to follow a certain seasonal pattern depending on the income patterns of the households in the rural and urban areas. The seasonality of IIP Consumer Goods is higher than Basic and Intermediate Goods, but it was substantially lower than IIP Capital Goods in early 1990s. Of late the seasonal variation of Capital and Consumer Goods is of the similar order. Over the period, the seasonal variation has been more or less stable (Chart 8).

The seasonality in the series follows the expected patterns. During the period June to October it remains at low levels. Coinciding with the Kharif harvest, the seasonal factors rise steeply in the month of November. Thereafter again it registers a steep rise in December and remains at this level until the end of the financial year, i.e., up to March. Here unlike the other industry groups the transition from trough to peak and vice-versa, is smoother. The seasonal factors are also reflective of the busy season and lean season in the Indian economy.

Synergies in Various Industrial Sectors

As discussed earlier the seasonal variations in one industry are transmitted to other related industries through supply and demand channels. The amplitude of seasonal variations differs across industries, but the pattern essentially reflects the synergies across the industry



groups. To examine the empirical validity of this hypothesis we worked out the correlations between four sets of related industrial sectors.

Seasonal factors of "Metals" and "Machinery" show a very high correlation coefficient of 0.81, while the correlation coefficient between the seasonal factors of "Metals" and "Transport Equipment" is 0.75. "Mining" and "Non-Metallic Minerals" show a correlation of 0.70 and the "Basic Goods" and "Intermediate Goods" show a correlation of 0.67. These observations are in line with the experiences of the other countries, cited in section II. The seasonal variation of related industrial sectors are highly correlated confirming the hypothesis that the seasonal variation arises out of synergies among the upstream and downstream industries.

Section IV
Concluding Observations

Seasonal variation in prices has decreased considerably during the last 20 years. The reduction had been particularly noticeable in mid 1990s and the seasonal fluctuations have stabilized to reasonably low levels. This could be attributed to better supply and demand management and also opening up of the economy. This has provided opportunities to mitigate the shortages and excess supply situations by resorting to import / export. In addition to the actual trade, the exposure to competition from the external sector in respect of demand and supply also has a stabilizing effect on the prices between different seasons.

Seasonal patterns of industrial production broadly reflect the busy and slack seasons. Traditionally the Indian economy was agro based and the agricultural production, which is harvested after the monsoon provided the impetus to the industry. As the structure of the industry has undergone change over the years, the overall seasonal variation has narrowed down. Among various industrial sectors, the food products sector has the maximum seasonal variation, which bears out this fact. Seasonal factors of the various sub-groups of the manufacturing industry at 2-digit level indicate that there is high correlation between the seasonal variations of various industry groups.

The analysis of the seasonal factors of the select variables has shown that overall seasonality has undergone a downward shift in almost all economic variables. This is an indication that the economy is becoming less susceptible to the shocks during the year and it has become more robust to weather the rough conditions like droughts, spurt in oil prices, etc. Monetary policy formulations in the scenario of stable inflation and low seasonality in price variables has certain advantages. The uncertainties over achieving the set targets become minimal with the incidence of reduced seasonality in prices. In the case of production it is necessary to unravel the underlying links of the various industrial groups, which enhance the synergies among them to maximise the output. To sum up, the scenario of reduced seasonality in prices and greater seasonal linkages among various industries, make the process of setting targets for attaining price stability with growth becomes more effective.

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Annex I: Estimation of Seasonal Factors

Ratio to Trend Method: There are several methods for estimating the seasonal factors of a time series. Methods differ in approaches as well as complexity. One of the simplest method is the "Ratio to Trend" method. In this method, a trend line is fitted to the time series by choosing an appropriate functional form. Then the data are expressed as percentage to the trend values, by assuming a multiplicative model. These percentages contain seasonal, cyclical and irregular (random) components. The cyclical and random components are wiped out by averaging the percentages over the different years, for a given month (or quarter). Either arithmetic mean or median can be used, but median is preferred, as extreme values do not affect it, which could be essentially due to random factors. Finally the seasonal factors are normalized by adjusting the total to 1200 for monthly data (or 400 for quarterly data) by multiplying them with an appropriate correction factor.

Ratio to Moving Average: An improvement over the "Ratio to Trend" method is the "Ratio to Moving Average" method, in which moving average (12 monthly for monthly data) is calculated to eliminate the seasonal movements. The moving average values give estimates of trend and cyclical movements. Then the original data (after eliminating data for first and last 6 months for a monthly series) are expressed as percentage to the moving average values. These percentages represent seasonal and irregular components. After averaging these parentages over the years, irregular component is eliminated and an estimate of seasonal factors is obtained. Finally the seasonal factors are normalized to the total of 1200 or 400 as the case may be.

US Census Bureau's X-12 ARIMA: The X-12-ARIMA seasonal adjustment procedure is an advanced version of the X- 11- ARIMA. The main new improvement in X-I2-ARIMA is the extensive set of time series model building facilities known as RegARIMA. RegARIMA provides some in- built regressors for removing non- stochastic term. After adjustment of such non-stochastic effects, best ARIMA model is used to extend the data series at both the ends and then usual X-11 procedure follows for seasonal adjustment.

Assuming multiplicative model, the original time series *(O_t)* can be expressed in the following form.

$$O_t = C_t\, S_t\, I_t$$

where C_t is the trend-cycle component, S_t is the seasonal component, and I_t is the irregular component.

1. Iterations are performed in the subsequent three steps. These provide estimates of the seasonal, trend-cycle and irregular components. Each, iteration refines estimates of the extreme values in the irregular components. After extreme values are identified and then modified, final estimates of the seasonal component, seasonally adjusted series, trend-cycle and irregular components are worked out.

2. Following are the three sub-steps in step 2.

   a) A centered 12-point moving average is applied to the original series O_t to provide a preliminary estimate C_t of trend-cycle. Next a preliminary estimate of $S_t\, I_t$ is obtained by $S_t\, I_t = O_t / C_t$.

   b) A moving average is then applied to the $S_t\, I_t$ to obtain an estimate S_t of the seasonal factors. $S_t\, I_t$ is then divided by this estimate to obtain an estimate of I_t-the irregular component. Next, a moving standard deviation is calculated from the irregular component and is used in assigning a weight to each monthly value for measuring its degree of extremeness. These weights are used to modify extreme values in $S_t\, I_t$. New seasonal factors are estimated by applying a moving average to the modified value of $S_t\, I_t$. A preliminary seasonally adjusted series is obtained by dividing the original series by these new seasonal factors. A second estimate of trend-cycle is obtained by applying a weighted moving average to this seasonally adjusted series.

   c) The same process is used to obtain second estimates of seasonally adjusted series and irregular component. This irregular component is again modified for extreme values and used to provide refined weights for identification of extreme values.

3. Using the same computations a second iteration is performed on the original series that has been adjusted by weights of irregular components developed in the first iteration. The second iteration produces final estimates of the weights of irregular components.

4. A third and final iteration is performed on the original series that has been adjusted by weights of irregular components computed during the second iteration. During this iteration, final estimates of seasonal factors, seasonally adjusted series, trend cycle component and irregular component are computed.

Use of Seasonal Dummies: Seasonality is also viewed as phenomenon, where the economic time series display dramatic differences in their mean values across seasons, and these differences persist over decades. A simple formulation of a time series X_t is given below.

$$X_t = \Sigma \alpha_i d_t^i + \eta_t$$

Where α_i is a coefficient, d_t^i is the seasonal dummy for the season i, and η_t is any stationary stochastic process. The seasonal dummy model is likely to be a good approximation for many economic time series, since a number of significant phenomenon are likely to produce seasonal dummy type variation in some economic time series. Seasonal dummy type models however, may not be appropriate when the seasonality is showing a shift over a time period.