How do we measure the business cycles?

1. Employment
2. Personal income
3. Production
4. Sales
What we have achieved?

1. Employment
2. Personal income
3. Production
4. Sales
Two steps towards better measurement

For production: GDP excluding agriculture and excluding government: Output of individuals and firms in industry and services

- Fluctuations in agriculture do not reflect business cycle conditions.
- Spending by Government does not reflect business cycle conditions.

Using firm data:

- We look at the sales of non-finance, non-oil companies
- For each pair of quarters, we work out the percentage change in sum of sales across all the firms
- Construct a net sales index
Part I

Seasonal adjustment
Why seasonal adjustment?

- Large seasonal movements can obscure important features of a time series:
  1. Direction
  2. Turning points
  3. Consistency between indicators

- Bell and Hillmer (1984) “Seasonal adjustment is done to simplify the data so that they may be more easily interpreted...without a significant loss of information”

- Seasonal adjustment is the first step towards a meaningful business cycle measurement.
No statistical agency in India releases seasonally adjusted data
This acts as roadblock
We have set up a framework to carefully monitor key macroeconomic series and adjust for seasonality through X-12-ARIMA program.
Steps in seasonal adjustment

- Pre-adjustment analysis
  - Visual inspection
  - Additive vs multiplicative seasonality
  - User defined regressors—Diwali effect
- X-12-ARIMA run
  - X-12-ARIMA diagnostics
  - Outlier detection and adjustment
  - Freezing model for subsequent adjustment
Seasonal fluctuations in IIP

![Graph showing seasonal fluctuations in IIP from 1995 to 2010.

The graph displays a upward trend with fluctuations, indicating seasonal variations in the Industrial Production Index (IIP).]
IIP: Adjusting for seasonality

NSA
Outlier unadjusted SA

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IIP: Adjusting for seasonality and outliers

NSA
Outlier adjusted SA

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### Our testing framework

#### List of candidate series for seasonal adjustment

<table>
<thead>
<tr>
<th>GDP</th>
<th>Non-agri GDP</th>
<th>Non-agri, non Govt GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net sales</td>
<td>Index of export income</td>
<td>Operating profits</td>
</tr>
<tr>
<td>IIP</td>
<td>IIP (Manufacturing)</td>
<td>IIP (Capital goods)</td>
</tr>
<tr>
<td>IIP (Consumer goods)</td>
<td>IIP (Mining)</td>
<td>Car production</td>
</tr>
<tr>
<td>Car sales</td>
<td>Exports</td>
<td>Non-oil exports</td>
</tr>
<tr>
<td>CPI (IW)</td>
<td>WPI (Food articles)</td>
<td>WPI (Fruits and vegetables)</td>
</tr>
<tr>
<td>M1</td>
<td>M3</td>
<td>Non-oil imports</td>
</tr>
<tr>
<td>WPI (Non-food, non-fuel), Non-oil non gold imports</td>
<td>Profit margin</td>
<td></td>
</tr>
<tr>
<td>Announced projects</td>
<td>Under implementation projects</td>
<td>Total outstanding</td>
</tr>
</tbody>
</table>
Part II

Business cycle turning points
### Selection of series

<table>
<thead>
<tr>
<th>List of candidate series for coincident indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exports</strong></td>
</tr>
<tr>
<td><strong>Imports</strong></td>
</tr>
<tr>
<td><strong>Pvt manufacturing announced</strong></td>
</tr>
<tr>
<td><strong>Govt announced</strong></td>
</tr>
<tr>
<td><strong>Govt infrastructure UI</strong></td>
</tr>
<tr>
<td><strong>All industries pvt</strong></td>
</tr>
<tr>
<td><strong>IIP (Manufacturing)</strong></td>
</tr>
<tr>
<td><strong>CPI-IW</strong></td>
</tr>
<tr>
<td><strong>REER</strong></td>
</tr>
<tr>
<td><strong>Operating profit</strong></td>
</tr>
<tr>
<td><strong>PBDIT to Sales</strong></td>
</tr>
<tr>
<td><strong>M3</strong></td>
</tr>
<tr>
<td><strong>Pvt manufacturing UI</strong></td>
</tr>
</tbody>
</table>
Reference series and data

- Non-agri Non-govt Gross Domestic Product (Constant prices SA).
- Data is available from 1999 (July-Sep) to 2013 (Apr-Jun).
- Variables are adjusted for seasonality and deflated with CPI-IW.
- Trade variables are deflated using WPI.
Part III

Methodology
Growth Cycle Approach

- Growth cycle approach to identify the turning points in Indian business cycle.
- The series is adjusted for seasonal fluctuations.
- Following Mintz, (1969,72,74) the identification of turning points is based on cyclical component.
Growth Cycle Approach

- The approach involves the choice of a filter to isolate the trend and the cyclical component.
- We use the HP filter to extract the cyclical component.
- The standardised cyclical component forms the reference series to apply the business cycle dating algorithm.
Part IV

Turning points
The identification of turning points dates back to the dating algorithm used by Bry and Boschan (1971).

The algorithm was improved and extended to quarterly series by Harding and Pagan, (2002) and (2006).
## GDP Non-agri Non-gov: Cyclical characteristics

<table>
<thead>
<tr>
<th>CF-Filter</th>
<th>HP-Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>Trough</td>
</tr>
<tr>
<td>2000 Q4</td>
<td>2001 Q3</td>
</tr>
<tr>
<td>2002 Q2</td>
<td>2005 Q2</td>
</tr>
<tr>
<td>2007 Q2</td>
<td>2009 Q2</td>
</tr>
<tr>
<td>2011 Q1</td>
<td>2011 Q4</td>
</tr>
</tbody>
</table>

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GDP Non-agri Non-gov: Cyclical characteristics with HP filter

Non-agri, non-govt GDP


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Cyclical characteristics of some key variables using HP filter

<table>
<thead>
<tr>
<th>Net Sales</th>
<th>IIP Manufacturing</th>
<th>Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>Trough</td>
<td>Peak</td>
</tr>
<tr>
<td>2000 Q3</td>
<td>2002 Q4</td>
<td>2000 Q4</td>
</tr>
<tr>
<td>2004 Q3</td>
<td>2005 Q3</td>
<td>2005 Q1</td>
</tr>
<tr>
<td>2007 Q4</td>
<td>2009 Q4</td>
<td>2007 Q4</td>
</tr>
<tr>
<td>2011 Q3</td>
<td></td>
<td>2011 Q1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012 Q3</td>
</tr>
</tbody>
</table>

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Net sales: Turning points

Net sales graph showing variations from 2000 to 2012.
Part V

Coincident indicators
Cross-correlation analysis

- It is a complement to the peaks and trough analysis.
- Gives an idea of the extent to which the cyclical component of reference series and candidate series are related.
- We find the lag at which the correlation is maximum and greater than 0.45.
- For coincident indicators, the correlation should be maximum and greater than 0.5 at lag=0 (current quarter)
- On the basis of this principle the chosen variables are:
  1. non-oil exports
  2. non-oil non-gold imports
  3. car sales
  4. private manufacturing under-implementation
  5. non-food credit
  6. IIP (Manufacturing)
  7. net sales
  8. operating profit
Coincident indicators: Alternative criteria

- We choose those variables whose correlation is greater than 0.45 at $t=0$ but not at the previous two quarters.
- This is done to exclude the possibility of a leading indicator being chosen as a coincident indicator.
- The variables chosen on the basis of this criteria are:
  1. non-oil exports
  2. non-oil non gold imports
  3. all industries under-implementation
  4. government announced projects
  5. outstanding government projects
  6. non-food credit
- We use these variables to construct a coincident index.
Construction of coincident index

- Conference Board (NBER) inverse standard deviation methodology
- Robust principal component analysis
Coincident index using the Conference Board methodology

- Calculate point-on-point changes
- Adjust point-on-point changes by component’s standardisation factor (inverse of standard deviation),
- Add the adjusted point-on-point changes across the components for each month
- Convert the series into index
- Repeat this procedure for reference series
- Plot the cyclical component of the reference index and the coincident index
Coincident index and reference series

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Principal component analysis

- Find the cyclical components of the chosen coincident variables
- The robust principal components of the cyclical variables are regressed on the cyclical component of the reference variable
- The predicted series is the coincident index
- Compare this with the cyclical component of reference series
Proportion of variance explained by the principal components

<table>
<thead>
<tr>
<th>PC</th>
<th>Proportion of variance (cumulative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1</td>
<td>48.2</td>
</tr>
<tr>
<td>PC2</td>
<td>79.8</td>
</tr>
<tr>
<td>PC3</td>
<td>90.9</td>
</tr>
<tr>
<td>PC4</td>
<td>96.1</td>
</tr>
<tr>
<td>PC5</td>
<td>99.3</td>
</tr>
<tr>
<td>PC6</td>
<td>100</td>
</tr>
</tbody>
</table>
Coincident index using robust PCA

![Graph showing coincident indicator and GDP growth rate over years.](image-url)
Next steps

- Sensitivity of results to the choice of filter
- Leading indicator analysis
Thank you