Analysing Business Tendency survey series for the presence of seasonality

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This study considers some of the characteristics of Business Tendency Survey (BTS) data and how these are taken into account in conventional statistical analysis techniques, such as seasonal adjustment procedures.
What do we know about BTS series?

- The nature of BTS series lend themselves to assuming a Data Generating Process (DGP) characterised by non-integration and non-seasonality.

- Indeed, BTS series are bounded by construction by ±100, which are their upper and lower limits, and so are likely to admit stationary patterns.

- Moreover, BTS questions are phrased to explicitly exclude seasonal movements.
.. but what happens in practice?

• BTS series might exhibit seasonal patterns, implicitly reflecting the difficulties experienced by respondents in distinguishing seasonal from non-seasonal variations.

• Therefore, analysts tend to run BTS data through seasonal adjustment procedures like TRAMO-SEATS or X12 ARIMA, often in automated modes, as the first step of their analysis, without a prior examination of the properties of these series.
... is that a ‘bad practice’?

- The use of seasonal adjustment might impact on the detection and properties of business cycle regimes.

  ➔ Empirical findings (Matas-Mir et al., 2005) have shown that seasonal adjustment distorts information about the extent and timing of turning points, while leading to less deep recessions.

- Moreover, there is some evidence that the use of seasonal adjustment automatic procedures might specify models that do not reflect the key characteristics of BTS series.
Do we need to seasonal adjust BTS series? What is the evidence from the literature?

- **Studies at the Euro area level:**
  - Franses et al. (2005) showed that, in the majority of cases, BTS series did not have stochastic trends or seasonal unit roots;
  - Similarly, Claveria et al. (2007) and Clar et al. (2007), found that most of the BTS series examined did not have significant seasonal patterns;

- **Studies at the national level:**
  - Crosilla (2006) found some Italian BTS data to be non-stationary and, in few cases, seasonally integrated.
... the mixed messages emerging from literature are already enough evidence to have a closer look at the data in order to answer the following questions:

1. Do BTS series really need to be seasonally adjusted?

2. If so, are the results provided by automatic seasonal adjustment procedures reasonable?
How did this study help answering these questions?

- A **simulation analysis** and evaluation of seasonal adjustment procedures in a controlled environment.

- An **application on observed BTS series** for which the main assumptions underlying the simulation exercise will be checked by some diagnostic tests.

- An **evaluation of seasonal adjustment automatic procedures** on real BTS data given the results of the diagnostic tests.
STAGE 1:

• The simulation analysis modeled a plausible Data Generating Process underlying BTS series based on an AR(1) process reflecting the assumptions of non-integration and non-seasonality;

• Six different scenarios were simulated with different autoregressive parameters and process means.

STAGE 2:

• These simulated series were seasonally adjusted with the automatic procedures of TRAMO-SEATS and X12 ARIMA.
Simulation results

Table 1. TRAMO-SEATS and X-12 ARIMA automatic procedures on simulated series (% of cases)

<table>
<thead>
<tr>
<th>TRAMO-SEATS</th>
<th>$\rho = 0.8, \mu = 0.5$</th>
<th>$\rho = 0.8, \mu = 0$</th>
<th>$\rho = 0.7, \mu = 0.5$</th>
<th>$\rho = 0.7, \mu = 0$</th>
<th>$\rho = 0.6, \mu = 0.5$</th>
<th>$\rho = 0.6, \mu = 0$</th>
<th>% Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTS Series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasonality</td>
<td>12</td>
<td>16</td>
<td>10</td>
<td>11</td>
<td>17</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Unit Roots</td>
<td>91</td>
<td>89</td>
<td>29</td>
<td>33</td>
<td>6</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>SA&amp;UR</td>
<td>10</td>
<td>16</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>X-12 ARIMA</td>
<td>$\rho = 0.8, \mu = 0.5$</td>
<td>$\rho = 0.8, \mu = 0$</td>
<td>$\rho = 0.7, \mu = 0.5$</td>
<td>$\rho = 0.7, \mu = 0$</td>
<td>$\rho = 0.6, \mu = 0.5$</td>
<td>$\rho = 0.6, \mu = 0$</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Seasonality</td>
<td>9</td>
<td>14</td>
<td>28</td>
<td>13</td>
<td>59</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>Unit Roots</td>
<td>80</td>
<td>84</td>
<td>26</td>
<td>29</td>
<td>6</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>SA&amp;UR</td>
<td>7</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: author’s elaborations on ISTAT data

- Both algorithms identified spurious integration and seasonality in series that were stationary and not seasonal by construction.
- TS found more unit roots than X12, while X12 identified more seasonality than TS.
- Both procedures were particularly sensitive to high autoregressive parameters; for example, TS found unit roots with a $\rho$ of 0.8 in 90% of the cases – on average, while X12 in 82%.
Were the simulations results confirmed by empirical findings?

...Let’s have a look at observed BTS data
Diagnostic tests on observed BTS series

- Observed BTS series were drawn from the Italian Manufacturing Survey carried out by ISTAT. The period considered went from Jan 1990 to Oct 2010.

- Diagnostic tests were run to assess the priors with which simulated series had been generated.

- In particular, the tests carried out checked for the presence/absence of:
  - regular and/or seasonal unit roots
  - determinist or stochastic seasonality
1. Assumption of non-integration

- ADF and PP results reject the null of Unit Roots for almost all series;
- KPSS results fail to reject the null of stationarity for all series;

2. Assumption of no-seasonality

- The M-HEGY test (Franses, 1991) results rejected the existence of unit roots at zero and all seasonal frequencies for all series.
- Test for Deterministic seasonality show could not reject the null of absence of deterministic seasonality suggesting that Italian Manufacturing series might be characterised by deterministic seasonal patterns.
Automatic seasonal adjustment on observed BTS data

- So, diagnostic tests told us that these series did not have regular and/or seasonal unit roots but that could be characterised by deterministic or stochastic stationary seasonal patterns.

- However, the performance of automatic seasonal adjustment procedures of TS and X12 on the observed BTS series confirmed the simulation results, finding unit roots at zero and seasonal frequencies.

### Table 2. Automatic model selection of TS and X-12 run for Italian Manufacturing series

<table>
<thead>
<tr>
<th>SURVEY VARIABLES</th>
<th>TRAMO-SEATS (p d q) (P D Q)</th>
<th>X12 ARIMA (p d q) (P D Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production, past 3 months</td>
<td>(0 1 3)  (0 1 1)</td>
<td>(2 1 2)  (0 1 1)</td>
</tr>
<tr>
<td>Export order books</td>
<td>(0 1 0)  (0 1 1)</td>
<td>(3 1 1)  (0 1 1)</td>
</tr>
<tr>
<td>Domestic orders</td>
<td>(3 1 0)  (0 1 1)</td>
<td>(2 1 2)  (0 1 1)</td>
</tr>
<tr>
<td>Stocks of finished products</td>
<td>(0 1 1)  (0 1 1)</td>
<td>(3 1 1)  (0 1 1)</td>
</tr>
<tr>
<td>Firm's liquidity</td>
<td>(0 1 1)  (0 1 1)</td>
<td>(1 1 0)  (0 1 1)</td>
</tr>
<tr>
<td>General economic situation, next 3 months</td>
<td>(0 1 1)  (0 1 1)</td>
<td>(0 1 1)  (0 1 1)</td>
</tr>
<tr>
<td>Firm's liquidity, next 3 months</td>
<td>(0 1 1)  (0 1 1)</td>
<td>(0 1 0)  (0 1 1)</td>
</tr>
<tr>
<td>Total order books, next 3 months</td>
<td>(0 1 0)  (0 1 1)</td>
<td>(0 1 0)  (0 1 1)</td>
</tr>
<tr>
<td>Selling prices, next 3 months</td>
<td>(0 1 0)  (0 1 1)</td>
<td>(0 1 0)  (0 1 1)</td>
</tr>
<tr>
<td>Production, next 3 months</td>
<td>(0 1 0)  (0 1 1)</td>
<td>(0 1 0)  (0 1 1)</td>
</tr>
</tbody>
</table>

Source: author’s elaborations on ISTAT data
1. Do BTS series need seasonal adjustment?

In the specific case, observed BTS series might have deterministic or stationary stochastic seasonality. So YES, they need seasonal adjustment.

2. Do seasonal adjustment procedures as TS and X12 run in automated modes provide good results?

NO, as these procedures tend to identify spurious regular and seasonal unit roots which are not detected in the observed data by the diagnostic tests results.
The recommendation from this study would be to avoid s.a. based on automatic procedures – when possible – and perform a detailed analysis of the series based on the classical Box-Jenkins approach modelling seasonality either with seasonal dummies (when deterministic) or with seasonal AR and/or MA components (when stationary stochastic).
Thanks for your attention!!