Reference Week Adjustment for Employment Insurance Statistics

November 20, 2019

Lorcan Mischler

Delivering insight through data for a better Canada
Agenda

- Overview of Employment Statistics Program
- Reference Week
- Issues Encountered During Seasonal Adjustment (SA)
- Solution 1: Modelling
- Solution 2: Alternative Data Source
Overview of EI Statistics Program

- EI Statistics Program:
  - Monthly estimates
  - Statistics on number of EI beneficiaries, number of claims, type of benefits, number of disqualifications and disentitlements.
  - Uses administrative data: administered by Service Canada on behalf of Employment and Social Development Canada
  - Data seasonally adjusted (X-12-ARIMA)
Reference Week

- Reference Week (RW): The week containing the 15th day of the month
- Number of beneficiaries obtained by counting number of people who qualified for EI benefits during the reference week (whether or not they have received benefits for other weeks)
- Reference week introduces a calendar effect due to location of the 15th day.
- Impacts month-to-month change in the EI statistical estimates.
Issues Encountered During Seasonal Adjustment

- Prior to 2017: beneficiaries wait 2 weeks before receiving EI benefits.
- Adjustment is made relative to where the 15th falls compared to Wednesday; done via a linear regARIMA model:

\[ y_t = \sum_i \beta_i x_{it} + z_t, \quad z_t \sim \text{ARIMA} \]

where:

- \( y_t \) is the dependent time series
- \( x_{it} \) are the regression variables depending on time \( t \)
- \( \beta_i \) are the regression parameters
- \( z_t \) are the regression residuals
Issues Encountered During Seasonal Adjustment

Positive adjustment

\[
x_{it} = +2
\]

\[
x_{it} = \delta_{it} - 15
\]

where \(\delta_{it}\) is Wednesday’s date during RW

Negative adjustment

\[
x_{it} = -3
\]

<table>
<thead>
<tr>
<th>MONTH</th>
<th>SUN</th>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THU</th>
<th>FRI</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MONTH</th>
<th>SUN</th>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THU</th>
<th>FRI</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Issues Encountered During Seasonal Adjustment

- As of 2017: new legislation changed the waiting period to one week.
  - Before 2017: 2 week waiting period
  - As of 2017: 1 week waiting period

- This introduced a problem for the reference week adjustment we were using.

- Most beneficiaries would request EI benefits at end of month:
  - Before 2017: Waiting period often intersects reference week
  - After 2017: Waiting period rarely intersects reference week (big impact on Health and Education sectors)
Issues Encountered During Seasonal Adjustment

- As of 2017, reference week adjustment did not seem necessary.
- Keeping the linear reference week adjustment: spikes in the data would be introduced post-2017.
- Removing the reference week adjustment: spikes introduced in pre-2017 data.
- Obviously, the linear regressor was not working as we wanted.

- Had to think of a new solution to take care of this problem.
Issues Encountered During Seasonal Adjustment

Beneficiaries, Manitoba, Education (with linear regressor)
Solution 1: Use Various Non-Linear Models

- Here, we tried various non-linear models and compared to linear model:
  - $f(x_{it}) = \sqrt[3]{x_{it}}$
  - $f(x_{it}) = \exp(x_{it})$
  - $f(x_{it}) = x_{it}^2$
  - $f(x_{it}) = x_{it}^2 + x_{it}$
  - $f(x_{it}) = \text{expit}(x_{it})$

  \[\text{expit}(x_{it}) = \logit^{-1}(x_{it}) = \log^{-1}\left(\frac{x_{it}}{1 - x_{it}}\right) = \frac{\exp(x_{it})}{\exp(x_{it}) + 1}\]

- 1341 series: 6 models, 12 months $\rightarrow$ 96,552 results
Solution 1: Use Various Non-Linear Models

Looking at the best model fit for each month based on $R^2_{adj}$, AIC, BIC (16,092 models)

<table>
<thead>
<tr>
<th>Model</th>
<th>$R^2_{adj}$ %</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>Cube root</td>
<td>21.11</td>
<td></td>
</tr>
<tr>
<td>Exponential</td>
<td>11.38</td>
<td></td>
</tr>
<tr>
<td>Quadratic</td>
<td>37.61</td>
<td></td>
</tr>
<tr>
<td>Quadratic with linear term</td>
<td>17.83</td>
<td></td>
</tr>
<tr>
<td>Expit</td>
<td>6.50</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>AIC %</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>6.05</td>
<td></td>
</tr>
<tr>
<td>Cube root</td>
<td>22.20</td>
<td></td>
</tr>
<tr>
<td>Exponential</td>
<td>12.93</td>
<td></td>
</tr>
<tr>
<td>Quadratic</td>
<td>42.09</td>
<td></td>
</tr>
<tr>
<td>Quadratic with linear term</td>
<td>9.57</td>
<td></td>
</tr>
<tr>
<td>Expit</td>
<td>7.16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>BIC %</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>6.33</td>
<td></td>
</tr>
<tr>
<td>Cube root</td>
<td>23.01</td>
<td></td>
</tr>
<tr>
<td>Exponential</td>
<td>13.97</td>
<td></td>
</tr>
<tr>
<td>Quadratic</td>
<td>44.44</td>
<td></td>
</tr>
<tr>
<td>Quadratic with linear term</td>
<td>4.72</td>
<td></td>
</tr>
<tr>
<td>Expit</td>
<td>7.53</td>
<td></td>
</tr>
</tbody>
</table>
Solution 1: Use Various Non-Linear Models

Beneficiaries, Manitoba, Education: Expit model for September
Solution 2: Use Detailed Data

- Pretend beneficiaires prior to 2017 had one-week waiting period (we know the date when people applied for EI)

- Since reference week adjustment works well for up to end of 2016, we would do seasonal adjustment in 2 parts:
  - Prior to 2017: use the linear regARIMA model
  - Use the information from the detailed data where we pretend we have a 1-week period up to end of 2016, and use the actual data in 2017 onward.

- Results are better and results in smoother graphs with no spikes.
Solution 2: Use Detailed Data

Beneficiaries, Manitoba, Education (without linear regressor)
Solution 2: Use Detailed Data

Beneficiaries, Manitoba, Education (hybrid approach; in production)
Conclusion

- Discontinuity and spike in our data gave us issues in seasonal adjustment.
- 2 solutions considered: modelling and alternative data source.
  - The hybrid model we chose in the end removed spikes and worked well.
- Maintain the linear models for now
  - There may be potential for considering the other models (perhaps quadratic) and may leave the door open to other models when we get more data.
Thank You!

Questions?

Contact: Lorcan Mischler
lorcan.mischler@canada.ca