The impacts of unusual weather on the Gross Domestic Product (GDP)

UNECE Expert Forum for Producers and Users of Climate Change-Related Statistics
Session 2: Measuring climate change adaptation

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Outline

Econometric model -> Relevant sectors -> Weather variables

Obtained results -> Recommendations for further research
Econometric model -> Relevant sectors -> Weather variables

Report (2014; Pim Ouwehand and Floris van Ruth): to adjust **GDP** also for **unusual weather effects** in order to distinguish their **irregular behavior** from structural economic changes and to estimate the **magnitude** of unusual weather effects.


Obtained results -> Recommendations for further research
Econometric model -> Relevant sectors -> Weather variables

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Climate change adaptation: Which sectors are at risk and which sectors will profit from climate change? -> Update of the former report (2020; Pim Ouwehand), in Dutch:

https://www.cbs.nl/nl-nl/maatwerk/2020/48/klimaatimpact-op-de-economie
The econometric model

ARIMA  AutoRegressive Integrated Moving Average
Is normally used to calculate a seasonally adjusted GDP
(quarterly time serie per sector).

To include unusual weather some extra variables are added.
They are transformed from daily to quarterly variables.

Per sector: several iterations towards an optimal model.
Sectors with significant unusual weather effects

**Cold weather** increases the heating needs
- B Mining and Quarrying
- D Energy (Electricity, gas, steam and air condition supply)

**Severe frost** hinders activities
- C Manufacturing
- F Construction

**Warm weather** leads to a sunny ‘going out’ mood
- I Accommodation and food service activities

Many unusual weather effects will tend to average out over a quarter. Retail sales will catch up shortly after a very rainy week with less sales.
Unusual weather; available indicators

Unusual weather: deviations from the long term average. Impact on GDP: detectable at sector level on a quarterly basis.

Available weather indicators

Temperature: daily average, min, max
Sunshine: number of hours, day-time %
Rainfall: daily sum, number of hours
Wind speed: daily average, 1h max
Snow: height
Unusual weather; regression variable ‘cold’

Cold weather increases heating needs. Only heating needed when the daily average is below 18 degrees Celsius.

‘Degree days’ = 18 minus ‘daily average’, if it is below 18°C it is 0, if it is 18°C or higher

<table>
<thead>
<tr>
<th>Daily average T</th>
<th>...</th>
<th>20</th>
<th>8</th>
<th>-1</th>
<th>-4</th>
<th>-8</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Degree days’</td>
<td>...</td>
<td>0</td>
<td>10</td>
<td>19</td>
<td>22</td>
<td>26</td>
<td>...</td>
</tr>
</tbody>
</table>

From daily to quarterly data: take the sum of ‘degree days’
Unusual weather; regression variable ‘frost’

**Severe frost** hinders activities. Count the days in a quarter with temperatures below 0°C, below -3°C, or below -7°C.

<table>
<thead>
<tr>
<th>Daily average T</th>
<th>...</th>
<th>20</th>
<th>8</th>
<th>-1</th>
<th>-4</th>
<th>-8</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 0°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Below -3°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Below -7°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Below 0°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>...</td>
</tr>
<tr>
<td>Below -3°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>...</td>
</tr>
<tr>
<td>Below -7°C</td>
<td>...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>...</td>
</tr>
</tbody>
</table>
Unusual weather; regression variable ‘warm’

Warm weather leads to a sunny ‘going out’ mood. More drinks, meals, and hotel bookings.

Best proxy maximum Temperature

Alternatives
Sunny days count 1 if ‘day-time % sun’ > 50%, otherwise 0
Nice days count 1 if sunny day AND average T > 18°C
Rainy days count 1 if ‘number of hours rain’ > 6
Impact unusual weather on GDP

Magnitude = 0,3 % GDP (Mining; Natural gas)

Magnitude = -0,4 % GDP (Construction and Manufacturing)
Impact unusual weather on GDP (sectors)

**Mining**

**Construction**

**Manufacturing**

**Energy**

**Accomodation and Food**

**Different y-axis values**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>-200</td>
<td>1000</td>
</tr>
<tr>
<td>Construction</td>
<td>-600</td>
<td>0</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-250</td>
<td>50</td>
</tr>
<tr>
<td>Energy</td>
<td>-50</td>
<td>50</td>
</tr>
<tr>
<td>Acc. &amp; Food</td>
<td>-60</td>
<td>40</td>
</tr>
<tr>
<td>GDP</td>
<td>-600</td>
<td>400</td>
</tr>
</tbody>
</table>
Recommendations

- The transformation from weather indicators (daily) to regression variables (quarterly) is not trivial. Also the iteration process towards an optimal model needs more standardisation. Future models should also take into account the Covid-19 effects.

- More sectors should be investigated, like Agriculture (drought effects). For the already investigated sectors the modeling could also be done for lower aggregates, where unusual weather effects might be more prominent (bottom-up approach).

- Unusual weather has both positive and negative effects on economic growth (GDP). Adaptation measures should not only be focused on sectors at risk (minimizing damages), but also on sectors that profit from unusual weather (maximizing economic opportunities).

- More budget is needed for additional (academic) research. The obtained results are not mature and should be seen as an inspiring first exercise.