Economic Time Series Filtering: An alternative approach with the neverhpfilter package

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June 1st, 2018
James Hamilton’s working paper, *WHY YOU SHOULD NEVER USE THE HODRICK-PRESCOTT FILTER* (2017) (<doi:10.3386/w23429>) summarizes the problem with the popular filter in three points:

1. The HP filter produces series with spurious dynamic relations that have no basis in the underlying data-generating process.
2. Filtered values at the end of the sample are very different from those in the middle, and are also characterized by spurious dynamics.
3. A statistical formalization of the problem typically produces values for the smoothing parameter vastly at odds with common practice, e.g., a value for $\lambda$ far below 1600 for quarterly data.
If you gave someone HP-Filtered data feeling like this...
In reality, its more like this:

CALL KENNY LOGGINS

CAUSE YOU'RE IN THE DANGER ZONE

( Inspired by the one and only Mara Averick @dataandme )
The 4th point of Hamilton’s abstract presents a solution

- (4) There’s a better alternative. A regression of the variable at date \( t + h \) on the four most recent values (for quarterly data) as of date \( t \) offers a robust approach to detrending that achieves all the objectives sought by users of the HP filter with none of its drawbacks.

\[
y_{t+8} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + \nu_{t+8}
\]

Which can be rewritten as:

\[
y_t = \beta_0 + \beta_1 y_{t-8} + \beta_2 y_{t-9} + \beta_3 y_{t-10} + \beta_4 y_{t-11} + \nu_t
\]
Do any of Hamilton’s peers agree? From the cover page:

I thank Daniel Leff for outstanding research assistance on this project and Frank Diebold, Robert King, James Morley, and anonymous referees for helpful comments on an earlier draft of this paper.
Implementing Hamilton’s alternative: neverhpfilter package

yth_glm: fits a generalized linear model object of class glm.

\[ y_{t+8} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+8} \]

yth_glm(x, h = 8, p = 4, ...)  

yth_filter: returns an xts object containing user defined combinations of the original, trend, cycle, and random walk series.

yth_filter(x, h = 8, p = 4,  
           output = c("x", "trend", "cycle", "random"),  
           ...)  

In addition the package comes with 14 documented data sets used to reproduce the results of Hamilton(2017).
Hamilton’s alternative: Model estimation function

For model estimation, I settled on `glm` because... model object!

```r
library(neverhpfilter)
gdp_model <- yth_glm(100*log(GDPC1), h = 8, p = 4)
```

<table>
<thead>
<tr>
<th>term</th>
<th>estimate</th>
<th>std.error</th>
<th>statistic</th>
<th>p.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>27.2025075</td>
<td>2.9638555</td>
<td>9.1780814</td>
<td>0.0000000</td>
</tr>
<tr>
<td>xt_0</td>
<td>1.1722639</td>
<td>0.2336541</td>
<td>5.0170908</td>
<td>0.0000010</td>
</tr>
<tr>
<td>xt_1</td>
<td>-0.3432205</td>
<td>0.3858303</td>
<td>-0.8895632</td>
<td>0.3745012</td>
</tr>
<tr>
<td>xt_2</td>
<td>-0.1296324</td>
<td>0.3856853</td>
<td>-0.3361092</td>
<td>0.7370525</td>
</tr>
<tr>
<td>xt_3</td>
<td>0.2769114</td>
<td>0.2320986</td>
<td>1.1930765</td>
<td>0.2338985</td>
</tr>
</tbody>
</table>
Hamilton’s alternative: Filtered series

```r
library(neverhpfilter)
gdp_filtered <- yth_filter(100*log(GDPC1),
                          h = 8, p = 4,
                          output = c("x", "trend", "cycle"))

tail(gdp_filtered, 8)
```

```
##    GDPC1 GDPC1.trend GDPC1.cycle
## 2015 Q4  971.3998    971.0746   0.32512275
## 2016 Q1  971.5444    970.4246   1.11980556
## 2016 Q2  972.0977    971.9094   0.18831943
## 2016 Q3  972.7833    973.3109  -0.52760922
## 2016 Q4  973.2190    973.2501  -0.03104638
## 2017 Q1  973.5261    974.1597  -0.63363121
## 2017 Q2  974.2795    974.9659  -0.68630695
## 2017 Q3  975.0563    975.2427  -0.18635065
```

```r
class(gdp_filtered)
```

```
[1] "xts" "zoo"
```
Got Dependencies?

#17: Dependencies.

Dependencies are invitations for other people to break your package.
-- Josh Ulrich, private communication
Got Dependencies?

Dirk Eddelbuettel

Wed, 28 Feb 2018

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Dependencies are invitations for other people to break your package.
-- Josh Ulrich, private communication

tools::package_dependencies("neverhpfilter")

## $neverhpfilter

## [1] "xts" "zoo"
Why depend on xts?

▶ Safer
▶ Model functions accept and return xts objects of any periodicity.

```r
class(GDPC1)
## [1] "xts" "zoo"

xts::periodicity(GDPC1)
## Quarterly periodicity from 1947 Q1 to 2017 Q3

y <- yth_filter(100*log(GDPC1), h = 8, p = 4)
class(y)
## [1] "xts" "zoo"

xts::periodicity(y)
## Quarterly periodicity from 1947 Q1 to 2017 Q3
Why depend on xts?

`plot(x, ...)` quickly produces nice graphs.

Log of Real GDP (GDPC1) and trend

1980 Q1 / 2017 Q3

880
900
920
940
960
880
900
920
940
960

−5
0
5
−5
0
5

Reproducing Hamilton’s solution

Hamilton’s table 2 compared with estimates from neverhpfilter::yth_filter, sorted by standard deviation of the cycle component. `yth_filter` estimates are labeled with the suffix `cycle`.

<table>
<thead>
<tr>
<th></th>
<th>cycle.sd</th>
<th>gdp.cor</th>
<th>random.sd</th>
<th>gdp.rand.cor</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment-rate</td>
<td>1.44</td>
<td>-0.81</td>
<td>1.72</td>
<td>-0.79</td>
<td>1948-1/2016-2</td>
</tr>
<tr>
<td>UNRATENSA.cycle</td>
<td>1.44</td>
<td>-0.81</td>
<td>1.71</td>
<td>-0.79</td>
<td>1948-Q1/2016-Q2</td>
</tr>
<tr>
<td>10-year-Treasury-yield</td>
<td>1.46</td>
<td>-0.05</td>
<td>1.51</td>
<td>0.08</td>
<td>1953-2/2016-2</td>
</tr>
<tr>
<td>GS10.cycle</td>
<td>1.46</td>
<td>-0.05</td>
<td>1.51</td>
<td>0.08</td>
<td>1953-Q2/2016-Q2</td>
</tr>
<tr>
<td>Fedfunds-rate</td>
<td>2.78</td>
<td>0.33</td>
<td>3.03</td>
<td>0.40</td>
<td>1954-3/2016-2</td>
</tr>
<tr>
<td>FEDFUNDS.cycle</td>
<td>2.78</td>
<td>0.33</td>
<td>3.03</td>
<td>0.41</td>
<td>1954-Q3/2016-Q2</td>
</tr>
<tr>
<td>Consumption</td>
<td>2.85</td>
<td>0.79</td>
<td>3.04</td>
<td>0.82</td>
<td>1947-1/2016-1</td>
</tr>
<tr>
<td>PCECC96.cycle</td>
<td>2.86</td>
<td>0.79</td>
<td>3.04</td>
<td>0.82</td>
<td>1947-Q1/2016-Q1</td>
</tr>
<tr>
<td>GDP-Deflator</td>
<td>2.99</td>
<td>0.04</td>
<td>4.11</td>
<td>-0.13</td>
<td>1947-1/2016-1</td>
</tr>
<tr>
<td>GDPDEF.cycle</td>
<td>2.99</td>
<td>0.03</td>
<td>4.10</td>
<td>-0.13</td>
<td>1947-Q1/2016-Q1</td>
</tr>
<tr>
<td>Employment</td>
<td>3.09</td>
<td>0.85</td>
<td>3.32</td>
<td>0.85</td>
<td>1947-1/2016-2</td>
</tr>
<tr>
<td>PAYEMS.cycle</td>
<td>3.09</td>
<td>0.85</td>
<td>3.32</td>
<td>0.85</td>
<td>1947-Q1/2016-Q2</td>
</tr>
<tr>
<td>GDP</td>
<td>3.38</td>
<td>1.00</td>
<td>3.69</td>
<td>1.00</td>
<td>1947-1/2016-1</td>
</tr>
</tbody>
</table>
Dear Justin,

Thanks for doing this!
I've linked to your page from both [http://econweb.ucsd.edu/~jhamilto/](http://econweb.ucsd.edu/~jhamilto/) and [http://econweb.ucsd.edu/~jhamilto/software.htm#HP](http://econweb.ucsd.edu/~jhamilto/software.htm#HP)

With gratitude,
Jim
And he did it!

Alternatives to Hodrick-Prescott Filter

James Hamilton's data with Matlab and RATS code

Justin Shea's R code
Download the package and collaborate

On Cran:

```r
install.packages("neverhpfilter")
```

Or dev version with current data:

```r
devtools::install_github("JustinMShea/neverhpfilter")
```
Thank you R/Finance!