**Continuous Mortality Investigation**

**Mortality Projections Committee**

**WORKING PAPER 82**


**The CMI format for heatmaps
of mortality improvements**

September 2015

**Contents**

# Continuous Mortality Investigation

# Mortality Projections Committee

# WORKING PAPER 82

# The CMI format for heatmaps
# of mortality improvements

## 1  Introduction

Heatmaps are used to illustrate patterns of mortality improvements, by age and calendar year; particularly to show cohort effects. A number of different formats have been used in CMI papers and presentations and by other authors.

As part of its review of the CMI Mortality Projections Model, the Mortality Projections Committee has considered what format would be best to use for heatmaps of mortality improvements. It has adopted a new format which has been used in CMI_2015 and will be used in other CMI outputs.

The Committee is making available an Excel workbook that contains a macro that will allow others to easily create heatmaps using the CMI format.

This Working Paper describes the new format and the thinking behind it, and use of the Excel macro (which is available alongside this paper, from the Institute and Faculty of Actuaries' website[1]).

Please note that this Working Paper is being made publically available. It makes reference to the CMI Model and other outputs which are restricted to those organisations and individuals who register as CMI users. Information on how to register is available on the CMI's website[2].

Any comments on this paper or the macro should be sent to projections@cmilimited.co.uk.

---

[1] http://www.actuaries.org.uk/research-and-resources/pages/cmi-working-paper-82
[2] http://www.actuaries.org.uk/research-and-resources/pages/how-access-cmi-outputs

## 2 The CMI format and its motivation

This section describes the choices made by the Committee in choosing its format for heatmaps, and their motivation. The main use of the format is to show smoothed mortality improvements, and this has influenced some of the Committee's decisions.

Figure 1 shows an example heatmap in the CMI format, showing mortality improvements by age and calendar year.
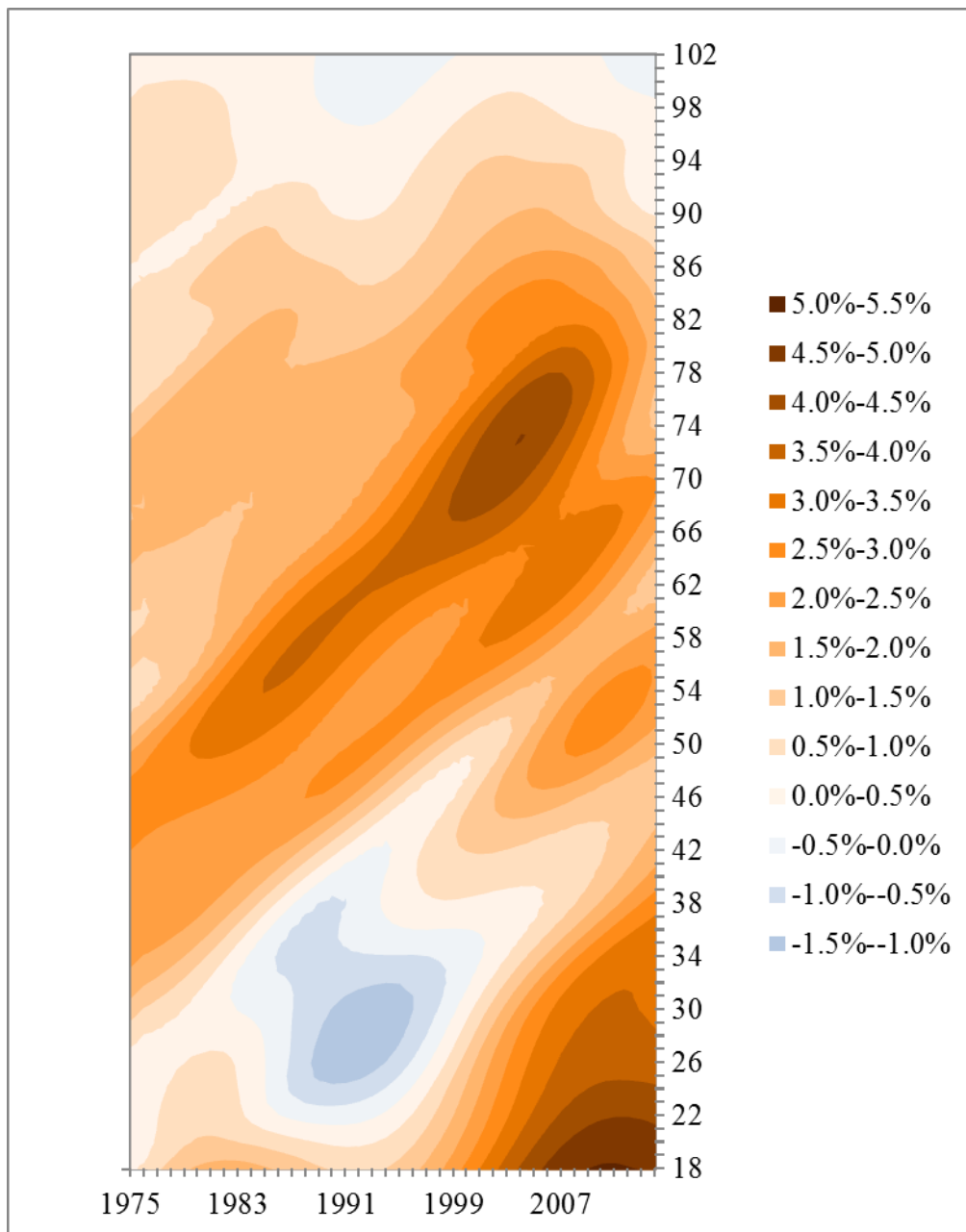


**Figure 1 – Example heatmap, of mortality improvements by age and calendar year, in the CMI format**

### 2.1  Colour palette

Previous versions of the CMI Model use a 'rainbow' palette, and this has been widely used elsewhere. While it is visually appealing, the Committee noted some concerns with this:
1. It can be difficult for colour-blind people to interpret.
2. Depending on the particular colours used, the perceived 'distances' between pairs of adjacent colours may not correspond well to the differences in mortality improvements that they represent.

To address these concerns, the new format uses a more limited palette, with oranges and browns for positive improvements, blues for negative improvements, and white for nil improvement.

### 2.2  Discrete or continuous

We plot improvements varying continuously by age and time, rather than plotting square blocks for each age/year combination. This reflects the continuous nature of smoothed improvements.

We plot discrete bands for each 0.5% range; e.g. improvements of 2.6% and 2.7% have the same colour as they are both in the range 2.5% to 3.0%. We considered the alternative of allowing colours to vary smoothly, but found that this made it harder to determine the level of improvement at a specific point on the heatmap.

### 2.3  Range of mortality improvements

We fix a mapping from improvement to colour, so that, say, a +2% improvement is represented by the same colour on every heatmap.

We use a range from -6% to +6%, with improvements above +6% being given the same colour as +6% (dark brown), and improvements below -6% being given the same colour as -6% (dark blue).

This range works well for the main use of the heatmaps by the CMI: smooth mortality improvements, for England & Wales, in the last 40 years, at an aggregate level. It may work less well for crude improvement rates, improvements for individual causes, or some other countries.
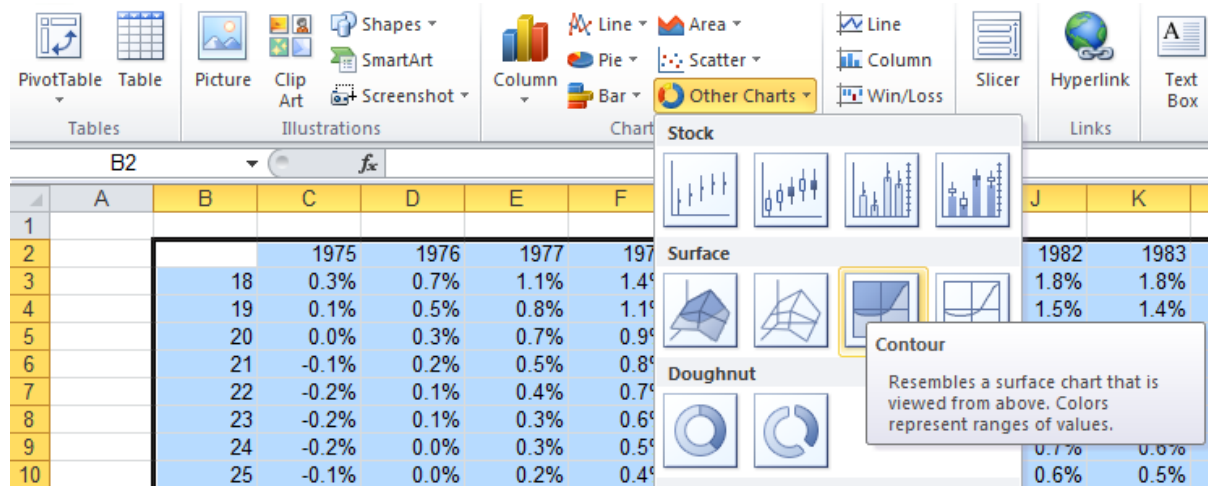
# 3 The Excel macro

This section describes the steps required to create and format an Excel chart using the CMI format.
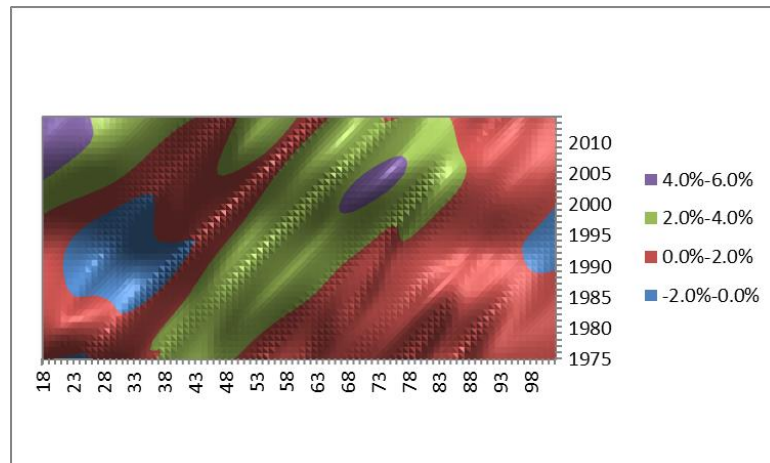
## 3.1 Create a Contour chart

A. First prepare the data. This should be arranged on an Excel worksheet in a grid, with ages as row headings and years as column headings (as in the screenshot below).

B. Select the data and create a Contour chart.



C. The chart should look something like this, with Excel's default formatting:
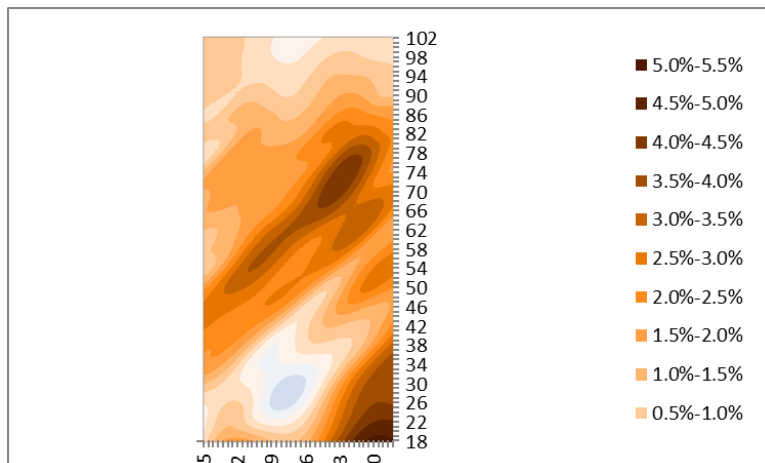


## 3.2 Apply formatting

D. If you have not already done so, open the add-in "CMI heat map format.xlsm" that contains the formatting macro, and "Enable Macros" if prompted to do so.

E. Click on the chart that you created in C.

F. Run the macro "ColourHeatMap", found under the "Developer" Menu.

G. The chart should now look something like this:



## 3.3  Tidy the chart as necessary

H. You may then need to tidy the chart slightly, including:

- adjusting the size of the legend so that all items are visible;
- re-sizing/re-shaping the chart; and
- adjusting the x-axis labels so they are visible.

It does not seem to be possible for us to automate this step, particularly as different heat maps will use different numbers of years and ages.

# 4 Colour codes

The colour codes for each range, in RGB and hexadecimal formats, are shown below. It is not necessary to know these if using the Excel macro, but they may be helpful for other applications.

| Mortality improvement | (R,G,B) colour | Hexadecimal colour |
|---|---|---|
| over +5.5% | (77,26,0) | 4D1A00 |
| +5.0% to +5.5% | (94,36,0) | 5E2400 |
| +4.5% to +5.0% | (129,57,0) | 813900 |
| +4.0% to +4.5% | (163,78,0) | A34E00 |
| +3.5% to +4.0% | (198,99,0) | C66300 |
| +3.0% to +3.5% | (233,119,0) | E97700 |
| +2.5% to +3.0% | (255,140,26) | FF8C1A |
| +2.0% to +2.5% | (255,161,67) | FFA143 |
| +1.5% to +2.0% | (255,182,109) | FFB66D |
| +1.0% to +1.5% | (255,203,151) | FFCB97 |
| +0.5% to +1.0% | (255,224,192) | FFE0C0 |
| 0.0% to +0.5% | (255,245,234) | FFF5EA |
| −0.5% to 0.0% | (240,244,249) | F0F4F9 |
| −1.0% to −0.5% | (210,222,238) | D2DEEE |
| −1.5% to −1.0% | (180,200,226) | B4C8E2 |
| −2.0% to −1.5% | (151,178,214) | 97B2D6 |
| −2.5% to −2.0% | (121,156,203) | 799CCB |
| −3.0% to −2.5% | (91,134,191) | 5B86BF |
| −3.5% to −3.0% | (61,112,180) | 3D70B4 |
| −4.0% to −3.5% | (31,90,168) | 1F5AA8 |
| −4.5% to −4.0% | (2,68,156) | 02449C |
| −5.0% to −4.5% | (0,46,145) | 002E91 |
| −5.5% to −5.0% | (0,24,133) | 001885 |
| below −5.5% | (0,13,128) | 000D80 |