



Chart Guidebook

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1 Charts: making the data speak to our readers

A typical Grattan report contains about 15 to 25 charts. They exist to complement and provide evidence for important points made in the text. Often an entire report can be summed up in a few charts.

Grattan charts also have a wide reach – not only reports, but op-eds and presentations. Some of them are republished by others. And the best charts are likely to have a long shelf life.

Grattan aims to produce charts of the highest standard – better than those seen in major newspapers, academic papers, and reports produced by government departments and consultant firms (not that the bar has been set very high). To do this, there are a number of guidelines and principles to follow (these apply to both report charts and presentation charts).

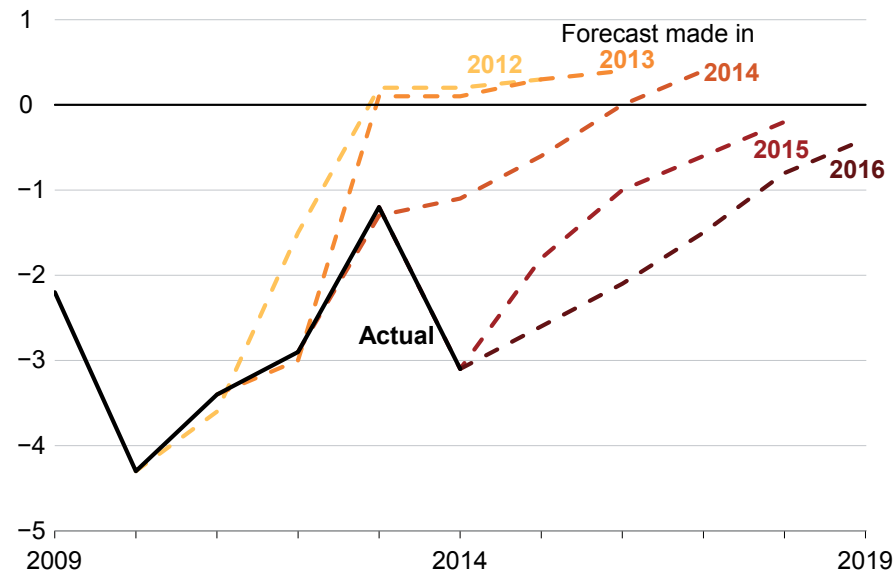
1.1 What makes a strong Grattan chart?

- simple, elegant and easy to follow
- reader drawn to key point straight away
- clearly labelled (axes, categories, *etc.*):
- doesn't mislead readers
- maximises the *data-ink* ratio (no chart junk)
- uses Grattan palette so that it's instantly recognisable

1.2 How to ruin a chart

- information overload
- reader has to work too hard to understand message

Figure 1: Treasury forecasts have continually been too optimistic
Budget surplus (deficit) as a percentage of GDP, forecast vs actual



Notes: This is an example of a strong Grattan chart – makes one single point very clearly, and the colours and style make it recognisable as a Grattan chart.

Source: Budget pressures 2014.

- reader distracted by unimportant quirks
- too many bells and whistles
- labels difficult to read

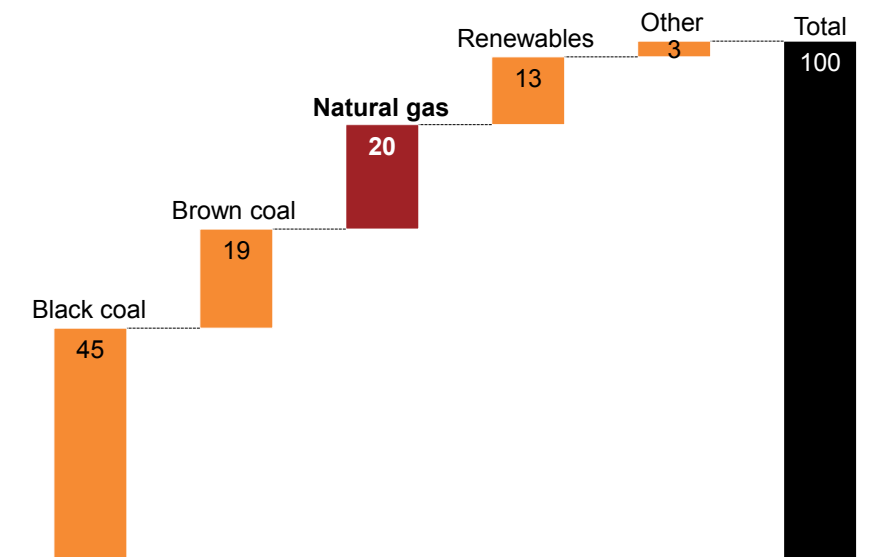
1.3 Make life as easy as possible for our readers

Often the best charts are the simplest. While it is tempting to add layers of complexity to charts, many readers will skip over them if they are too hard to understand. A good test of your charts readability is to ask your Grattan co-workers – if they are not able to understand what your chart is saying within 10 seconds, how can you expect the average reader to take away the key point?

The following principles will greatly assist our readers in understanding charts:

- use descriptive titles: highlight the point the chart is making (use the subtitle for Y-axis units)
- use prominent colours for data you wish to highlight, and lighter colours for less-important data (see Figure 2)
- use the right chart type to present the data (see Chapter 3)
- highlight or add explanation as necessary (it's ok to use text boxes on charts)
- think about minimising the eye movement of readers:
 - place category labels as close to data as possible
 - use labels, arrows, *etc.* to draw viewer to key parts of the chart
 - arrange categories in a logical order (e.g. largest to smallest)
 - avoid vertical and angled text (use horizontal text only)

Figure 2: Gas-fired power supplies one fifth of Australia's electricity
Percentage of electricity generation by fuel source, 2012-13



Notes: Colour has been used to draw reader to most important category. Labelling each column above the data rather than below the X-axis reduces eye movement, while using data value labels instead of a Y-axis reduces clutter.

Source: Gas at the crossroads (edited).

1.4 Gullible and sceptical readers

It is extremely easy to mislead with charts, and it can even happen unintentionally. Perhaps because of this, many readers are naturally sceptical of what they see in charts (“you can use statistics to prove anything!”). We don’t want to mislead gullible readers by making our chart tell a different story to what the data actually says, but we also want to convince sceptical readers that we’re not trying to mislead them.

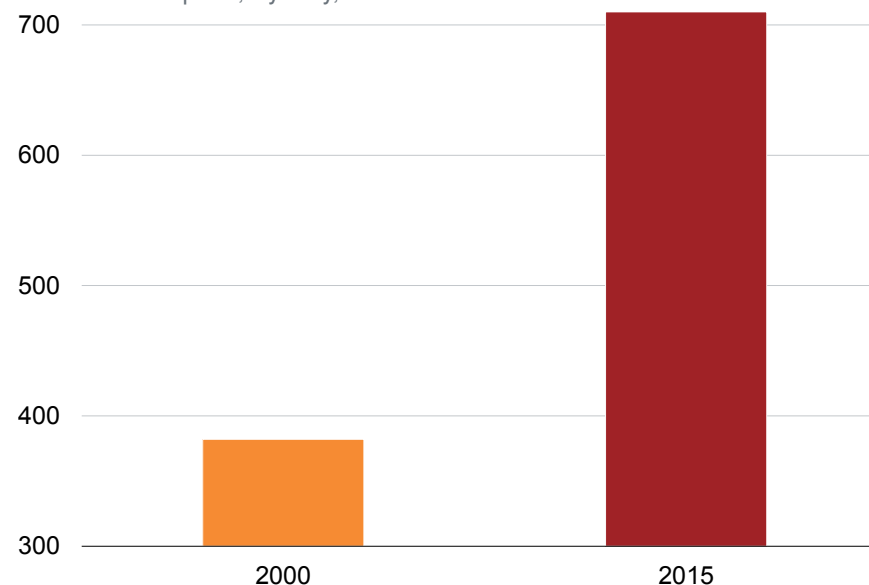
Here are some common ways that charts mislead:

- data manipulation to convey a point, *e.g.*:
 - nominal instead of real dollars
 - starting an index from a cherry-picked point in time
 - comparing Australia to a particular selection of countries
 - excluding part of the data that tells a different story
- choosing Y-axis range to exaggerate differences in data (*e.g.* bar charts that don’t start at zero – see Figure 3)
- orientation of pie charts
- category order in area charts
- 3D charts, infographics,¹ and other effects (just don’t do it!)
- area charts, pie charts, and dual-axes charts can easily mislead, sometimes unintentionally (don’t avoid completely, but be careful).

1. *A Sugary Drinks Tax* did use an infographic to great effect but, in general, they are best avoided.

Figure 3: Australian house prices have increased a lot over the last 15 years

Median house price, Sydney, thousands of dollars



Notes: The obvious misleading feature is the Y-axis not starting at zero, but there are other misleading features. For instance, it appears to use nominal, not real dollars, and only Sydney is included, perhaps because it’s experienced the fastest growth.

Source: Fortunately this has never been published in a Grattan report. But this type of chart has been known to appear in the tabloids.

1.5 Maximising the data-ink ratio

The data-ink ratio is a concept introduced by Edward Tufte, a charting expert.² The principle of maximising the data-ink ratio motivates us to create charts that are as simple, elegant and aesthetically pleasing as possible.

Anything that distracts the viewer from the key message can be considered *chart junk* – get rid of it! But according to this principle, even subtle features (visual clutter) that do nothing to enhance the readability of the charts should be removed.

Here are a few examples of chart junk and visual clutter:

- gridlines that are too dark (best to use a light grey)
- border around chart
- shadows and effects
- background colour (keep it white or transparent)
- too much text on chart (text on a chart is ok, but too much defeats the purpose of using a chart)
- redundant labels
- unnecessary or excessive use of colours/shading (using the entire Grattan palette might look pretty, but if the colours do not represent anything it can be distracting)
- too many tick marks (and corresponding labels) on axes

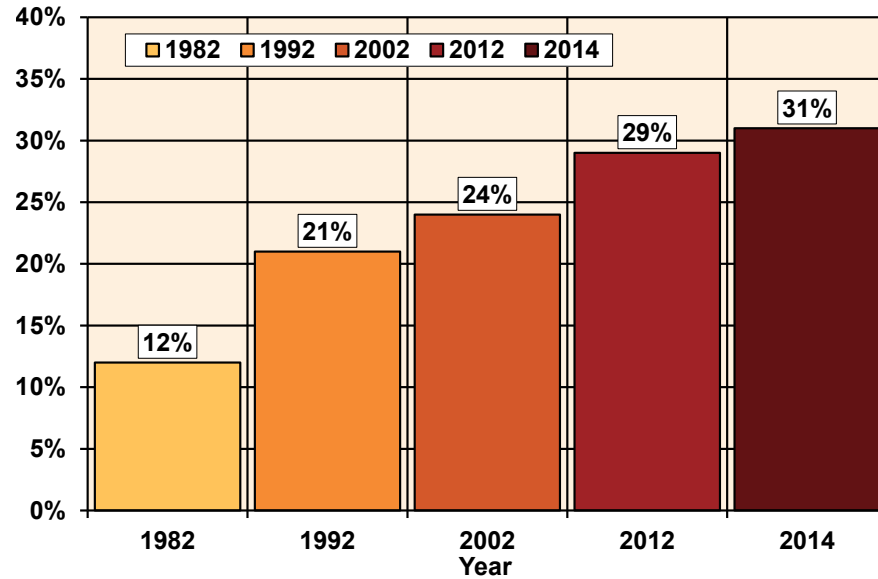
Here are some suggestions to maximise the data-ink ratio (as always, use your better judgement – these are principles, *not* rules):

- in general, use between four and seven gridlines/value labels on the Y-axis:
 - one option is to use a value label for every second gridline (use *minor* gridlines) – for example, you can have gridlines at 2, 4, 6, 8, 10, 12 and value labels 4, 8, 12 (the gridlines make it easier to interpret data points, but having few value labels reduces clutter)
- if you have more values labels on the Y-axis than data points on the chart, consider removing the Y-axis (and gridlines) completely and label the data points directly:
 - this is most applicable for a bar/column chart with only a few bars
 - can also apply to a line chart where you just want to emphasise the start and finish points
- if the units of your X-axis is obvious (e.g. ‘year’), there is no point including a label
- if your chart units are ‘dollars’ (or ‘millions of dollars’), is it better to label this in the chart subtitle, and keep the ‘\$’ signs off the Y-axis
- if your chart units are large numbers (e.g. in the millions of dollars), scale your axis accordingly and use the chart subtitle to indicate this

2. It is worth lovingly turning through his droolingly beautiful book *The Visual Display of Quantitative Information*, which is kept on the bookshelf in the north-east wing.

Figure 4: An example of a chart with low data-ink

Percentage of 17–19 year olds enrolled in university

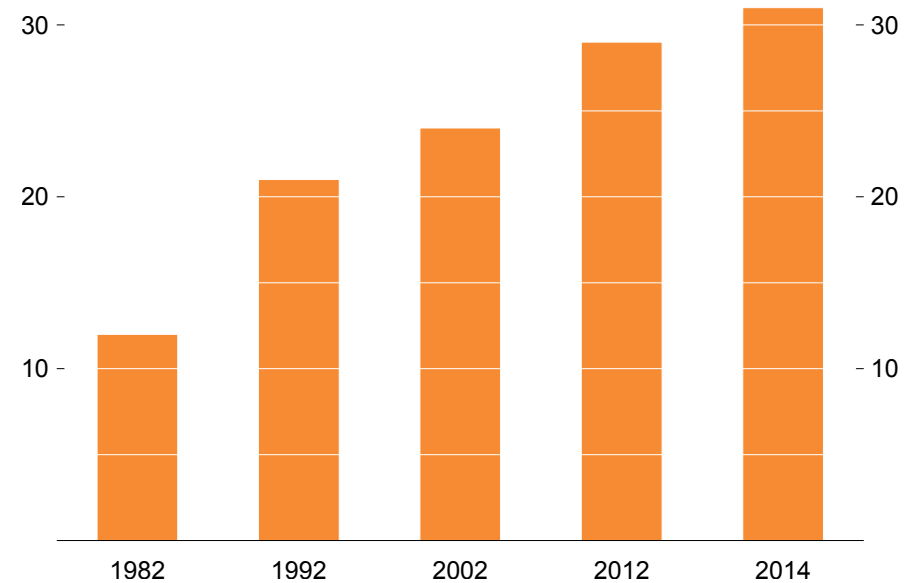


Notes: Chart junk: gridlines too dark, too many Y-axis value labels, redundant elements (X-axis label, percentage signs, legend, vertical gridlines, data labels), and unnecessary elements that distract (bold text, different colours, small gap between bars, background shading).

Source: Mapping Australia's Higher Education (though the version published was much nicer).

Figure 5: The same chart with high data-ink

Percentage of 17–19 year olds enrolled in university



Notes: Chart is less colourful, but much more elegant and easy to read. Taking the data-ink principle to its extreme means we would probably remove the Y-axis on the right-hand side, but having it on both sides does minimise the eye movement of the reader. If we wanted to increase the data-ink ratio even further, we could remove the Y-axis on both sides, and just use a data label for each bar.

Source: Mapping Australia's Higher Education (though the version published was not quite as nice).

2 The rules

There are a number of formatting rules in place for creating Grattan charts. This is to ensure consistency within and across reports. The most important of these rules is to only use Grattan colours – this is what makes our charts recognisable when they are published elsewhere. There are templates set up with the correct formatting in place, but sometimes manual adjustments are necessary.

2.1 Programs used for making charts

Most Grattan charts are created using PowerPoint. Although the chart settings can be quite restrictive, there are some clever ‘cheats’ that can be used to produce almost any chart you can envisage (see Chapter 4). The rules outlined in this section refer to charts made in PowerPoint. If using a PC, make sure you have MS Office 365 installed on your machine (go to <https://portal.office.com> and login using your email and password – it is a free download for Melbourne University staff).³

If you are an R user, Hugh Parsonage has written an impressive package (available on GitHub) that can be used to create charts with Grattan formatting. The *Grattan* package is very flexible, and has the advantage of being integrated into an R script (with charts updating automatically with changes in the analysis).

Grattan is also beginning to experiment with interactive charts (HTML) published in op-eds. There are a range of programs that can be used for this purpose, including R and Plotly, Tableau, and Google charts, but the easiest to use for basic charts is Datawrapper. This is discussed in more detail in Chapter 5.

3. By all reports, this version is worse for Macs.

2.2 PowerPoint Chart templates

To start making charts, open the template file ‘Charts for reports.potx’, available on the Z drive (Z:\Templates\Charts) and Dropbox, and save to a local folder. This file has all the correct defaults, including the aspect ratio, Grattan colour palette, font sizes and text box settings. It also contains example charts that can be edited (right click anywhere on the data, and select ‘edit data’ -> ‘edit data in Excel’, then paste your data over the existing data). For presentations, use the template file ‘Charts for presentations.potx’ or ‘Charts for presentations 16-9 (widescreen)’.⁴

There are also templates for most charts, available on the Z drive, at Z:\Templates\Charts\Office chart templates, and on Dropbox. These templates need to be saved in your local template folder. To find this folder, create a chart in PowerPoint, right click on the chart and select ‘save as template’, then copy and paste all templates to this address. If you are using a Mac, you may need to change the settings to show hidden files and folders.

Once installed to the local folder, you can insert a Grattan chart by going to ‘insert’, then selecting ‘charts’ and ‘templates’.

2.3 Aspect ratio

2.3.1 Standard chart

A standard Grattan report chart has an aspect ratio of 1.53 – the PowerPoint template has dimensions: 22.16 × 14.5cm. Report charts should utilise an entire slide – make sure to extend the corners of the

4. To convert a report chart to a presentation chart, click on a slide, select all items on the slide, and copy and paste across – the chart should fit nicely into the available space in the presentation.

chart to the corners of the slide.⁵ When a chart is inserted into a report, the width of the slide will be equal to the report column width.

There may be the occasional chart that requires a different aspect ratio. This can be changed by going to the 'design' tab, and selecting 'slide size'.⁶ Unless you plan to insert a chart across multiple columns, the slide width should be kept at 22.16cm to ensure the font sizes are correct when the chart is inserted into a report. The height can be increased or decreased as desired.

2.3.2 Whole-column chart

Occasionally a chart will look better displayed over an entire column – this may be the case when there are many categories on the Y-axis, or perhaps two charts stacked on top of each other. Increasing the height to 22.16cm (aspect ratio of 1.0) will create a taller chart that will usually fit into a single column along with chart title, subtitle, notes, and sources (see Figure 6). It may be possible to increase the height by slightly more if the notes and sources do not take up much space.

2.3.3 Charts with a wider aspect ratio

While most charts can be presented using the standard aspect ratio, there are a number of scenarios in which it may be desirable to reduce the height of a chart, thereby increasing the aspect ratio:

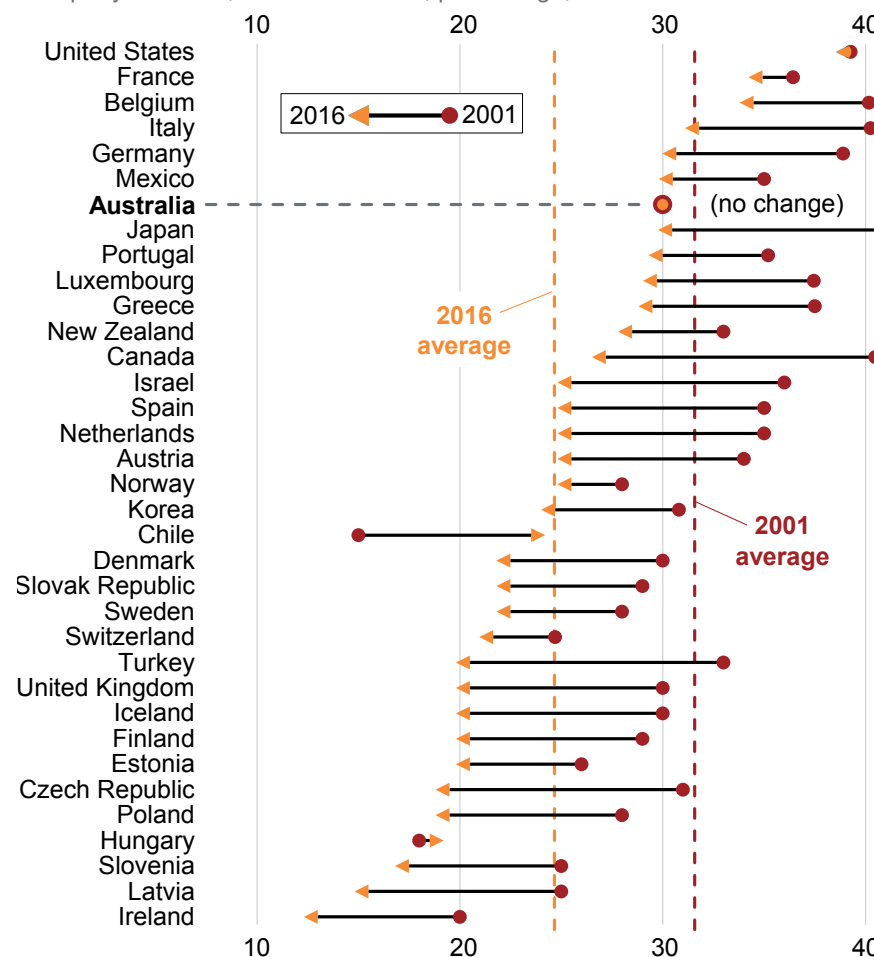
- fitting two or more charts in a single column where each chart has a separate subtitle (a height of 10cm should work for this purpose)
- increasing the visual appeal of certain charts – e.g. line charts with a long time-series often look better with a wider aspect ratio

5. The Y-axis numbers should be hard against the left border of the slide.

6. Unfortunately, PowerPoint only allows a single aspect ratio across slides in a single file. Thus, if you adjust the aspect ratio of one or more charts, these must be stored in a separate file to your standard charts.

Figure 6: Company tax rates have been falling across advanced economies

Company tax rates, OECD countries, percentage, 2001 and 2016



Notes: This is an example of a chart that requires a whole column.

Source: Stagnation Nation.

- improving the overall formatting of a report – e.g. the placement of charts relative to text may be optimised by inserting a shorter chart with text underneath.

2.3.4 Whole-page chart

Whole-page charts are rarely used in Grattan reports, but if you desire one (for instance, you want to display four charts in a 2x2 setting), then an aspect ratio of 2.2 can be used. Increase the slide width to 48.73cm and the height to 22.15cm.

2.4 How to insert a PowerPoint chart into a report

Charts must be saved as a PDF to be inserted into \LaTeX . It is possible to save individual slides as a PDF, or save an entire chartpack. The PDF(s) should be saved into the ‘atlas’ folder of the \LaTeX repository.⁷

The following \LaTeX code can be used to insert a chart (including title, units, etc.):

```
\begin{figure}
\caption{Chart title \label{fig:chartXreference}}
\units{Chart units}
\includegraphics[page=5]{atlas/chartpack.pdf}
\noteswithsource{Notes go here}{Sources go here}
\end{figure}
```

(this code would insert the 5th slide of the file ‘chartpack.pdf’).

If you need to include notes *or* sources, but not both, use the command `\notes` or `\source` instead of `\noteswithsource`.

7. The easiest way to do this is to link your ShareLaTeX account to Dropbox, then keep all .pptx and .pdf files in the ‘atlas’ folder. Whenever you update one or more slides, simply re-save the file as a PDF and the report will automatically update with the new charts.

Determining placement of charts

\LaTeX automatically ‘floats’ charts in the PDF output – that is, it chooses where to place them based on your input, and allows text to flow around them. As a general rule, \LaTeX will place each chart in the next available right column after it appears in the code, usually with no text appearing in the same column. It is possible to override these settings but, as a general rule, it is best to leave this until the report is close to publication.

If you have a whole-column chart, it is best to use the `figureTop` environment, i.e.:

```
\begin{figureTop}
\end{figureTop}
```

If you want to place two figures side-by-side on a page, use the following code:

```
\doublecolumnfigure{%
\caption{Left chart title \label{fig:leftchartXreference}}
\units{Left chart units}
\includegraphics[page=10]{atlas/chartpack.pdf}
\noteswithsource{Notes go here}{Sources go here}%
}{
\caption{Right chart title \label{fig:rightchartXreference}}
\units{Right chart units}
\includegraphics[page=11]{atlas/chartpack.pdf}
\noteswithsource{Notes go here}{Sources go here}%
}
```

2.5 Colours

The Grattan colour palette includes six colours along a yellow-orange-red spectrum. The colour spectrum is designed so that each shade is distinguishable when printed in black and white, and also distinguishable to people with most forms of colour blindness. There are also six shades of grey (*e.g.* for a chart appearing in a book), and certain colours to use for gridlines, shading an area of a chart (*e.g.* to emphasise a forecast), and to match the box background. These colours are defaults in the PowerPoint template, but you may occasionally need the RGB, Hexidecimal or CYMK colour codes, listed in Tables 2.1 to 2.3. Greys should be avoided for displaying data in reports, since these may not be distinguishable from colours when printed.

2.5.1 Which colours to use for different data types

There is no hard and fast rule for which of the six Grattan colours you should prioritise. But here are some suggestions:

- default colour: Light Orange (this is very close to the colour used for the Grattan logo, so probably the most recognisable). You can potentially use this colour on every chart
- colour for emphasising data: Red (contrasts well with Light Orange). Can also use for negative values (*e.g.* budget costs)
- colour for less-important data: Light Yellow
- avoid text in Light Yellow (too hard to read!)
- use consistent colours across charts for the same categories
- consider alternative ways of presenting the data to keep number of colours to a minimum
- avoid transparent colours, as there are problems printing these. Instead, use 'faded' colours (see Table 2.1 for RGB codes)

Table 2.1: Grattan colour palette











	Light Yellow RGB: 255, 224, 127 Hex: FFE07F CMYK: 0, 12.16, 50.2, 0 Faded RGB: 255, 231, 159
	Yellow RGB: 255, 195, 90 Hex: FFC35A CMYK: 0, 23.53, 64.71, 0 Faded RGB: 255, 210, 131
	Light Orange RGB: 246, 139, 51 Hex: F68B33 CMYK: 0, 43.5, 79.27, 3.53 Faded RGB: 248, 168, 102
	Dark Orange RGB: 212, 88, 42 Hex: D4582A CMYK: 0, 58.49, 80.19, 16.86 Faded RGB: 222, 129, 95
	Red RGB: 160, 34, 38 Hex: A02226 CMYK: 0, 78.75, 76.25, 37.25 Faded RGB: 183, 89, 92
	Dark Red RGB: 98, 18, 20 Hex: 621214 CMYK: 0, 81.63, 79.59, 61.57 Faded RGB: 137, 77, 78


Table 2.2: Grattan shades of grey

Grey 1
 RGB: 217, 217, 217
 Hex: D9D9D9
 CMYK: 0, 0, 0, 14.9

Grey 2
 RGB: 174, 174, 174
 Hex: AEAFAE
 CMYK: 0, 0, 0, 31.76


Grey 3
 RGB: 130, 130, 130
 Hex: 828282
 CMYK: 0, 0, 0, 49.02


Grey 4
 RGB: 87, 87, 87
 Hex: 575757
 CMYK: 0, 0, 0, 65.88


Grey 5
 RGB: 43, 43, 43
 Hex: 2B2B2B
 CMYK: 0, 0, 0, 83.14


Black
 RGB: 0, 0, 0
 Hex: 000000
 CMYK: 0, 0, 0, 100


Table 2.3: Other Grattan colours

Official Grattan logo colours
 RGB: 243, 144, 29
 Hex: F3901D
 CMYK: 0, 40.74, 88.07, 4.71

 RGB: 106, 115, 123
 Hex: 6A737B
 CMYK: 13.82, 6.5, 0, 51.76

Gridlines
 RGB: 195, 199, 203
 Hex: C3C7CB
 CMYK: 3.94, 1.97, 0, 20.4

Forecast shading
 RGB: 225, 227, 229
 Hex: E1E3E5
 CMYK: 1.75, 0.87, 0, 10.2

Box background
 RGB: 254, 240, 222
 Hex: FEF0DE
 CMYK: 0, 5.51, 12.6, 0.39

2.6 Text and fonts

One of the best PowerPoint tricks is to utilise text boxes rather than rely on the default chart elements – this gives you a lot more flexibility. The best way to insert a text box is as follows:

- select the slide, but make sure the chart is deselected (*i.e.* click somewhere on the background outside of the slide). If the chart is selected, the text box will become part of the chart and it is harder to make adjustments to its position later
- insert text box and type text
- ensure text box has no left, right, top and bottom margins (the default), that there is no border, and either no fill or white fill.

The font and font size are chosen to match those in the report – be sure to always follow these rules:

- use Arial, size 18 for all text (including axes labels and values, data labels, text boxes)⁸
- use black, non-bold font for any text on the axes – the X-axis label (if necessary) should be created with a text box
- use a text box with coloured and bold text to label data categories not shown on axes (the text colour should match the colour used for the data)
- if you want to display a legend, it is better to create your own (using text boxes and coloured squares) rather than the default chart legend
- avoid angled and vertical text – use horizontal text only

8. Some older charts use size 22, but the slide dimensions are larger. The font size is equivalent when such charts are inserted into a report.

- avoid grey text since this may clash with colours if printed in black and white

2.7 Miscellaneous rules that apply to all charts

- the X-axis line should be black with a width of 0.75pt. Remove the Y-axis line if gridlines are in place
- gridlines should be a light grey (see Table 2.3 on the preceding page) so as not to distract from data
- the Y-axis title (chart units) should not be displayed on the slide – this is inserted separately in \LaTeX
- there is no need to label the X-axis unless the units are not obvious.

2.8 Making charts replicable

Many Grattan charts are used across multiple reports and presentations. Often they need to be updated with new data. As a general rule, it should be simple and straightforward for somebody else to find and edit your chart without having to ask for your help.

- use the 'notes' space below each PowerPoint slide to put in the chart details: title, units, data sources (with url), file where analysis can be found, and any other relevant information
- rather than linking each chart directly to an Excel workbook containing the analysis, data should be copied and pasted into a PowerPoint chart created from scratch. This is because links to Excel are easily broken
- all chart data should be published in an Excel workbook on the Grattan website (after report publication) so that they can be replicated by anybody. A template for this is available on the Z drive: Z:\Templates\Chart data template.

3 Creating specific charts

3.1 Choosing the right chart type

There are usually a number of different ways you can present the same data. There is no particular chart that is *always* better than others, and often the best chart for particular data is not clear until you have exhausted all other options. Nonetheless, here are some scenarios in which one chart type is likely to make more sense than another.

Displaying time-series data – line chart or bar chart?

- stocks: continuous data measured at different points in time (*e.g.* government debt, housing stock, population) is better displayed on a line chart than a bar chart
- flows: when data are measured over a given period of time (*e.g.* budget deficit, intake of international students by year), it often makes more sense to display it on a bar chart than a line chart. Exceptions to the rule:
 - long time series
 - some measures that are technically flows, but have little variation over time (*e.g.* GDP, average income).

Displaying cross-tabulation (multiple categorical variables) – stacked or clustered bar chart?

- stacked bar charts make it easy to compare the *totals* across a single categorical variable – it makes sense to use this chart when you want to emphasise the aggregates, or if you want to compare proportions relative to one group

- clustered bar charts make it easier to compare values across *both* categories – if there is no reason to aggregate the data, then this chart is usually preferable to the stacked bar.

Displaying proportions of each category relative to the whole – pie chart or waterfall chart?

- pie charts are most appropriate when there are very few categories (usually two or three), or when it makes sense to emphasise one category relative to all others
- waterfall charts look better when there are four to six categories – unlike pie charts, waterfall charts make it easy for the reader to identify proportions *and* actual values. Unlike pie charts, they also allow for negative values.

Displaying multiple time series – single chart or multiple charts?

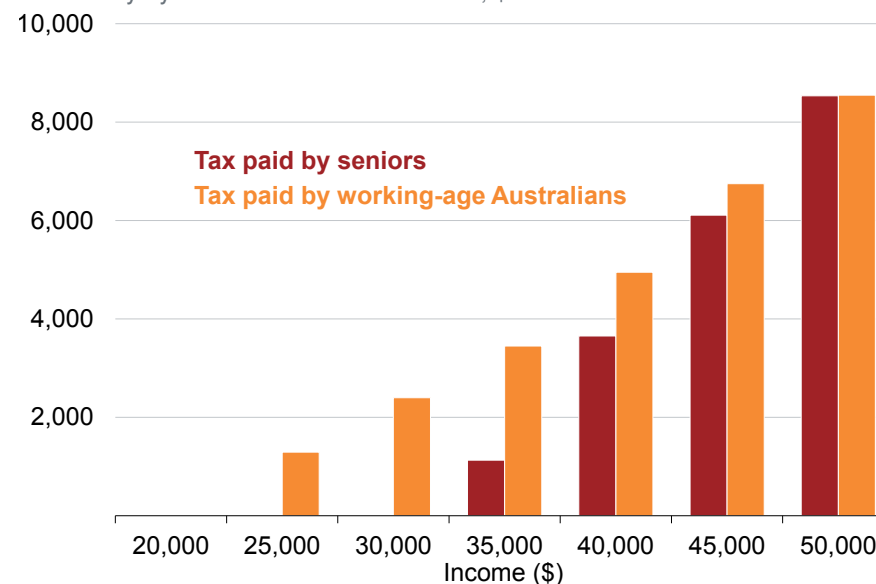
- if the purpose of the chart is to show that a common trend exists across multiple series, a single line chart is usually appropriate
- if there is little overlap between series, but data exist over a similar range, then a single line chart is appropriate
- if it is important for the reader to pick up aspects of each individual series, it may be better to display them separately (either as a *panel* chart, or using multiple charts).

3.2 Bar/column chart

- vertical bars are preferred (in MS Office this is called a 'column' chart)
- use horizontal bars (a 'bar' chart) if there are long category names, or too many categories to fit the names in on the X-axis. Sometimes horizontal bars also look better for displaying positive and negative values
- categories should be placed in their 'natural' order, *e.g.*:
 - youngest to oldest age group
 - ascending/descending by value
- use different colours only to indicate categories/groups (do not use different colours just to make a chart look 'pretty'). If three or more colours used, ensure these are lightest to darkest (or vice versa)
- gap width: default is 100% (*i.e.* width of gap is the same as the width of the bar), but it can be useful to experiment with this parameter to optimise the look of the chart – in general, it is best to ensure that bars are not too wide
- use white borders around bars, 0.75pt
- X-axis tick marks: use to separate clusters
- category labels: for stacked bars, use coloured text boxes for each category placed at the right of chart, as close to each category as possible. For clustered bars, it is often difficult to place text boxes close to the data – an alternative is to create a legend using coloured boxes and black text, placed either at the top right, or below the X-axis.

Figure 7: Seniors pay less tax than a worker on the same income

Tax liability by taxable income in 2015–16, \$2016

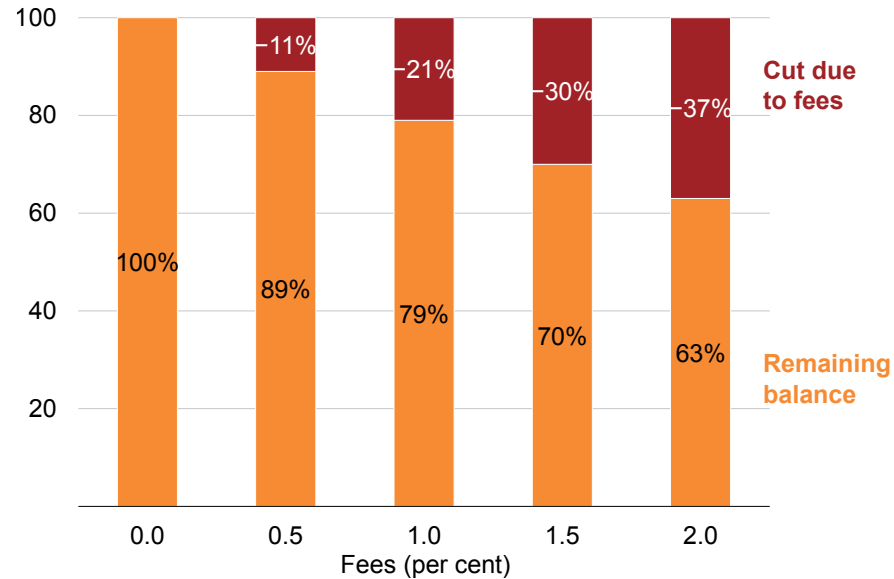


Notes: Clustered column charts can be effective when comparing across two categories.

Source: Age of entitlement: age-based tax breaks.

Figure 8: Even apparently small fees reduce retirement balances

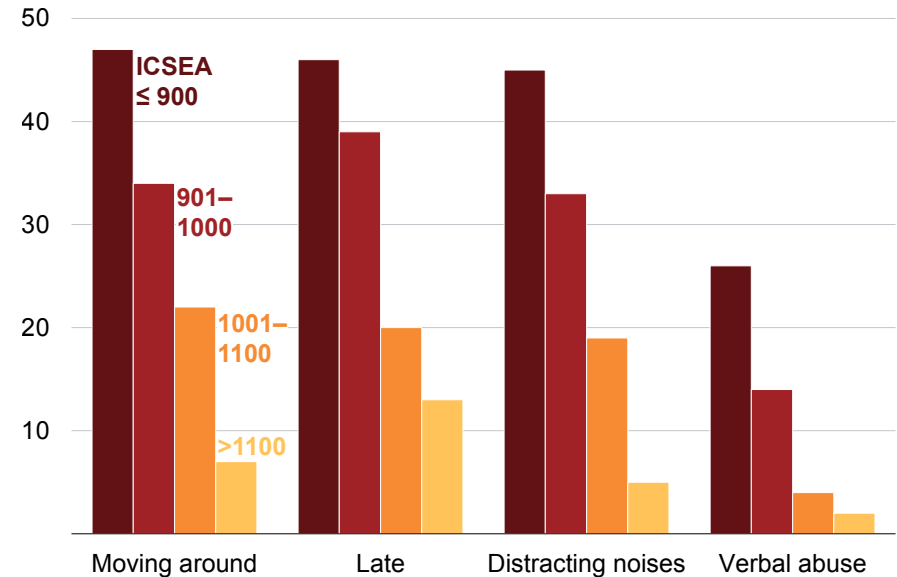
Retirement balances relative to fund with zero fees, per cent



Source: Super sting.

Figure 9: More teachers report unproductive behaviours as very common in low-SES schools

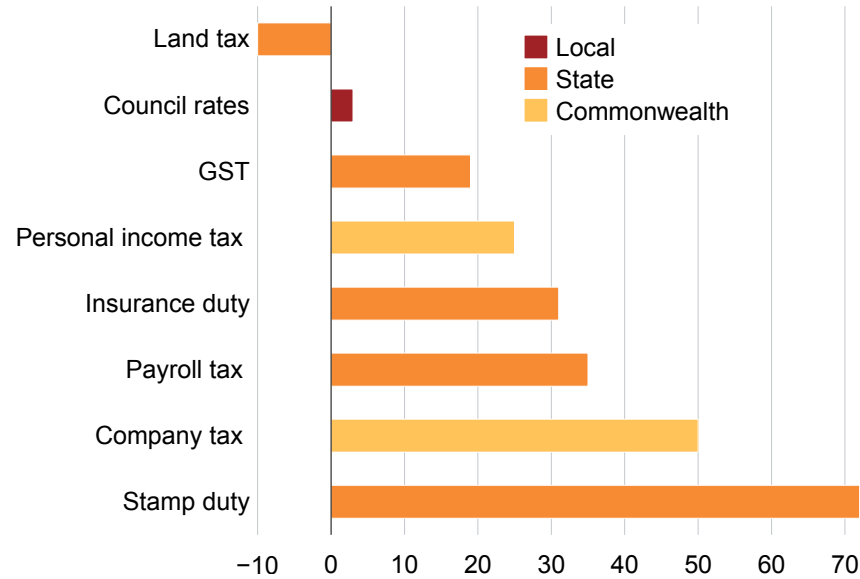
Percentage of teachers who report behaviours 'several times daily', by school socioeconomic status, selected behaviours



Source: Engaging students.

Figure 10: Taxes vary considerably in their efficiency

Marginal excess burden of key Australian taxes, cents per dollar of revenue

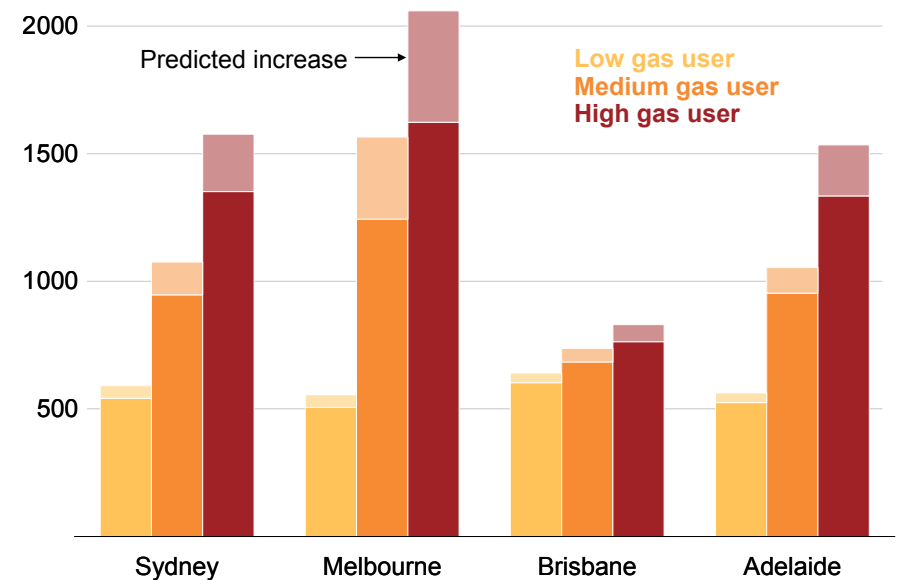


Notes: Long(ish) names, a large number of categories, and a negative value mean that this chart looks better with horizontal bars.

Source: What price value capture?

Figure 11: Household gas bills are likely to increase most in Melbourne

Average gas bill including predicted increase, \$2014

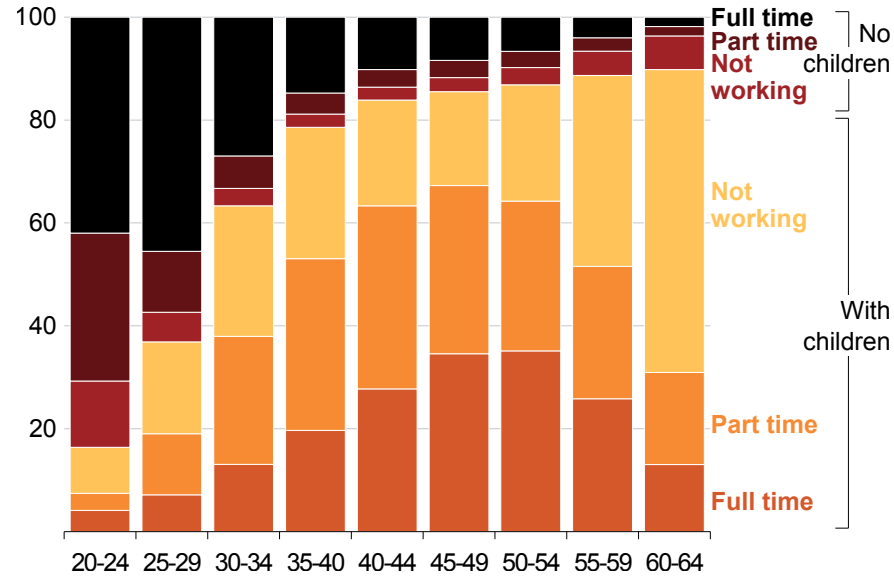


Notes: This is both a stacked and clustered column chart.

Source: Gas at the crossroads.

Figure 12: Most mothers work part-time or not at all

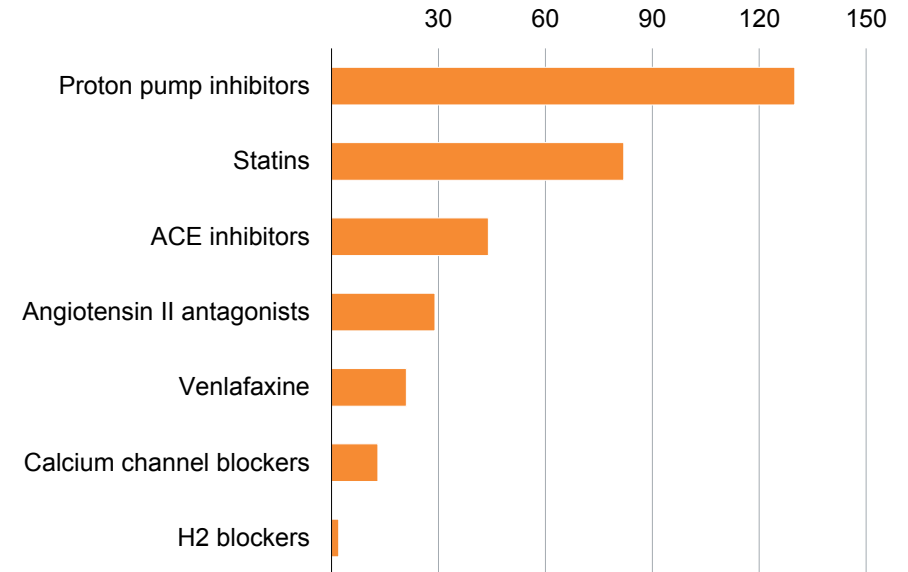
Female workforce participation by age cohort, percentage of total



Source: *Game changers*.

Figure 13: With premiums that covered the full cost gaps, the government would save \$320 million a year for seven groups alone

Predicted savings of premium introduction, millions of dollars



Source: *Premium Policy?*

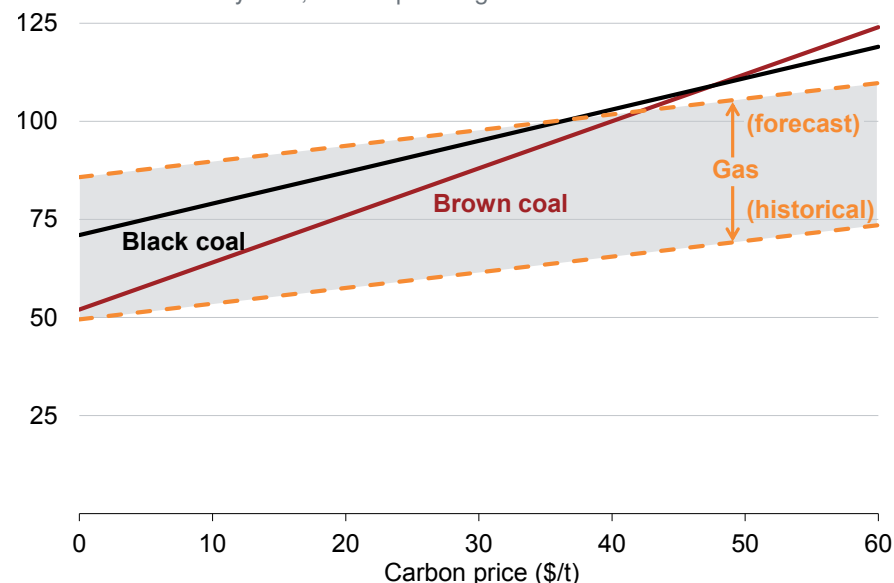
3.3 Line chart

- consider choosing a 'scatter' chart with connecting lines rather than a 'line' chart (allows for more flexibility with the X-axis)
- line width: default is 3pt, but consider a smaller width if you have many data points, or many lines
- X-axis tick marks: position X-axis 'on tick marks', not 'between tick marks'. As a general rule, keep the number of tick marks to a minimum (important: make it clear where series begins and ends)
- category labels: use coloured text boxes, placed either at the right of the chart (next to their respective categories), or placed on chart close to the relevant line
- forecasts: use a dotted line, or otherwise placed a light grey (see Table 2.3 on page 14) rectangular box behind the section where the forecast takes place
- markers: if you want to highlight a particular data point (or the beginning and end points), consider using a marker (usually a circle or triangle of about 8pt works best)
- colours: use a different colour for each series.⁹ If you want to highlight a particular series, use a darker colour (e.g. red), and consider using light yellow for all other series.
- showing a trend: slopes are most noticeable at an angle of about 45 degrees – the Y-axis range can be adjusted for this purpose (this is called *banking*)
- Y-axis range: note that it is not necessary to start the Y-axis at zero (although sometimes desirable) – choose a range so that the reader can clearly see the trends.

9. If the lines do not overlap, you may consider using the same colour for each series, as long as each is clearly labelled.

Figure 14: Gas-fired power is likely to require a carbon price above \$40 a tonne before it is cheaper than coal

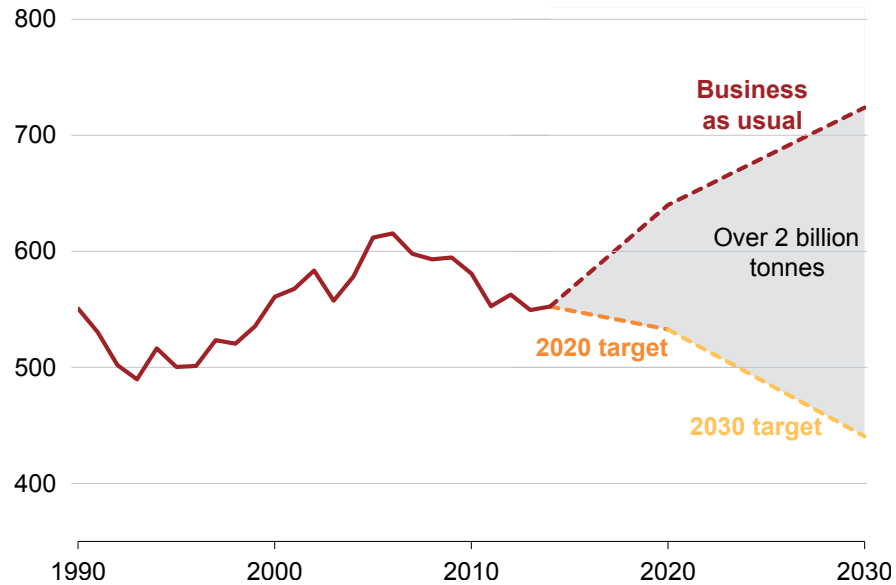
Wholesale electricity cost, dollars per megawatt-hour



Source: *Gas at the crossroads*.

Figure 15: Australia must achieve more than 2 billion tonnes of emissions abatement to achieve the 2030 target

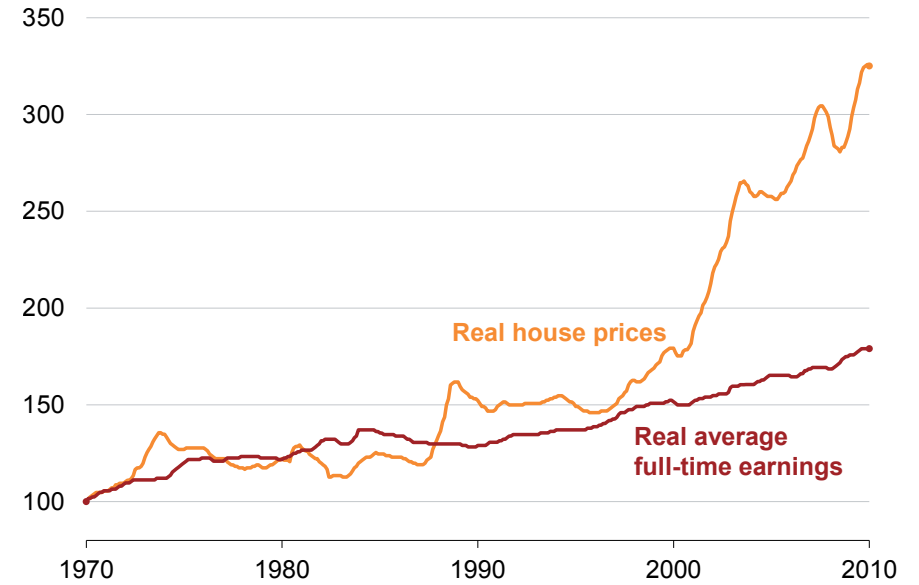
Annual emissions, tonnes of CO₂ equivalent



Source: Climate phoenix.

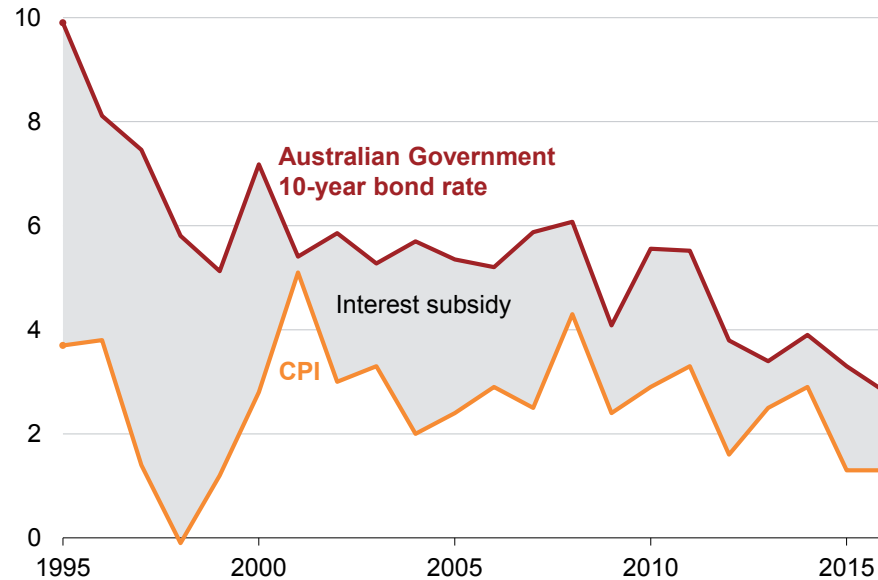
Figure 16: House prices have grown much faster than earnings since 2000

Index of real house prices and real average full-time earnings, 1970 = 100



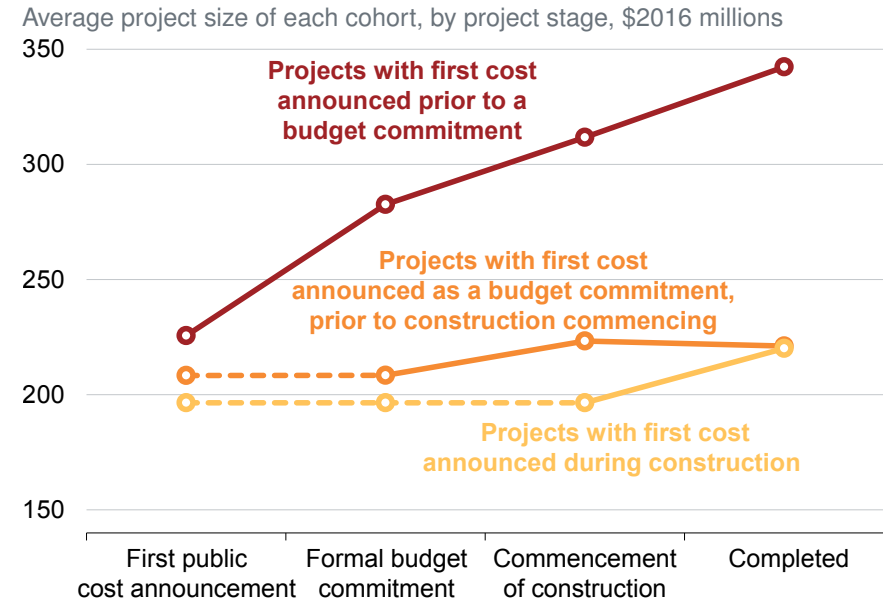
Source: Wealth of generations.

Figure 17: The government's cost of borrowing generally exceeds CPI
Per cent a year



Source: Shared interest.

Figure 18: Projects announced prematurely have larger cost overruns at all stages of the project life-cycle
Average project size of each cohort, by project stage, \$2016 millions



Source: Cost overruns in transport infrastructure.

3.4 Waterfall chart

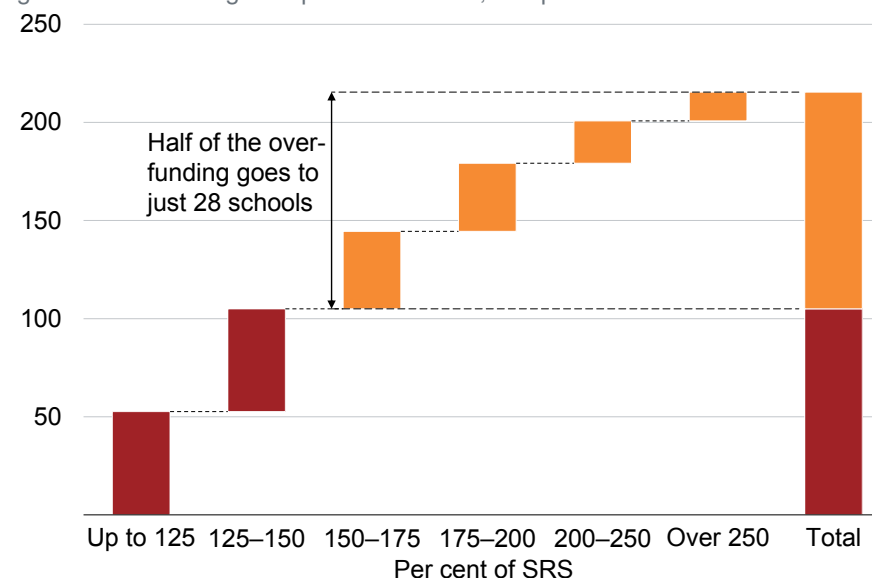
- useful chart for displaying one-way tabulation (either as levels, or as percentage of total) – similar function to a pie chart, but tends to look nicer, particularly if there are four or more categories
- can be inserted directly using PowerPoint 2016, although this does a poor job if you have negative values. The alternative is to use a stacked column chart with some series ‘hidden’ (no fill, no border)
- consider using levels on the Y-axis, and display percentages above each bar
- colours: use different colours sparingly – e.g. to indicate positive and negative values, or a different colour for the ‘total’ column
- when in doubt, follow the rules and guidelines for bar/column charts.

3.5 Pie chart

- looks best for displaying the proportion of one category relative to a whole
- it is easiest for readers to perceive proportions close to a quarter, half or three-quarters. The key arc should start from 12 o’clock
- colours: use a prominent colour for the category of interest, and a light colour for other categories
- good practice to display percentages on chart (as the size of slices can be difficult to read)
- a close alternative is the ‘donut’ chart (a pie chart with a hole in the middle) – the hole can be used to display information.

Figure 19: A tiny number of schools receive nearly than half of the over-funding dollars

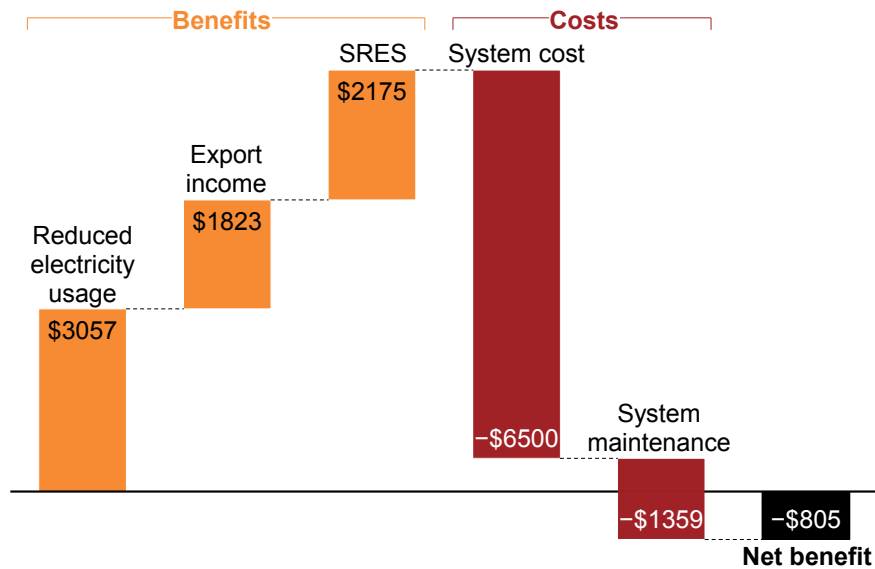
Distribution of over-funding in 2014 (\$ millions), by level of combined government funding as a per cent of SRS, independent schools



Source: Circuit breaker.

Figure 20: The economics of solar PV do not stack up for a typical Brisbane household under a demand tariff

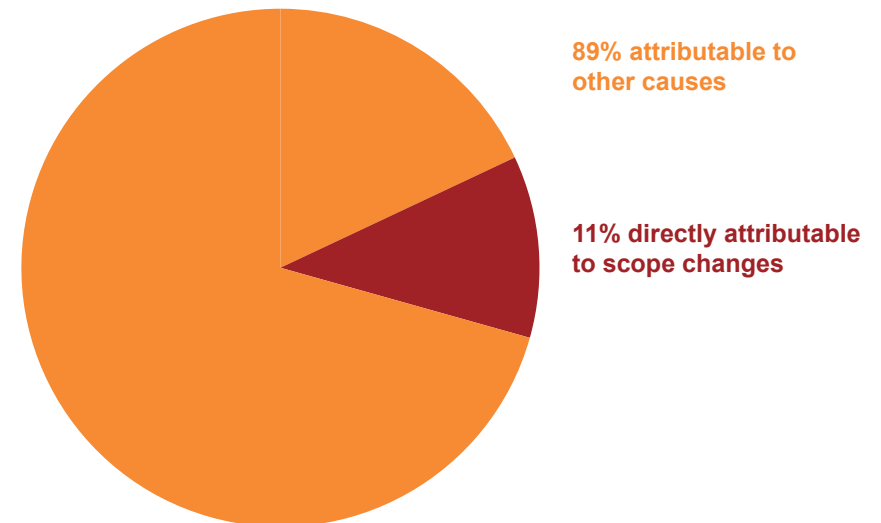
Net present benefits and costs of a 3-kilowatt solar PV system, typical Brisbane household, \$2015



Source: Sundown, sunrise.

Figure 21: Most cost overruns are not attributable to scope changes

Proportion of cost overruns attributable to scope change, per cent



Source: Cost overruns.

3.6 Scatter chart

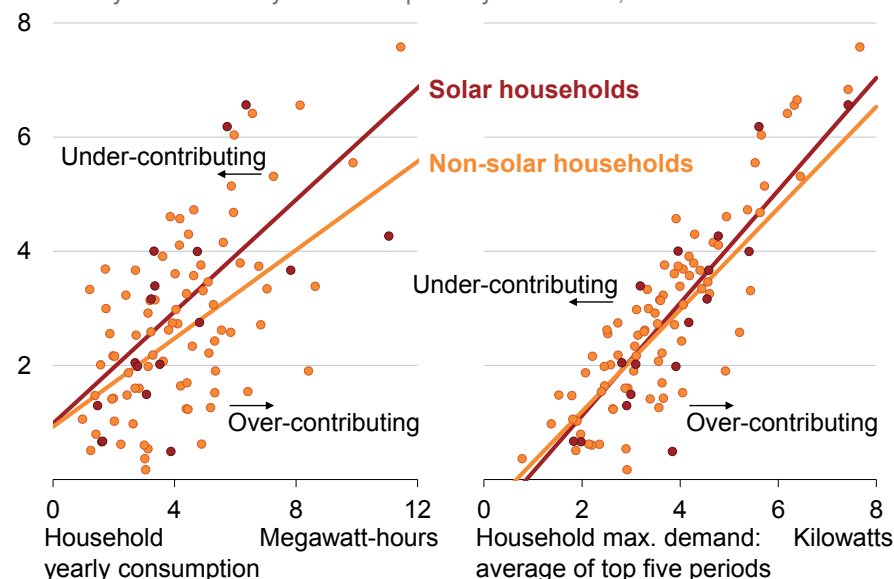
- typically used to display raw data showing the relationship between two variables. Display the 'dependent' variable on the Y-axis and the 'independent' variable on the X-axis
- if you have a large sample, consider displaying a random sub-sample (around 100 data points seems to work well)
- marker style and size: circles are best, size depends on how many data points there are
- colours: can use different colours for different groups (e.g. males and females). Consider transparent colours if there are many data points
- trend line: can be useful to help show what the relationship looks like
- bubbles: can add a dimension to the chart by letting the size of each data point depend on a third variable (called a 'bubble' chart).

3.7 Area chart

- standard area chart: appropriate when the area under the curve has an explicit meaning
- stacked area chart: useful for time-series stock data that naturally aggregate. Can be a misleading chart – areas are actually different sizes depending on their relative position
- histogram: can be a useful way of showing the distribution of a variable
- marimekko: a bar chart with variable column widths (created with an area chart) – both the height *and* width of each column represents a particular dimension (sometimes the area of each column also has a particular interpretation).

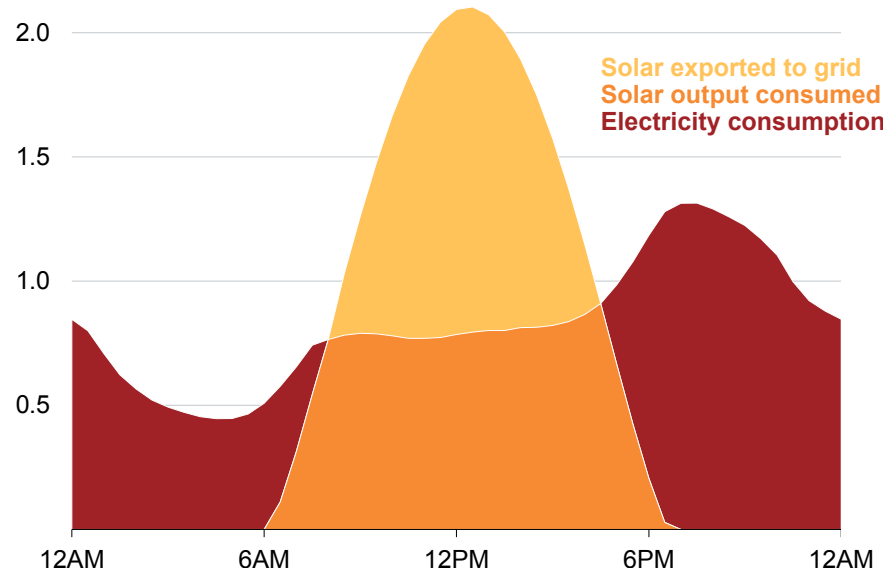
Figure 22: A household's yearly electricity consumption is weakly correlated with their usage at system-wide peak times, while their maximum demand has a stronger correlation

Electricity demand at system-wide peak by household, kilowatt-hours



Source: *Fair pricing for Western Australia's electricity.*

Figure 23: Household electricity consumption is typically highest when solar PV output is low
Average power consumption and 3-kilowatt solar PV output, typical Melbourne household, kilowatts

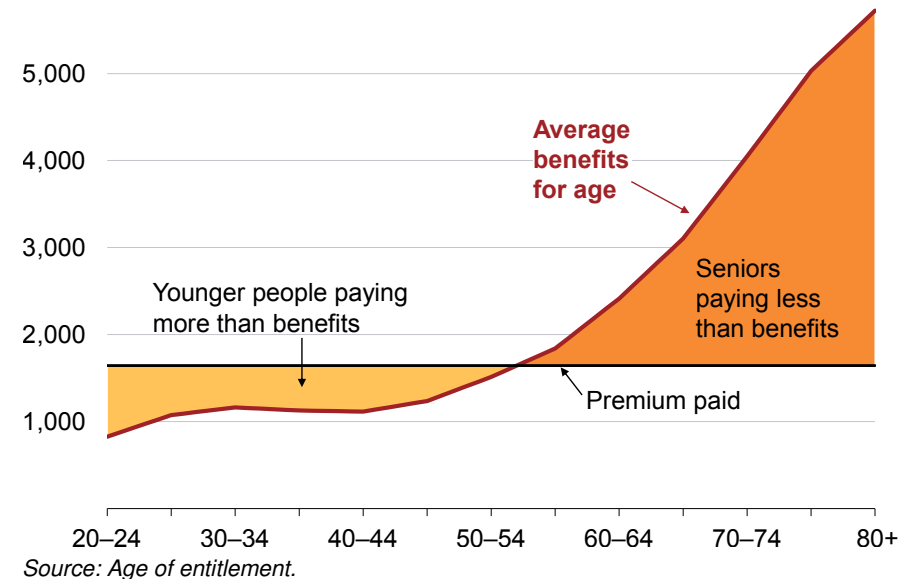


Notes: This is a rare example of a stacked area chart that actually works well, given that each shaded area can be interpreted.

Source: Sundown, sunrise.

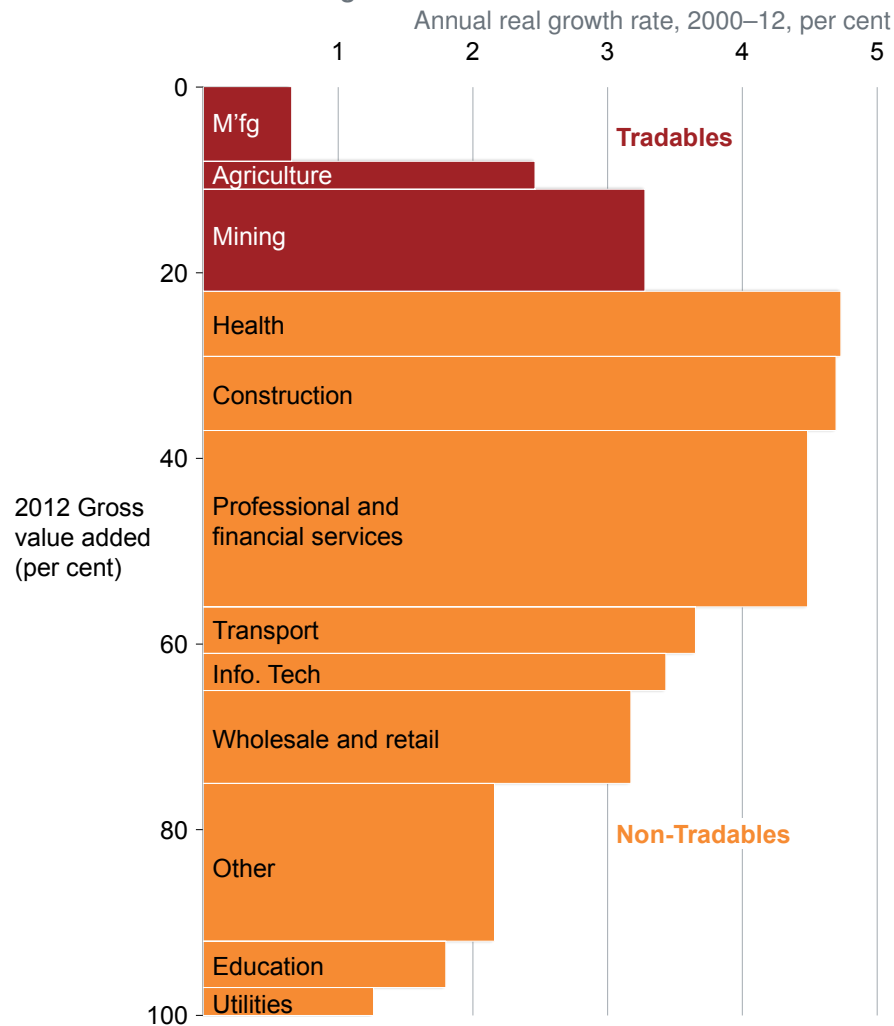
Figure 24: Community ratings protect seniors from high insurance premiums, and mean younger Australians pay more

Average private health insurance benefits per annum, nominal dollars



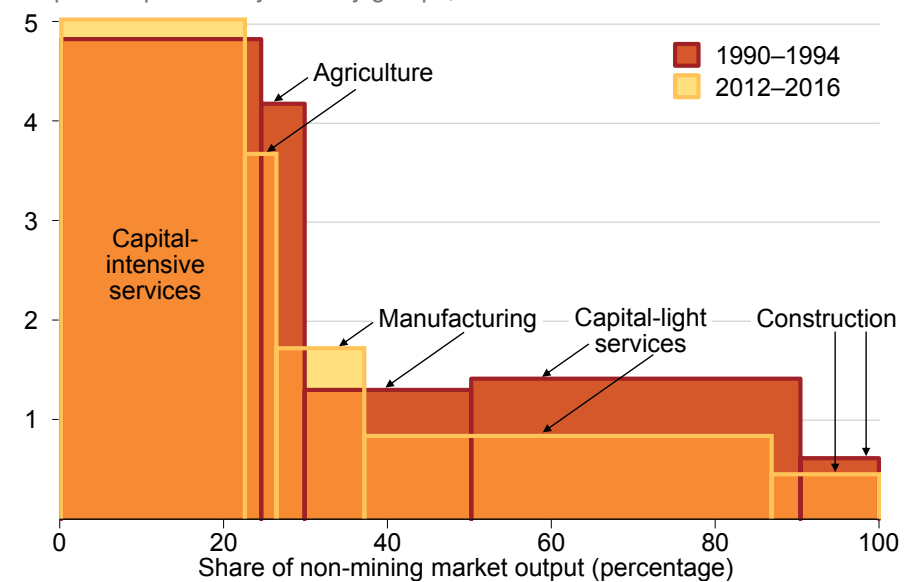
Source: Age of entitlement.

Figure 25: Output grew strongly in some non-traded sectors that have little connection with mining



Source: *The mining boom.*

Figure 26: Australia's industry mix has become more capital light
Capital-output ratio by industry groups, 1990 to 1994 and 2012 to 2016



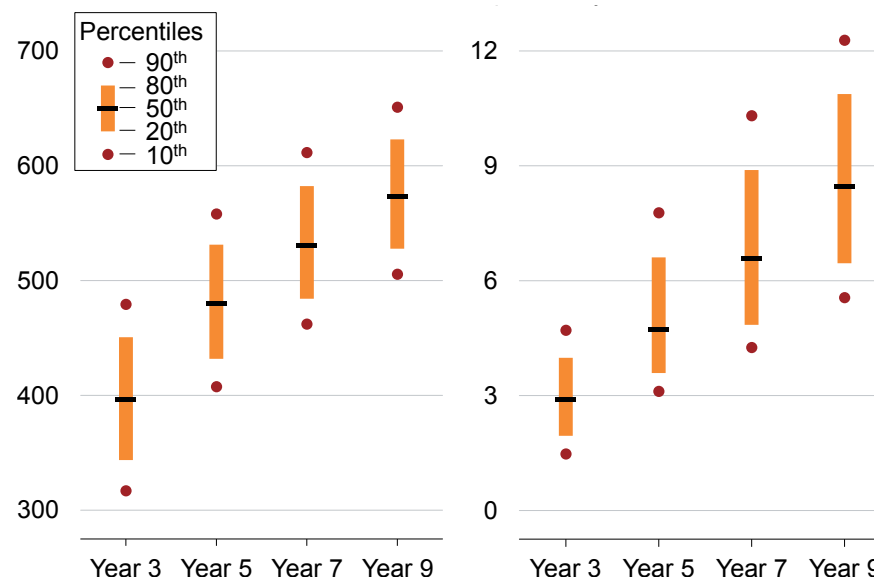
Source: *Stagnation nation?*

3.8 Other chart types

- Box chart: designed to show percentiles of a distribution, or to show point estimates with confidence intervals. Best created using a scatter chart
- Histogram: shows the distribution of a variable. Best created using a vertical column chart (for equal bin widths), or an area chart (for unequal bin widths). Typically presented with no gap between bars
- Contour map: similar to a histogram, but across two dimensions (requires more advanced software)
- Venn diagram: shows all possible combinations between three (or two) discrete variables. Can be created using 'SmartArt' in PowerPoint, but better programs exist online
- Heat map matrix: essentially a table of data where cells are shaded according to their values. Can help with spotting patterns in the data
- Choropleth map: a *geographic* map where areas are shaded according to their values. Popular with the tabloids (requires special software – Carto is best for interactive maps, while MapInfo or ArcGIS are good for static maps)
- Radar chart, pyramid chart: best to avoid (they are just 'fancy' charts that someone dreamed up, but they are actually harder to read).

Figure 27: Equivalent year levels suggest that the spread of achievement is increasing with school year

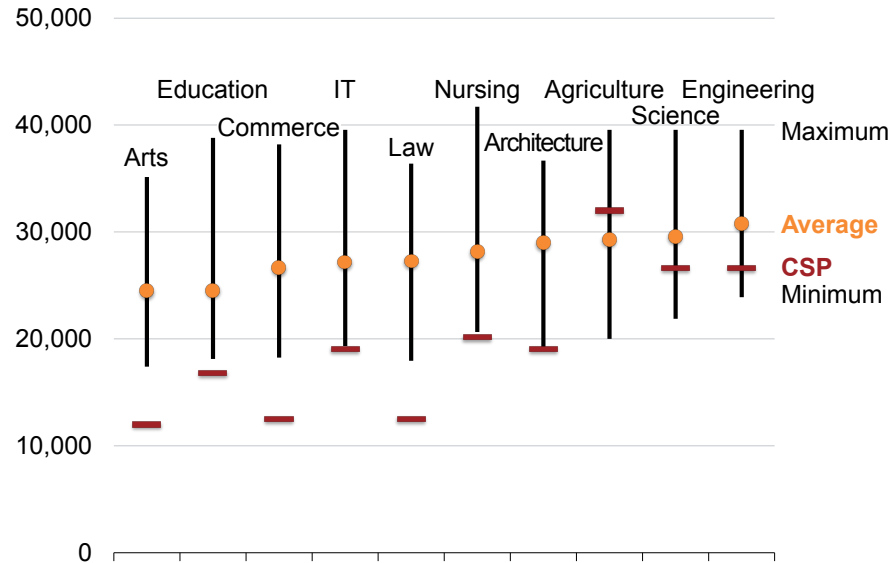
Achievement spread in a typical school by actual year level, numeracy NAPLAN scale score
Equivalent year level



Source: Widening gaps.

Figure 28: There is wide variation in international student fees

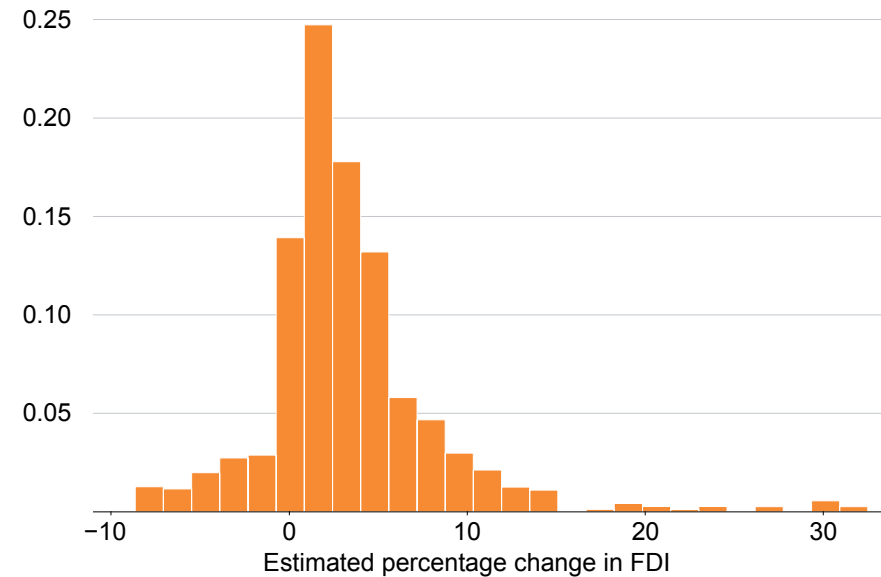
Annual international student bachelor degree fees, \$2016



Source: Mapping Australian higher education 2016.

Figure 29: There are a wide range of empirical estimates on how FDI responds to a corporate tax cut

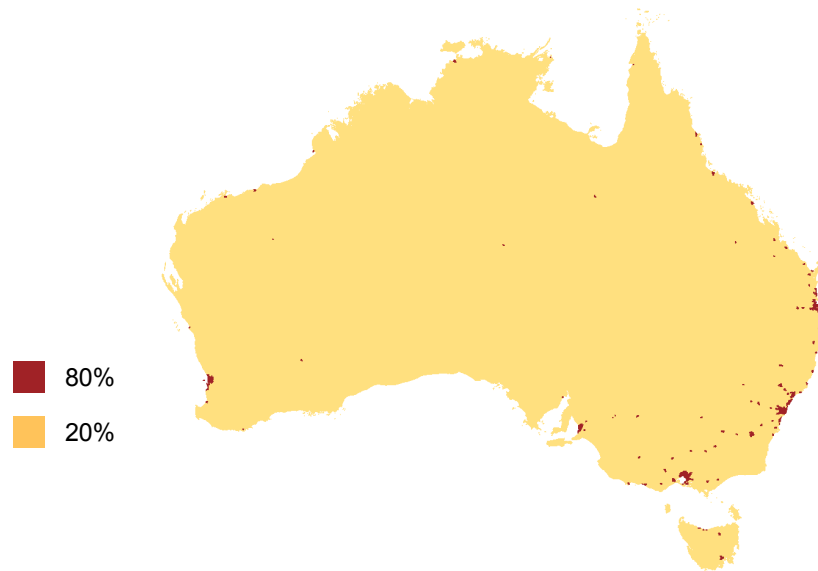
Distribution of estimated increase in FDI inflows in response to a one percentage point corporate tax cut, proportion of studies



Source: Stagnation nation?

Figure 30: 80 per cent of Australia's economic activity takes place on less than 1 per cent of its land mass

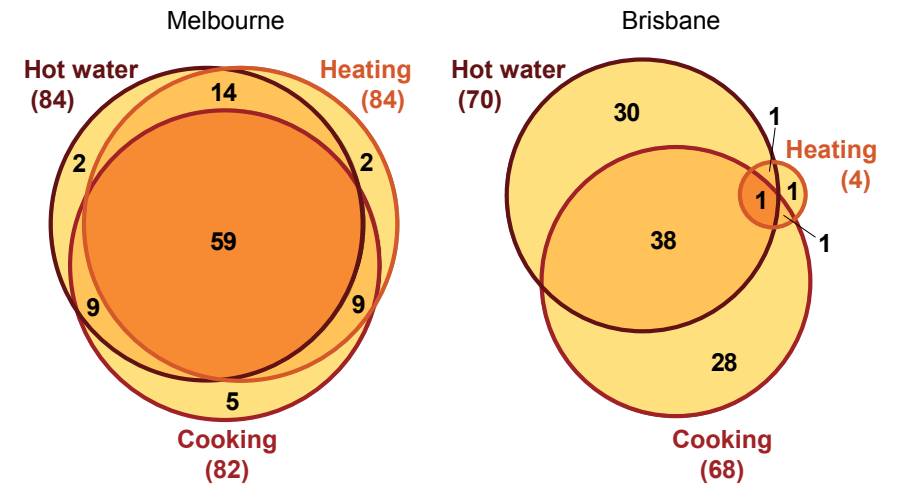
Distribution of economic activity, 2011-12



Source: Mapping Australia's economy.

Figure 31: Gas appliance connections vary greatly across two cities

Gas appliance use as a percentage of total gas connections



Source: Gas at the crossroads.

3.9 Combination charts

Dual-axis chart

- a second series (with a different scale, or different units to the first) is displayed on a 'secondary axis' – a second Y-axis is displayed on the right-hand side
- purpose of chart is usually to show that two series move together (or in opposite directions) over time
- usually either both series are displayed as lines, or one is a line and another a column series
- the data values on both axes should align with the gridlines
- use \LaTeX to indicate axes titles in colour, e.g.:

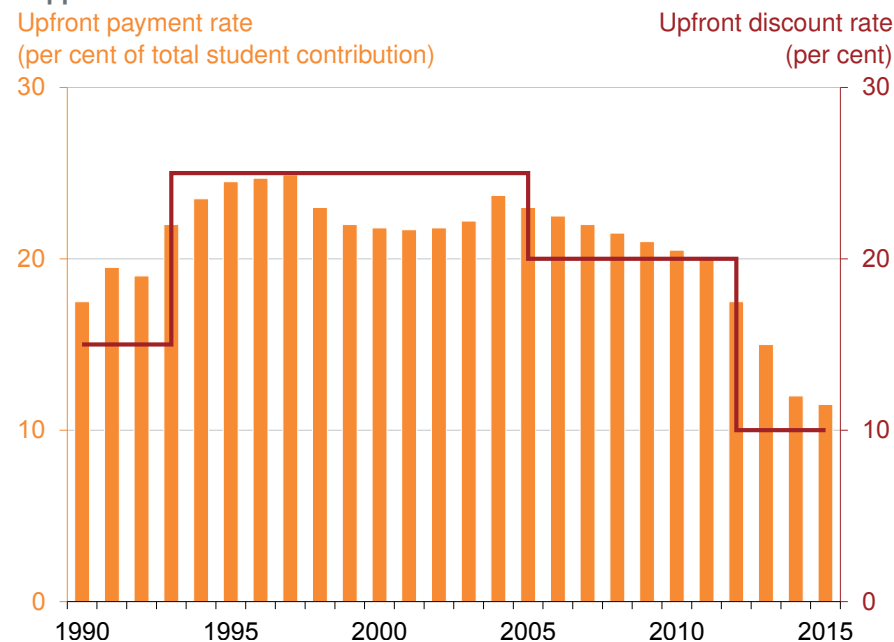
$$\backslash\text{units}\{\backslash\text{color}\{\text{Color3}\}\{\text{LHS title}\}\backslash\text{hfill}\backslash\text{color}\{\text{Color5}\}\{\text{RHS title}\}\}^{10}$$
- if the relationship is clear with each axis starting at zero, keep it at that. If not, you will need to adjust the scale(s):
 - it is very easy mislead the reader by adjusting the scales – be careful that your chart is not exaggerating the relationship
 - consider a panel chart as an alternative way of displaying multiple series.

Panel chart

- a 'panel chart' displays separate series in separate panes (bars/columns, lines, *etc.* – can be side-by-side or top-bottom)
- can require some innovative PowerPoint techniques.

10. 'Color3' is light orange, 'Color5' is red.

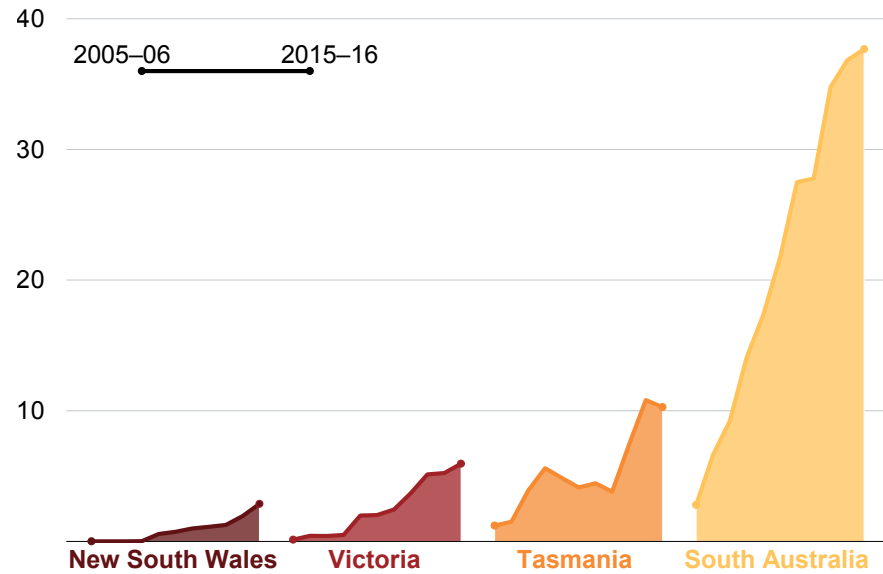
Figure 32: Upfront payment rates are declining for government-supported students



Source: Shared interest.

Figure 33: Almost 40 per cent of electricity generation in South Australia now comes from wind farms

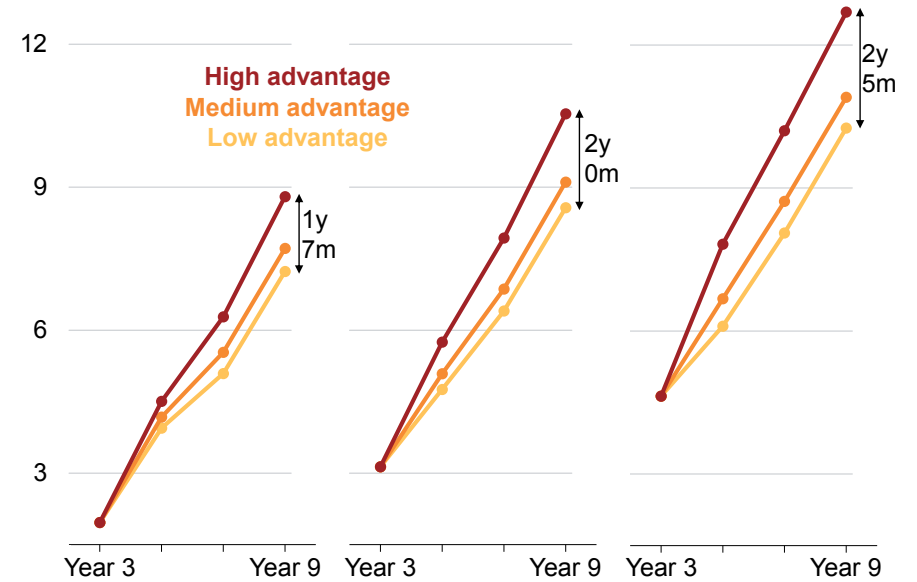
Per cent of regional output



Source: Keeping the lights on.

Figure 34: Even from the same score in year 3, students in disadvantaged schools make much less progress to year 9

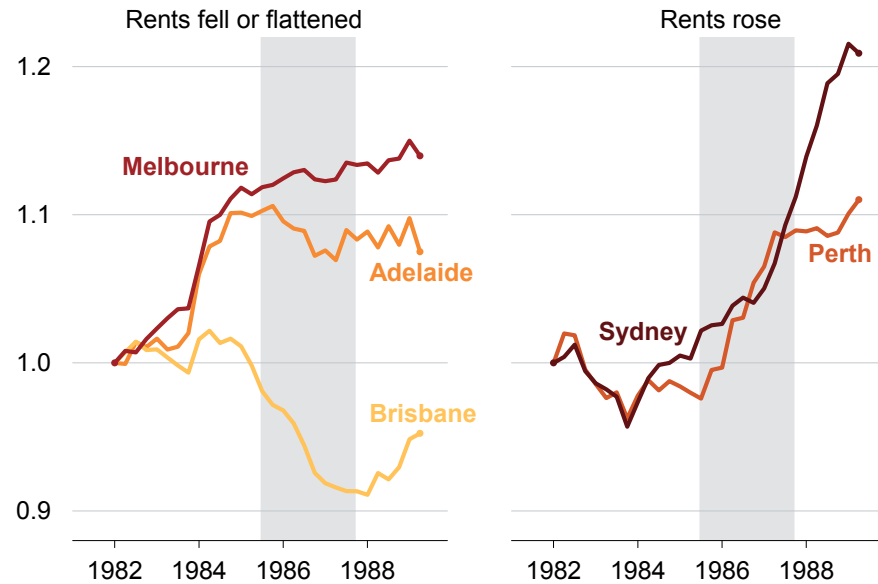
Equivalent year level by year 3 score and level of school advantage



Source: Widening gaps.

Figure 35: Rents did not rise when negative gearing was removed in Melbourne, Adelaide, or Brisbane

Index of real rents, 1982 = 1.0

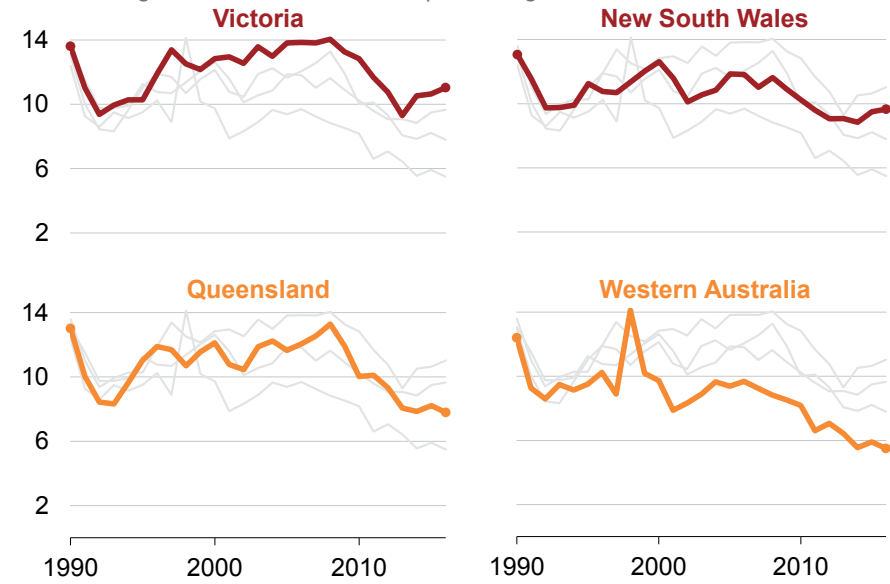


Notes: Shaded area indicates period where rental losses could not be written off against wage income.

Source: Hot property.

Figure 36: Non-mining investment has started to pick up in the non-resource states

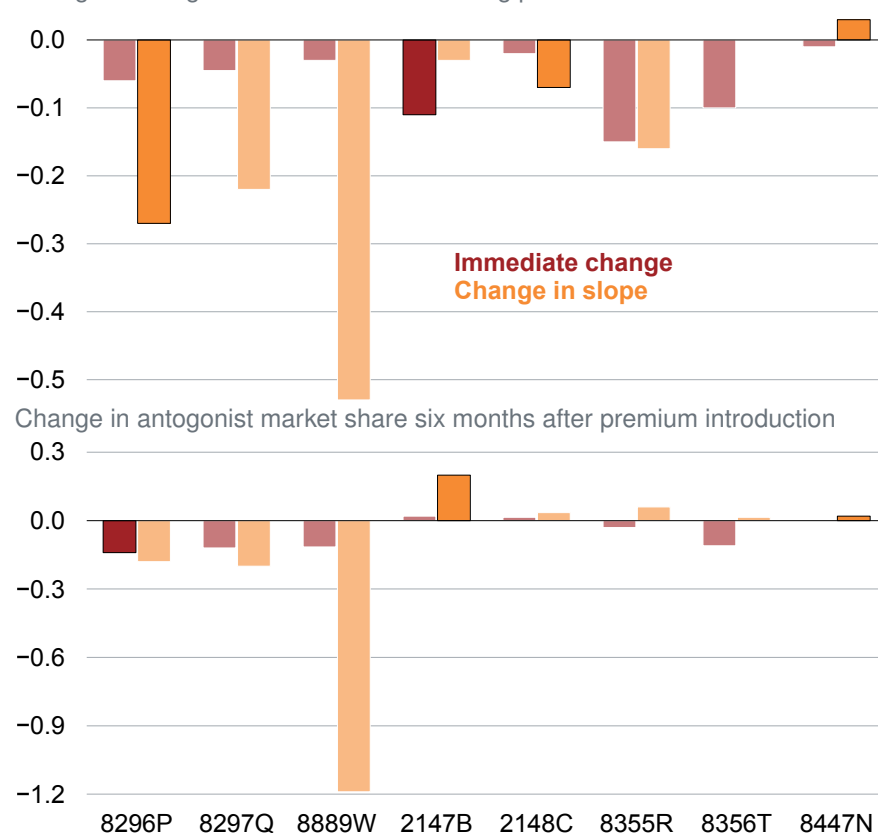
Non-mining business investment as percentage of GSP



Source: Stagnation nation?

Figure 37: Regression results show that changes are always small and not always statistically significant

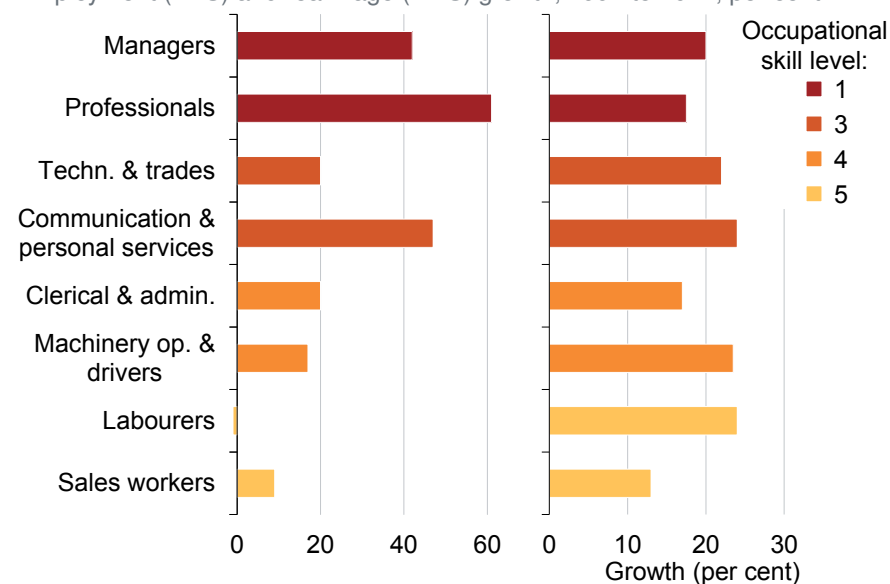
Change in antagonist market share following premium introduction



Notes: Lighter colours are not statistically significant. As a general rule, regression results are not directly presented in Grattan reports (although they may be an input to a chart) – the above charts were presented in a technical appendix.

Source: Premium Policy?

Figure 38: There is a trend towards jobs requiring more education
Employment (LHS) and real wage (RHS) growth, 1997 to 2011, per cent



Source: *The mining boom*.

4 Handy PowerPoint hints and ‘cheats’

PowerPoint’s default chart settings can be quite restrictive – this has been a source of frustration for many Grattan staff. But there are ways of getting around these restrictive settings, some of which involve a little ingenuity. Where there is a will, there is a way.

4.1 Use text boxes instead of PowerPoint’s default value labels

PowerPoint’s default value labels can be difficult to override. For instance, they may place text on an angle, place the labels too far from the axes, or include values that you do not want displayed. Sometimes it is best to set ‘label position’ to ‘none’, and instead create text boxes to show the value labels you want:

- ensure Y-axis labels are right-aligned, and X-axis labels are top-aligned (make use of ‘align’)
- ensure each label text box is correctly positioned using ‘distribute horizontally/vertically’
- be careful when making chart changes – you may need to re-align the value labels

4.2 Use different series chart types on the same chart

It is straightforward to combine different chart types to enhance readability. Some example combinations include:

- stacked column and scatter line chart (to produce a waterfall – *e.g.* see Figure 19)
- scatter dot and scatter line chart (*e.g.* see Figure 22)
- line and area chart (*e.g.* see Figures 33 and 35).

It is reasonably straightforward to combine different series chart types in PowerPoint:

1. choose a chart type and select data
2. select data for secondary series (chart tools -> design -> select data -> add series). Note that if your chart type is a bar/column, and your second series is a scatter, you will only be able to select one dimension at this point. Note that your chart may look like it has been destroyed
3. right click anywhere on the data and select ‘change series chart type’. Change your secondary series chart type as desired (sometimes the secondary series needs to be displayed on a secondary axis, but not always)
4. if your secondary chart type is a scatter, you may need to select the second dimension (chart tools -> design -> select data -> edit series)
5. if your secondary chart type is an area, you may need to change the X-axis type to a ‘date axis’
6. if using a secondary axis, ensure that the X- and Y-axes ranges align for the primary and secondary series.

4.3 Use excel data to create non-data features

Non-data features, such as dotted lines between bars, arrows, and shaded regions, have often been created using ‘shapes’. But shapes can be difficult to align with data, and often look messy when the report is published. An alternative approach is to use excel data to create such features.

To add dotted lines to a waterfall chart:

1. right click on the data, select edit data -> edit data in Excel
2. add a scatter series with X values equal to 1.25, 2.25, *etc.*,¹¹ and Y values equal to the sum of each corresponding row
3. ensure that the series has no line and no marker (it should be invisible)
4. making sure the series is selected, go to chart tools -> design -> add chart element -> error bars -> more error bars options. PowerPoint will display horizontal and vertical black lines around the points of this series
5. select a vertical error bar and hit delete
6. select a horizontal error bar. Set direction to 'plus', end style to 'no cap', and error amount to 0.5. The horizontal error bars should now line up between each bar
7. change the dash type of the error bar to a dotted line.

Note that this approach can also be used to create gridlines, axis lines, and tick marks. Adding an arrow to an error bar is straightforward – select a data point, and change 'begin arrow type' (or 'end arrow type') to an arrow.

Adding a shaded region between two line series can be achieved by adding the same two series a second time, and placing them on an area chart.¹² The area of the series with the lower Y values should be coloured white, with the other area coloured a light grey. Ensure that the white area is in front of the grey – if not, go to chart tools -> design -> select data, and re-order the series.

11. See Section 4.2 on the preceding page. These values will need to be adjusted if the gap width is not set to 100%.

12. This becomes slightly more complex if the two series overlap.

4.4 Other useful hints

Use multiple charts to achieve desired layering

There are occasions when PowerPoint will not let you layer your data and other chart elements as you would like (*e.g.* gridlines in front of an area chart). If you have exhausted other options, copy and paste your chart so that it is overlaid on the original (select both charts -> align left -> align top) – it should visually appear as one chart in the slide. On the 'front' chart, switch off the elements you would like to appear behind others to achieve the desired layering.¹³ It may pay to make use of 'send to back/bring to front' to get the layering right.

Use white shapes to cover undesirable default chart elements

You may wish to remove particular elements (or parts of elements) from your chart that cannot easily be deleted. One option is to use a white rectangle (white fill, no border) to cover any element that you don't wish to appear. For example, if a text box overlaps with a gridline you may wish to cover the part of the gridline behind the text.

Set slide background to transparent for a chart that will appear in a box

Slides with a white background will appear this way when placed into a report – this is a problem if the chart appears in a box. To ensure the chart appears correctly, set the background to 100% transparency – LaTeX will override the background with the box colour.¹⁴ However, any chart elements that are white (including white boxes that cover other elements) should be re-coloured to the box background colour.

13. Deleting elements may change the shape of a chart. Instead, you can switch off elements by selecting 'no fill' or 'no line' without changing the chart's shape.

14. Alternatively, you can set the slide background to the box colour, but for an unknown reason the colours appear slightly different in the report.

5 Creating interactive charts with Datawrapper