1 Inline equations

Math notation is embedded within paragraphs using the dollar sign. Example : $a^2 + b^2 = c^2$ or $e^{-i\pi} + 1 = 0$.

Note that when you say xy, he thinks of it as x multiplied by y (which is the math way of thinking about it). So $log(x)$ comes out ugly: he is thinking you are multiplying l, o and g. You have to say $\log(x)$ to make him use his special inbuilt function for log.

2 Displayed equations

The next step up is “displayed equations”, which are not embedded in text. Compare this against the inline equation shown upstairs:

$$e^{-i\pi} + 1 = 0$$

$$\Phi(x) = \int_{-\infty}^{x} \phi(t)\, dt$$

Note that the two equations don’t line up perfectly by themselves. Each is centred; that is all you are promised. To make them line up perfectly, read on.

Some things come out differently inline when compared with displayed equations. Example: $\sum_{i=1}^{p} \beta_i \epsilon_{t-i}^2$ versus

$$\sum_{i=1}^{p} \beta_i \epsilon_{t-i}^2$$

3 Lining up the equal-to signs

This is done using eqnarray. There is an analogy with the use of the “ampersand” when compared with tabular.

Here’s an example:

$$\begin{eqnarray} e^{-i\pi} + 1 & = & 0 \\ \Phi(x) & = & \int_{-\infty}^{x} \phi(t)\, dt \end{eqnarray}$$

Compare this with the version shown previously.

Here's another example. The GARCH(p, q) model, suggested by Bollerslev 1986, consists of the following:

$$\begin{aligned} y_t &= \alpha x_t + \epsilon_t \\ \epsilon_t | I_{t-1} &\sim N(0, h_t) \\ h_t &= \beta_0 + \sum_{i=1}^{p} \beta_i \epsilon_{t-i}^2 + \sum_{j=1}^{q} \gamma_j h_{t-j} \end{aligned}$$

Here x_t are explanatory variables, h_t is the innovation variance at time t, and the volatility equation has parameters $\beta \in \Re^{p+1}$ and $\gamma \in \Re^q$.

4 Making bracket signs of the right size

By default, "(" and ")" give you fixed sized brackets. A key requirement in mathematics typesetting is to shift to bigger and bigger brackets, depending on the needs of the stuff within the brackets.

This is done by prefixing the bracket signs with "left" and "right". Look:

$$X = \rho B \tag{1}$$

$$E = VN(d_1) - XN(d_2) \tag{2}$$

$$\text{where } d_1 = \left(\log \frac{V}{X} + \frac{\sigma_V^2 T}{2} \right) (\sigma_V \sqrt{T})^{-1} \tag{3}$$

$$\text{and } d_2 = d_1 - \sigma_V \sqrt{T} \tag{4}$$

This example shows four new things:

1. eqnarray instead of eqnarray* gives equation numbers,
2. Each equation can be given a separate label, and then you can reference equation 2 as is usual in TeX.
3. If you want to place english text inside the equation block, you have to use textrm, else he typesets "and" as *and*,
4. The bracket signs were made perfect using "left" and "right".

Here is an example of showing a bivariate normal distribution, in an eqnarray context:

$$
\begin{array}{rcl}
y^* & = & \beta' X + e_1 \\
y & = & 1 \qquad \text{if} \quad y^* > 0 \\
z & = & \gamma' W + e_2 \qquad \text{if} \quad y = 1 \\
\left(\begin{array}{c} e_1 \\ e_2 \end{array} \right) & \sim & N\left(\left[\begin{array}{c} 0 \\ 0 \end{array} \right], \left[\begin{array}{cc} \sigma_1^2 & \cdot \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{array} \right] \right)
\end{array}
$$

Now we get fancier with this theme: big brackets can encompass groups of properly laid out equations! In generic latex, you'd do:

$$
\left\{ \begin{array}{lcl}
\mu(\nabla u, \nabla v) & = & (f, v) \\
(\nabla \cdot u, q) & = & 0
\end{array} \right.
$$

By the time you are doing things like this, it's better to use amsmath –

$$
\begin{cases}
\mu(\nabla u, \nabla v) & = (f, v) \\
(\nabla \cdot u, q) & = 0
\end{cases}
$$