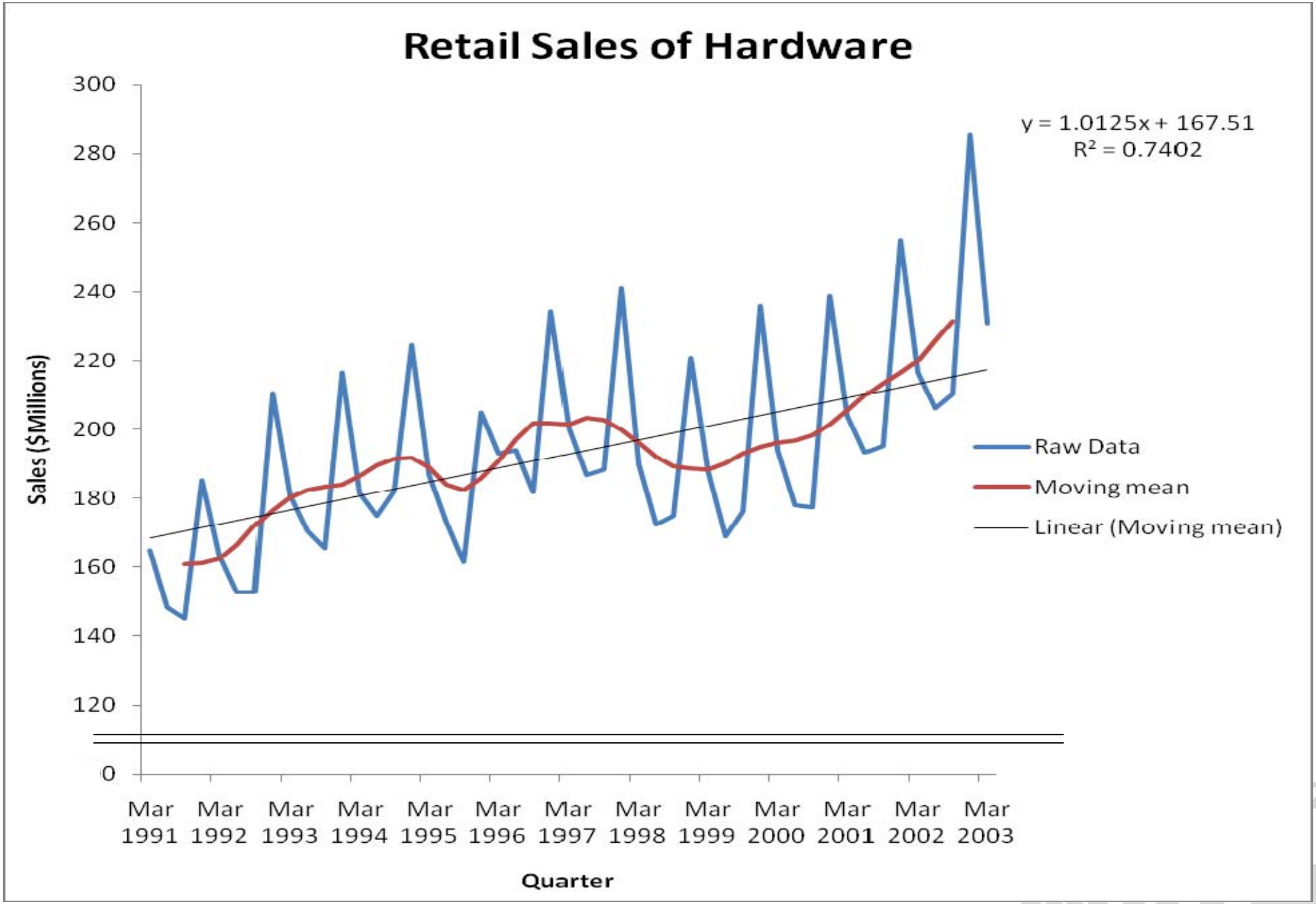
Model Answers: Report on Hardware Retail Sales 1991 – 2003

This is quarterly data collected by Statistics New Zealand. It is total retail sales by Hardware stores for each quarter.

Here is the table of my analysis:

Quarter	Date Index Number	Hardware Sales $(million)	Trend Estimate (moving mean	Seasonal and Irregular
Mar 1991	1	165		
Jun 1991	2	149		
Sep 1991	3	145	161	-15
Dec 1991	4	185	161	24
Mar 1992	5	163	163	1
Jun 1992	6	153	167	-14
Sep 1992	7	153	172	-19
Dec 1992	8	210	176	34
Mar 1993	9	181	180	1
Jun 1993	10	171	183	-12
Sep 1993	11	166	183	-18
Dec 1993	12	216	184	32
Mar 1994	13	182	187	-5
Jun 1994	14	175	190	-15
Sep 1994	15	182	191	-9
Dec 1994	16	225	192	33
Mar 1995	17	187	189	-2
Jun 1995	18	173	184	-11
Sep 1995	19	162	182	-21
Dec 1995	20	205	186	19
Mar 1996	21	193	191	2
Jun 1996	22	194	197	-3
Sep 1996	23	182	202	-20
Dec 1996	24	234	202	33
Mar 1997	25	200	202	-1
Jun 1997	26	187	203	-17
Sep 1997	27	188	203	-14
Dec 1997	28	241	200	41
Mar 1998	29	190	196	-6
Jun 1998	30	172	192	-20
Sep 1998	31	175	189	-14
Dec 1998	32	221	189	32
Mar 1999	33	188	188	-1
Jun 1999	34	169	190	-21
Sep 1999	35	176	193	-17
Dec 1999	36	236	195	41
Mar 2000	37	194	196	-2
Jun 2000	38	178	197	-19
Sep 2000	39	177	198	-21
Dec 2000	40	239	201	38
Mar 2001	41	204	206	-2
Jun 2001	42	193	210	-16
Sep 2001	43	195	213	-18
Dec 2001	44	255	217	38
Mar 2002	45	217	220	-4
Jun 2002	46	206	226	-20
Sep 2002	47	210	231	-21
Dec 2002	48	285		
Mar 2003	49	231		
Jun 2003	50			
Sep 2003	51			
Dec 2003	52			
Mar 2004	53	219.44	221.1725	


Retail Sales of Hardware
y = 1.0125x + 167.51
R² = 0.7402
Raw Data
Moving mean
Linear (Moving mean)
Sales ($Millions)
300
280
260
240
220
200
180
160
140
120
0
Mar 1991
Mar 1992
Mar 1993
Mar 1994
Mar 1995
Mar 1996
Mar 1997
Mar 1998
Mar 1999
Mar 2000
Mar 2001
Mar 2002
Mar 2003
Quarter

Analysis

Retail hardware sales show a generally increasing trend. This can be fitted quite well by a line over the long term.

In the period March 1991 to March 2003 sales are increasing by approximately $1.0 million per quarter, which is $4 million per year. This can be seen by the equation of the line of best fit, which has a gradient of 1.0125.

At the end of the data the rate of quarterly increase is much higher. From September 1999 to September 2002 the moving mean increases by $38 million (231 – 193) which is a quarterly increase of almost $3.2 million.

The moving mean shows a slight cyclic pattern. This may well reflect underlying cyclic patterns in the economy.

Seasonal effects

I have taken the average difference from the mean to find a measure of the seasonal effects:

Season	Average
March	-1.73
June	-15.27
September	-17.25
December	33.18

As can be seen, the December quarter shows a major increase over the other months, which is reflected by a sharp upwards spike in the graph every 4th data point.

The March quarter shows sales just below the long term average, and the other two much lower sales.

It makes sense that the Summer months should have the highest sales, as people tend to do more garden and house work in Summer. The huge spike for December likely reflects Christmas buying.

Every year shows the seasonal pattern very strongly, except 1996 for some reason.

Forecast

Based on the trend from the regression line the forecast for the March 2004 quarter would be **$219 million**. The calculation for this is:

$$\text{Forecast} = 1.0125 \times 53 + 167.51 - 1.73$$

The 53 is the number my numbering system assigns to March 2004 (see table). The -1.73 is the average estimated seasonal effect for March ($1.73 million lower than usual on average) and the formula is for the model of the trend line shown on the graph above.

Since, the moving mean rises quite sharply at the end and the data, and the trend line is clearly quite different, it would be reasonable to estimate a higher result than just using the formula. As the moving mean about $10 million more than the trend at the end, we could add this, giving a rough estimate of around $220 Million.

(*Note: even if making a prediction different from that shown just by the trend line, be sure to include a calculation using the formula you generate. You need to be able to show you understand and can use the formula, even if you do not trust the accuracy.*)

Accuracy

All forecasts are likely to be wrong if there are big changes in underlying economic conditions. I would want to know these are likely to stay stable before I put too much faith in any predictions.

My forecast of $220 Million unlikely to be very accurate as the straight line over the full time period is not a very good model for the data in the short term.

The seasonal pattern remains fairly constant, so I have confidence 2004 will be reasonably similar in that respect.

Improvements

1) The forecast in the short term would be better predicted using only the trend for the last three years, which is quite linear.

   Some input from economists as to whether the economy is likely to continue an upward cycle for the next year would give more confidence to using the most recent data only. If a downward turn is expected then this can be adjusted for.

2) It is clear from the graph that the seasonal effects are increasing as the retail sales increase. For the most recent three Decembers the increase over the moving mean is closer to $40 million, rather than the long term average of 33. However this won't affect my March 2004 forecast very much as the final March quarters are close to the long term average.

   An improvement might be to only use recent seasons in calculating the seasonal effects, rather than going back over ten years. This would lower my March forecast by about $1M.

   A seasonal calculation assuming a multiplicative method, rather than my additive method, would also likely yield more accurate results. The linear prediction for the next periods would be multiplied by the appropriate ratio, rather than adding a set number.

3) For comparisons between years an index system could be used. Sales in March 1991 could be assigned a value of 1000 and all values after that would be divided by that month's sales and multiplied by 1000 to give comparative values.

   This method would be extremely useful for comparing say growth in hardware sales against growth in other retail areas, as each could be given a common starting point.

4) Some of the "growth" in hardware sales may be solely an effect of inflation. In particular changing rates of inflation may give what seems like changing rates of growth. Sales should be recorded in constant dollars from March 1991 to prevent this (if they aren't already).

   Likewise growth might just be resulting from growth in the population. Using figures per 100,000 head of population can be used to control for this, if that seems relevant.