9.2 The file *ex9_2.dat* contains 105 weekly observations on sales revenue (*SALES*) and advertising expenditure (*ADV*) in millions of dollars for a large midwest department store in 2008 and 2009. The following relationship was estimated:

$$\widehat{SALES_t} = 25.34 + 1.842\ ADV_t + 3.802\ ADV_{t-1} + 2.265\ ADV_{t-2}$$

(a) Describe the relationship between sales and advertising expenditure. Include an explanation of the lagged relationship. When does advertising have its greatest impact? What is the total effect of a sustained $1 million increase in advertising expenditure?

(b) The estimated covariance matrix of the coefficients is

	C	ADV	ADV_{t-1}	ADV_{t-2}
C	2.5598	−0.7099	−0.1317	−0.7661
ADV	−0.7099	1.3946	−1.0406	0.0984
ADV_{t-1}	−0.1317	−1.0406	2.1606	−1.0367
ADV_{t-2}	−0.7661	0.0984	−1.0367	1.4214

Using a one-tail test and a 5% significance level, which lag coefficients are significantly different from zero? Do your conclusions change if you use a one-tail test? Do they change if you use a 10% significance level?

(c) Find 95% confidence intervals for the impact multiplier, the one-period interim multiplier, and the total multiplier.

9.4* The following least squares residuals come from a sample of size $T = 10$:

t	1	2	3	4	5	6	7	8	9	10
$\hat{e}_t$	0.28	−0.31	−0.09	0.03	−0.37	−0.17	−0.39	−0.03	0.03	1.02

(a) Use a hand calculator to compute the sample autocorrelations:

$$r_1 = \frac{\sum_{t=2}^{T} \hat{e}_t \hat{e}_{t-1}}{\sum_{t=1}^{T} \hat{e}_t^2} \qquad r_2 = \frac{\sum_{t=3}^{T} \hat{e}_t \hat{e}_{t-2}}{\sum_{t=1}^{T} \hat{e}_t^2}$$

(b) Test whether (i) r_1 is significantly different from zero and (ii) r_2 is significantly different from zero. Sketch the first two bars of the correlogram. Include the significance bounds.

9.6 Increases in the mortgage interest rate increase the cost of owning a house and lower the demand for houses. In this question we consider an equation where the monthly change in the number of new one-family houses sold in the U.S. depends on last month's change in the 30-year conventional mortgage rate. Let *HOMES* be the number of new houses sold (in thousands) and *IRATE* be the mortgage rate. Their monthly changes are denoted by $DHOMES_t = HOMES_t - HOMES_{t-1}$ and $DIRATE_t = IRATE_t - IRATE_{t-1}$. Using data from January 1992 to March 2010 (stored in the file *homes.dat*), we obtain the following least squares regression estimates:

$$\widehat{DHOMES_t} = \underset{(3.498)}{-2.077} - \underset{(16.98)}{53.51}DIRATE_{t-1} \qquad \text{obs} = 218$$
$$\text{(se)}$$

(a) Interpret the estimate −53.51. Construct and interpret a 95% confidcnce interval for the coefficient of $DIRATE_{t-1}$.

(b) Let $\hat{e}_t$ denote the residuals from the above equation. Use the following estimated equation to conduct two separate tests for first-order autoregressive errors.

$$\hat{e}_t = -0.1835 - \underset{(16.087)}{3.210}DIRATE_{t-1} - \underset{(0.0649)}{0.3306}\hat{e}_{t-1} \qquad R^2 = 0.1077$$
$$\text{(se)} \qquad \text{obs} = 218$$

(c) The model with AR(1) errors was estimated as

$$\widehat{DHOMES_t} = \underset{(2.497)}{-2.124} - \underset{(14.10)}{58.61}DIRATE_{t-1} \quad e_t = \underset{(0.0649)}{-0.3314}e_{t-1} + \hat{v}_t$$

(se)

$$\text{obs} = 217$$

Construct a 95% confidence interval for the coefficient of $DIRATE_{t-1}$, and comment on the effect of ignoring autocorrelation on inferences about this coefficient.

9.22 An important relationship in macroeconomics is the consumption function. The file *consumptn.dat* contains quarterly data from 1960Q1 to 2009Q4 on the percentage changes in disposable personal income and personal consumption expenditures. We describe these variables as income growth (*INCGWTH*) and consumption growth (*CONGWTH*). To ensure that the same number of observations (197) are used for estimation in each of the models that we consider, use as your sample period 1960Q4 to 2009Q4. Where relevant, lagged variables on the right-hand side of equations can use values prior to 1960Q4.

(a) Graph the time series for *CONGWTH* and *INCGWTH*. Include a horizontal line at the mean of each series. Do the series appear to fluctuate around a constant mean?

(b) Estimate the model $CONGWTH_t = \delta + \delta_0 INCGWTH_t + v_t$. Interpret the estimate for δ_0. Check for serially correlated errors using the residual correlogram, and an *LM* test with two lagged errors. What do you conclude?

(c) Estimate the model $CONGWTH_t = \delta + \theta_1 CONGWTH_{t-1} + \delta_0 INCGWTH_t + v_t$. Is this model an improvement over that in part (b)? Is the estimate for θ_1

significantly different from zero? Have the values for the AIC and the SC gone down? Has serial correlation in the errors been eliminated?

(d) Add the variable $CONGWTH_{t-2}$ to the model in part (c) and re-estimate. Is this model an improvement over that in part (c)? Is the estimate for θ_2 (the coefficient of $CONGWTH_{t-2}$) significantly different from zero? Have the values for the AIC and the SC gone down? Has serial correlation in the errors been eliminated?

(e) Add the variable $INCGWTH_{t-1}$ to the model in part (d) and re-estimate. Is this model an improvement over that in part (d)? Is the estimate for δ_1 (the coefficient of $INCGWTH_{t-1}$) significantly different from zero? Have the values for the AIC and the SC gone down? Has serial correlation in the errors been eliminated?

(f) Does the addition of $CONGWTH_{t-3}$ or $INCGWTH_{t-2}$ improve the model in part (e)?

(g) Drop the variable $CONGWTH_{t-1}$ from the model in part (e) and re-estimate. Why might you consider dropping this variable? The model you should be estimating is

$$
\begin{aligned}
CONGWTH_t = \delta + \theta_2 CONGWTH_{t-2} + \delta_0 INCGWTH_t \\
+ \delta_1 INCGWTH_{t-1} + v_t
\end{aligned}
\tag{9.94}
$$

Does this model have lower AIC and SC values than that in (e)? Is there any evidence of serially correlated errors?