The attached STATA do and log files and graphs contain commands and output for a VECM using the same West German quarterly income and consumption data that was used for the VAR example. The variables lincome and lconsumption are the logs of income and consumption.

The `dfuller` command carries out an augmented Dickey-Fuller test. The `trend` option causes a linear trend to be included in the DF regression equation. An intercept coefficient is included. The `lags(2)` option causes two lagged first differences to be included in the DF equation. The first two tests are of the null hypotheses that the log consumption and log income variables contain a unit root. They both are accepted since the P-values are greater than .05. The next two tests check the null hypotheses that the first differences of these two variables contain unit roots. Since a trend in levels becomes a constant in first differences, no trend was included this time. Both null hypotheses are rejected. Overall, these tests suggest then that both lincome and lconsumption are I(1).

`vecrank` creates a table containing the Johansen tests used to determine the rank of the cointegrating matrix in the VECM. The `lags(3)` option refers to the number of lags in an underlying “levels” VAR, which, when reparameterized into a VECM involving first differences and error correction terms, has only 2 lags. The following sequential test procedure is often used to determine the number of cointegrating relations among the variables. Each row of the table tests a different null hypothesis. The null hypothesis is that the number of cointegrating relationships is equal to \( r \), which is given in the “maximum rank” column of the output. The alternative is that there are more than \( r \) cointegrating relationships. The null is rejected if the trace statistic is greater than the critical value. Start by testing \( H_0 : r = 0 \). If it rejects, repeat for \( H_0 : r = 1 \). When a test is not rejected, stop testing there, and that value of \( r \) is the commonly-used estimate of the number of cointegrating relations. In this example, \( H_0 : r = 0 \) is not rejected at the 5% level (11.12 < 15.41). In other words, this trace test result does not reject the null hypothesis that these two variables are not cointegrated. Nevertheless, we will proceed to estimate the VECM model.

`vec` estimates the VECM model. \( r = 1 \) is the default number of error correction terms. This number can be set if necessary using the `rank(#)` option. The output looks similar to VAR output. One difference is that this VECM output contains the coefficient estimate of the error correction term in each equation, denoted as \( .ce1 \).
The four `irf` commands define a name for the irf file (`vec,eg`), create the file (where the `step(50)` option is used to cause the responses to be plotted up to 50 periods ahead instead of 8 periods), and finally create and print the graph. The impulse response functions are on the last page. Unlike the ones in the VEC example, these do not converge to zero. Instead they appear to be converging to nonzero values. This is mainly because these IRFs refer to the logged variables, whereas the IRFs given in the VAR handout were for first differences of the logged variables.

`veclmar` tests for autocorrelation in the errors, the same as `varlmar` did for VAR estimation. There is no evidence of autocorrelation.

The first `test` command tests the joint hypothesis that all four of the coefficients on the twice-lagged first differences appearing in the VECM system equal zero. (Two are in the “D-lconsumption” equation and the other two in the “D-lincome” equation.) This test could be used to decide if including the second lag in the VECM was necessary. The $P$-value is almost exactly .05. If it had been .50 for example, we might have tried re-estimating the VECM with one less lag.

The final two `test` commands are testing for Granger causality. By having already concluding that log income and log consumption are cointegrated, we have implicitly concluded already that there is a long-run causal relation between them. So the causality being tested for in a VECM by these tests is sometimes called “short-run Granger causality”.
clear
capture log using "C:\Documents and Settings\courses\761 and 762\w08\vec\vec.log", replace
use "C:\Documents and Settings\courses\761 and 762\w07\VAR\lutkepohl.dta"
tsset
dfuller lconsumption,trend lags(2)
dfuller lincome,trend lags(2)
dfuller D.lconsumption,drift lags(2)
dfuller D.lincome,drift lags(2)
vecrank lconsumption lincome, lags(3)
vec lconsumption lincome, lags(3)
irf set vec_eg, replace
irf create vec_eg, step(50) replace
irf graph irf
* graph print
graph export "C:\Documents and Settings\courses\761 and 762\w08\VEC\vec.eps", replace
veclmar
test ([D_lconsumption]: L2D.lconsumption L2D.lincome) ([D_lincome]: L2D.lconsumption L2D.lincome)
test ([D_lconsumption]: LD.lincome L2D.lincome)
test ([D_lincome]: LD.lconsumption L2D.lconsumption)
log close
VEC log file

. use "C:\Documents and Settings\courses\761 and 762\w07\VAR\lutkepohl.dta"
(Quarterly SA West German macro data, Bil DM, from Lutkepohl 1993 Table E.1)

. tsset
time variable:  qtr, 1960q1 to 1982q4

. dfuller lconsumption,trend lags(2)
Augmented Dickey-Fuller test for unit root Number of obs =  89
Test Statistic  -------- Interpolated Dickey-Fuller --------
                1% Critical  5% Critical  10% Critical
               Value        Value        Value
-----------------------------------------------------------------------------
Z(t)            -0.365         -4.064         -3.461         -3.157
-----------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9879

. dfuller lincome,trend lags(2)
Augmented Dickey-Fuller test for unit root Number of obs =  89
Test Statistic  -------- Interpolated Dickey-Fuller --------
                1% Critical  5% Critical  10% Critical
               Value        Value        Value
-----------------------------------------------------------------------------
Z(t)            -0.179         -4.064         -3.461         -3.157
-----------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9919

. dfuller D.lconsumption,drift lags(2)
Augmented Dickey-Fuller test for unit root Number of obs =  88
Test Statistic  -------- Z(t) has t-distribution --------
                1% Critical  5% Critical  10% Critical
               Value        Value        Value
-----------------------------------------------------------------------------
Z(t)            -3.127        -2.372         -1.663         -1.292
-----------------------------------------------------------------------------
p-value for Z(t) = 0.0012

. dfuller D.lincome,drift lags(2)
Augmented Dickey-Fuller test for unit root Number of obs =  88
Test Statistic  -------- Z(t) has t-distribution --------
                1% Critical  5% Critical  10% Critical
               Value        Value        Value
-----------------------------------------------------------------------------
Z(t)            -3.302        -2.372         -1.663         -1.292
-----------------------------------------------------------------------------
p-value for Z(t) = 0.0007

vecrank lconsumption lincome, lags(3)

Johansen tests for cointegration
Trend: constant                     Number of obs =     89
Sample: 1960q4 1982q4               Lags =       3
                     5% maximum          trace    critical
rank  parms       LL     eigenvalue statistic    value
 0     10      578.27699           .     11.1264*   15.41
 1     13      582.78731    0.09639      2.1058     3.76
 2     14       583.8402    0.02338

vec lconsumption lincome, lags(3)

Vector error-correction model
Sample: 1960q4 1982q4                           No. of obs      =        89
AIC             = -12.80421
Log likelihood =  582.7873                         HQIC            = -12.65769
Det(Sigma_ml)  =  7.04e-09                         SBIC            =  -12.4407

Equation           Parms      RMSE     R-sq      chi2     P>chi2
                     |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lconsumption  |    _ce1
              |     L1.  -.2325255   .0829183    -2.80   0.005    -.3950425   -.0700086
              |     LD.  -.2181972   .1219194    -1.79   0.074    -.4571548    .0207603
              |     L2D.  -.0539739   .1183305    -0.46   0.648    -.2858973    .1779496
D_lincome     |    _ce1
              |     L1.  -.0827167   .0986174    -0.84   0.402    -.2760033    .11057
              |     LD.   .3735242   .1450026     2.58   0.010     .0893243    .6577241
              |     L2D.   .1498023   .1407342     1.06   0.287    -.1260317    .4256363
              |     _cons  -.022882   .0058409    -0.39   0.695    -.0137362    .0091598
-------------+----------------------------------------------------------------
D_lincome     |    _ce1
              |     L1.   .1538797   .1232890     1.25   0.212    -.0877622    .3955216
              |     LD.   .2488728   .1131988     2.20   0.028     .0270071    .4707384
              |     L2D.  -.1614264   .1466315    -1.10   0.271    -.4488189    .125966
              |     _cons  .0064324   .0069468     0.93   0.354    -.0071831    .0200479


Cointegrating equations

<table>
<thead>
<tr>
<th>Equation</th>
<th>Parms</th>
<th>chi2</th>
<th>P&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>_ce1</td>
<td>1</td>
<td>13954.43</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Identification: beta is exactly identified
Johansen normalization restriction imposed

| beta | Coef. | Std. Err. | z     | P>|z|   | [95% Conf. Interval] |
|------|-------|-----------|-------|-------|---------------------|
| _ce1 |       |           |       |       |                     |
| lconsumption | 1 | . | . | . | . |
| lincome    | -.962309 | .0081463 | -118.13 | 0.000 | -.9782753 | -.9463426 |
| _cons | -.2015623 | . | . | . | . |

.irf set vec_eg, replace
(file vec_eg.irf created)
(file vec_eg.irf now active)

.irf create vec_eg, step(50) replace
irfname vec_eg not found in vec_eg.irf
(file vec_eg.irf updated)

.irf graph irf
* graph print
.graph export "C:\Documents and Settings\courses\761 and 762\w08\VEC\vec.eps", replace
(note: file C:\Documents and Settings\courses\761 and 762\w08\VEC\vec.eps not found)
(file C:\Documents and Settings\courses\761 and 762\w08\VEC\vec.eps written in EPS format)

.lagrange-multiplier test
<table>
<thead>
<tr>
<th>lag</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.9037</td>
<td>4</td>
<td>0.20646</td>
</tr>
<tr>
<td>2</td>
<td>4.3022</td>
<td>4</td>
<td>0.36665</td>
</tr>
</tbody>
</table>

H0: no autocorrelation at lag order
.test ([D_lconsumption]: L2D.lconsumption L2D.lincome) ([D_lincome]: L2D.lconsumption L2D.lincome)
( 1) [D_lconsumption]L2D.lconsumption = 0
( 2) [D_lconsumption]L2D.lincome = 0
( 3) [D_lincome]L2D.lconsumption = 0
( 4) [D_lincome]L2D.lincome = 0
\begin{verbatim}
  \text{chi2( 4) =  9.48} \\
  \text{Prob > chi2 =  0.0501}
\end{verbatim}

\textbf{test ([D_1consumption]: LD.lincome L2D.lincome)}

\begin{enumerate}
\item [D_1consumption]LD.lincome = 0
\item [D_1consumption]L2D.lincome = 0
\end{enumerate}

\begin{verbatim}
  \text{chi2( 2) =  5.10} \\
  \text{Prob > chi2 =  0.0781}
\end{verbatim}

\textbf{test ([D_lincome]: LD.lconsumption L2D.lconsumption)}

\begin{enumerate}
\item [D_lincome]LD.lconsumption = 0
\item [D_lincome]L2D.lconsumption = 0
\end{enumerate}

\begin{verbatim}
  \text{chi2( 2) =  6.67} \\
  \text{Prob > chi2 =  0.0357}
\end{verbatim}

\begin{verbatim}
\text{. log close}
  \text{log: C:\Documents and Settings\courses\761 and 762\w08\vec\vec.log}
\text{log type:  text}
\text{closed on:  23 Jan 2008, 15:02:39}
\end{verbatim}
Graphs by irfname, impulse variable, and response variable