

# Correlated Errors

- 1 Estimated regression coefficients are still unbiased, but they are no longer MLEs.

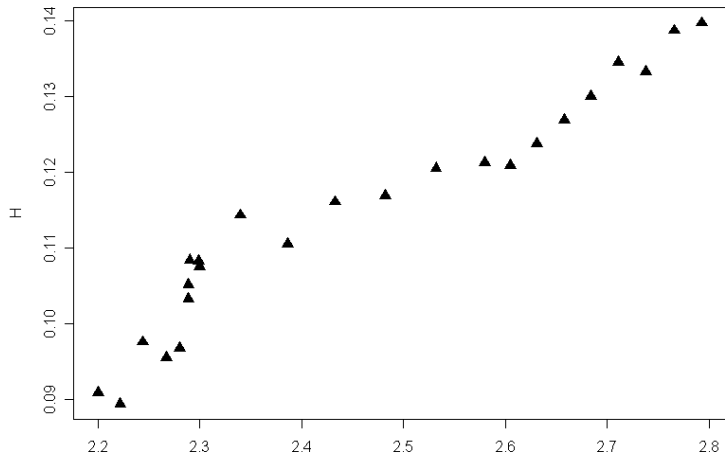
$$E[(X'X)^{-1}X'Y] = (X'X)^{-1}X'E[Y] = \beta.$$

- 2 MSE may seriously underestimated the variance of the error terms.
- 3 Standard errors are too small  $\rightarrow$   $t$ -statistics too large  $\rightarrow$  false positives.
- 4 Confidence intervals not large enough.

# Housing Starts

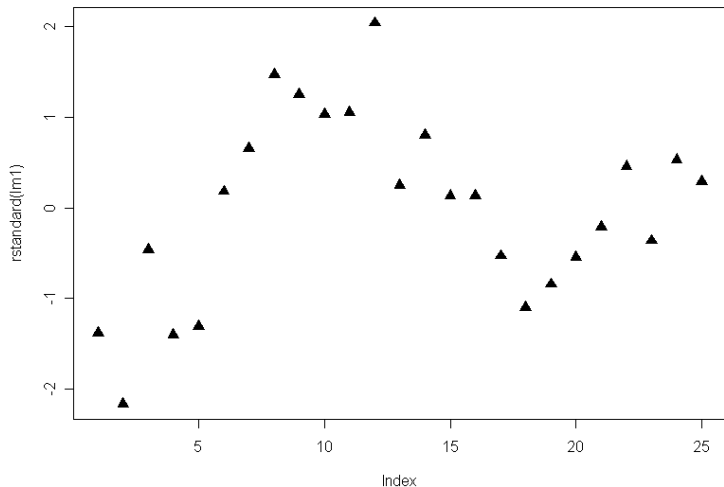
$H_t$ : housing starts (millions).  $P_t$  Size of the 22 to 44 year population group (millions).

$$H_t = \beta_0 + \beta_1 P_t + \epsilon_t$$



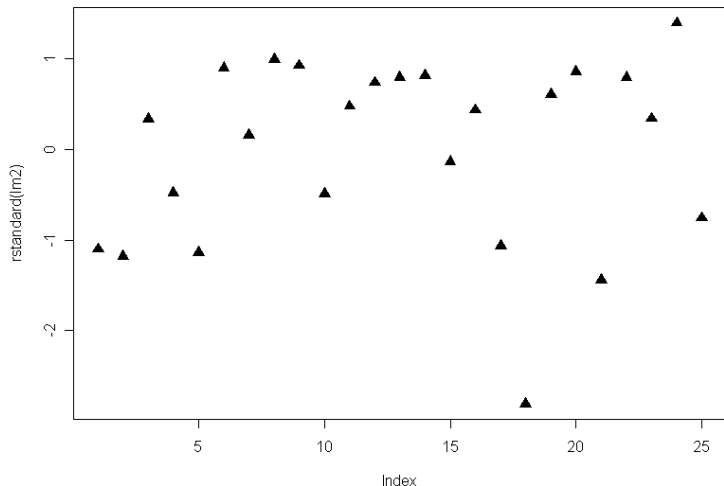
# Housing Starts

Standard residuals from ordinary least squares.



# Housing Starts

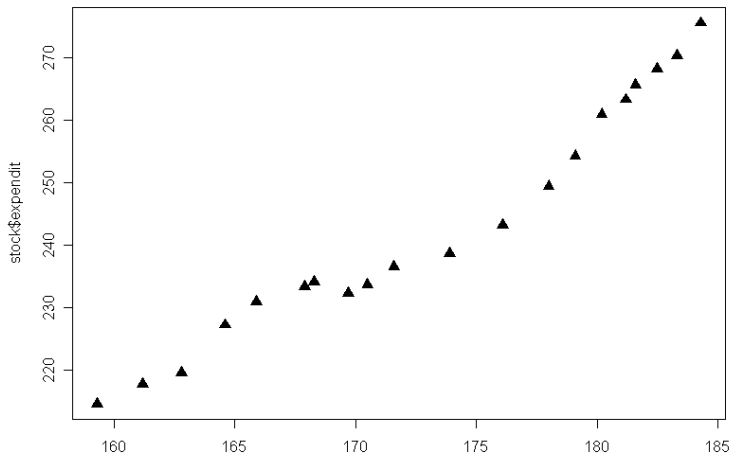
Standard residuals after including mortgage availability index.



# Consumer Expenditure

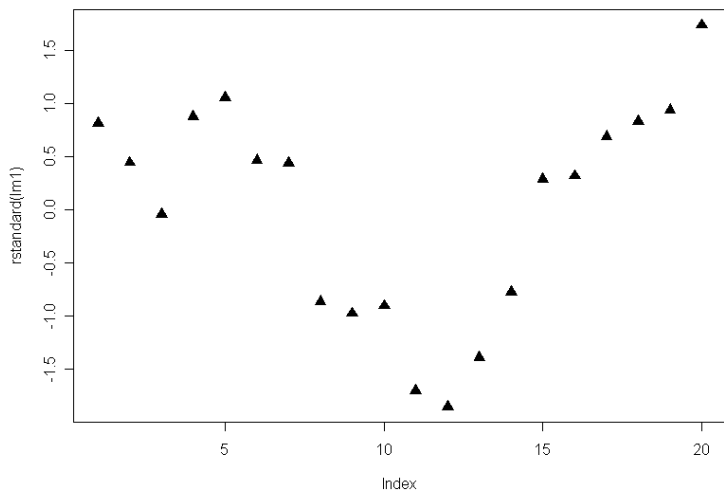
How does consumer expenditure depend on the price of money?

$Y$  is the consumer expenditure,  $X$  is the stock of money, both in billions of current dollars for the United States.



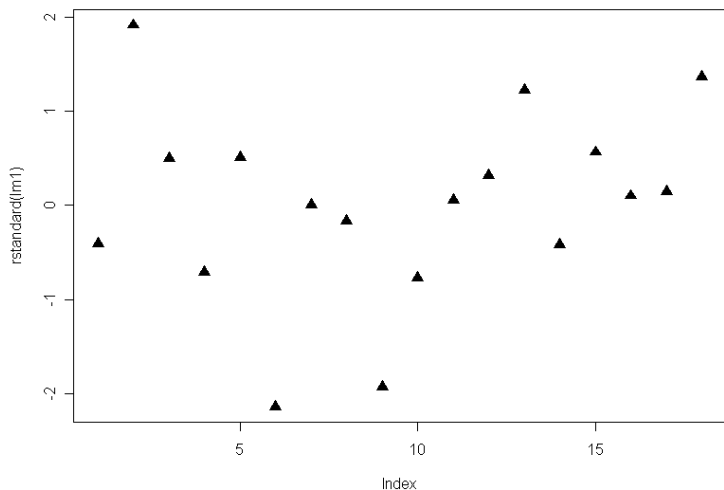
# Consumer Expenditure

Standardized residuals from ordinary least squares:



# Consumer Expenditure

After Cochran Orcutt procedure:



# Summary

- The simplest kind of correlation in the errors is autocorrelation. Often, it works as a first approximation.
- The Durbin Watson Test can be used to detect autocorrelation.
- Sometimes, autocorrelation is caused by a seasonal variable being missing from the model (e.g. Housing Starts data).
- When autocorrelation can not be removed from the data, the Cochran-Orcutt procedure can be used to correct for it.