

Wald Tests with R

```
> # Wald test example
>
> # Re-generate Gamma data
> set.seed(3201); alpha=2; beta=3
> D <- round(rgamma(50,shape=alpha, scale=beta),2); D
[1] 20.87 13.74 5.13 2.76 4.73 2.66 11.74 0.75 22.07 10.49 7.26 5.82 13.08
[14] 1.79 4.57 1.40 1.13 6.84 3.21 0.38 11.24 1.72 4.69 1.96 7.87 8.49
[27] 5.31 3.40 5.24 1.64 7.17 9.60 6.97 10.87 5.23 5.53 15.80 6.40 11.25
[40] 4.91 12.05 5.44 12.62 1.81 2.70 3.03 4.09 12.29 3.23 10.94
> momalpha <- mean(D)^2/var(D); momalpha
[1] 1.899754
> mombeta <- var(D)/mean(D); mombeta
[1] 3.620574
>
> gml12 <- function(theta,datta)
+   { gml12 <- -sum(dgamma(datta,shape=theta[1],scale=theta[2],log=T))
+     gml12
+   } # End of gml12
>
> # Maximum likelihood estimation
> gamama = nlm(gml12,c(momalpha,mombeta),hessian=T,datta=D)
> thetahat = gamama$estimate; thetahat
[1] 1.805930 3.808674
> kov = solve(gamama$hessian) # Inverse of (estimated) observed info
> kov
      [,1] [,2]
[1,] 0.1111796 -0.2345578
[2,] -0.2345578 0.6555641
>
> # Wald test of H0: alpha = beta
> # LR test gave G2 = 4.2776, p = 0.039
>
> source("http://www.utstat.utoronto.ca/~brunner/Rfunctions/Wtest.txt")
> Wtest

function(L,Tn,Vn,h=0) # H0: L theta = h
# Note Vn is the estimated asymptotic covariance matrix of Tn,
# so it's Sigma-hat divided by n. For Wald tests based on numerical
# MLEs, Tn = theta-hat, and Vn is the inverse of the Hessian.
{
  Wtest = numeric(3)
  names(Wtest) = c("W","df","p-value")
  r = dim(L)[1]
  W = t(L%*%Tn-h) %*% solve(L%*%Vn%*%t(L)) %*%
    (L%*%Tn-h)
  W = as.numeric(W)
  pval = 1-pchisq(W,r)
  Wtest[1] = W; Wtest[2] = r; Wtest[3] = pval
  Wtest
}
>
> LL = rbind(c(1,-1)); LL
      [,1] [,2]
[1,] 1 -1
> Wtest(LL,thetahat,kov)
      W      df      p-value
3.24550195 1.00000000 0.07161975
```

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<http://www.utstat.toronto.edu/~brunner/oldclass/appliedf17>