```
clear
set scheme sj
*=====================================================================
* QUESTION 1: BREAST CANCER SCREENING
*
* The posterior can be found in one of three ways
* (a) numerical integration using integ
* (b) write a program for evaluating the log-posterior
* (c) theoretically using the conjugacy of gamma prior and Poisson mean
*---------------------------------------------------------------
* USING INTEG
* data 942 deaths in 1.55 lots of 100,000 woman-years
* prior G(60,10)
* Likelihood normalization is arbitrary
*---------------------------------------------------------------
clear
range theta 400 800 1000
gen logL = -theta*1.55 + 942*log(theta*1.55)
su logL
gen Likelihood = exp(logL-r(max))
integ Likelihood theta
replace Likelihood = Likelihood/r(integral)
gen Prior = gammaden(60,10,0,theta)
gen Posterior = Likelihood*Prior
integ Posterior theta
replace Posterior = Posterior/r(integral)
twoway (line Posterior theta) (line Likelihood theta) (line Prior theta), ///
  legend(pos(1) ring(0) col(1)) title(Control Group)
*---------------------------------------------------------------
* USING PROGRAM FOR LOG-POSTERIOR
*---------------------------------------------------------------
clear
cap program drop logpost
program logpost
    args logp b

    local theta0 = `b'[1,1]
    scalar `logp' = 0
    logdensity poisson   `logp'  942  `theta0'*1.55
    logdensity gamma   `logp'  `theta0' 60 10
end
tempname pf
matrix b = J(1,1,0)
postfile `pf' theta0 logp using temp.dta, replace
foreach theta0 of numlist 400(1)800 {
   matrix b[1,1] = `theta0'
   logpost logf b
   post `pf' (`theta0') (logf)
}
postclose `pf'
use temp.dta, clear
su logp
gen p = exp(logp - r(max))
integ p theta0
replace p = p/r(integral)
twoway (line p theta0) (function y = gammaden(60,10,0,x) , range(400 800)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
  title(Control Group)
*---------------------------------------------------------------
* USING CONJUGACY
* ignoring constants
* Poisson Likelihood exp(-theta*1.55)* theta^942
* Gamma prior theta^59 * exp(-theta/10)
* Posterior theta^1022 * exp(-theta*1.65) => G(1023,1/1.65)
*---------------------------------------------------------------
twoway (function y = gammaden(1023,1/1.65,0,x) , range(400 800)) ///
   (function y = gammaden(60,10,0,x) , range(400 800)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
```

```
  title(Control Group)
*-------------------------------------------------------------
* ANALYSIS OF THE SCREENED GROUP
* my prior G(55,10)
* 876 deaths in 1.55 lots of 100,000 woman-years
* Could be analysed in three ways again but I will used the log-posterior
* program as it is the most generalizable
*-------------------------------------------------------------
clear
cap program drop logpost
program logpost
    args logp b

    local theta0 = `b'[1,1]
    scalar `logp' = 0
    logdensity poisson   `logp'  876  `theta0'*1.55
    logdensity gamma   `logp'  `theta0' 55 10
end
tempname pf
matrix b = J(1,1,0)
postfile `pf' theta0 logp using temp.dta, replace
foreach theta0 of numlist 400(1)800 {
   matrix b[1,1] = `theta0'
   logpost logf b
   post `pf' (`theta0') (logf)
}
postclose `pf'
use temp.dta, clear
su logp
gen p = exp(logp - r(max))
integ p theta0
replace p = p/r(integral)
twoway (line p theta0) (function y = gammaden(60,10,0,x) , range(400 800)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
  title(Group Offered Screening)
*-------------------------------------------------------------
* Superimposing the two posteriors
*-------------------------------------------------------------
twoway (function y = gammaden(1023,1/1.65,0,x) , range(400 800)) ///
   (function y = gammaden(941,1/1.65,0,x) , range(400 800)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Controls") label( 2 "Screen") ) ///
  title(Posterior Distributions)
*=============================================================================
* QUESTION 2: CONTRAST NEPHROPATHY
*
* Enter the data and display
*-------------------------------------------------------------
clear
set obs 7
input t nt c nc
1 41 9 42
8 45 6 40
6 92 10 91
2 25 13 29
10 38 9 41
2 60 15 61
4 102 19 98
gen lnRR = .
gen se = .
forvalues i=1/7 {
   local a = t[`i']
   local b = c[`i']
   local c = nt[`i']
   local d = nc[`i']
   qui iri `a' `b' `c' `d'
   qui replace lnRR = log(r(irr)) in `i'
   qui replace se = (log(r(ub_irr))-log(r(lb_irr)))/3.92 in `i'
}
```

```
gen study = _n
gen ub = lnRR + 1.96*se
gen lb = lnRR - 1.96*se
save cnma.dta, replace
twoway (scatter study lnRR) (rcap lb ub study , horiz), xline(0, lpat(dash)) ///
   xtitle(log Relative Risk) ylabel(1(1)7) ///
   title(Contrast Nephropathy Meta-analysis) leg(off)
*-------------------------------------------------------------
* My prior on the logRR is N(-0.4,sd=0.3)
* fixed effects meta-analysis conditional on se
*-------------------------------------------------------------
cap program drop logpost
program logpost
   args logp b

   local theta = `b'[1,1]
   scalar `logp' = 0
   logdensity normal `logp' lnRR `theta' se
   logdensity normal `logp' `theta' -0.4 0.3
end
tempname pf
matrix b = J(1,1,0)
postfile `pf' theta logp using temp.dta, replace
foreach theta of numlist -2(0.01)1 {
   matrix b[1,1] = `theta'
   logpost logf b
   post `pf' (`theta') (logf)
}
postclose `pf'
use temp.dta, clear
su logp
gen p = exp(logp - r(max))
integ p theta
replace p = p/r(integral)
save temp.dta, replace
twoway (line p theta) (function y = normalden(x,-0.4,0.3) , range(-2 1)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
  title(Contrast Nephropathy Meta-analysis) xtitle(log Relative Risk)
*-------------------------------------------------------------
* probability that logRR > 0
*-------------------------------------------------------------
di "Prior " %10.2f 100*(1-normal(0.4/0.3))
qui integ p theta if theta > 0
di "Posterior " %10.2f 100*r(integral)
*-------------------------------------------------------------
* Transfer to RR scale
*-------------------------------------------------------------
gen phi = exp(theta)
gen pRR = p/exp(theta)
twoway (line pRR phi if phi < 2) (function y = normalden(log(x),-0.4,0.3)/x ,
range(0.1 2)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
  title(Contrast Nephropathy Meta-analysis) xtitle(Relative Risk)
*-------------------------------------------------------------
* My prior on the logRR is N(-0.4,sd=0.3)
* random effects meta-analysis conditional on se and phi=0.5
*-------------------------------------------------------------
cap program drop logpost
program logpost
   args logp b

   local theta = `b'[1,1]
   scalar `logp' = 0
   logdensity normal `logp' lnRR `theta' ser
   logdensity normal `logp' `theta' -0.4 0.3
end
use cnma.dta, clear
tempname pf
```

```
matrix b = J(1,1,0)
gen ser = sqrt(se*se+0.25)
postfile `pf' theta logp using tempr.dta, replace
foreach theta of numlist -2(0.01)1 {
   matrix b[1,1] = `theta'
   logpost logf b
   post `pf' (`theta') (logf)
}
postclose `pf'
use tempr.dta, clear
su logp
gen pr = exp(logp - r(max))
integ pr theta
replace pr = pr/r(integral)
twoway (line pr theta) (function y = normalden(x,-0.4,0.3) , range(-2 1)) , ///
  legend(pos(1) ring(0) col(1) label(1 "Posterior") label( 2 "Prior") ) ///
  title(Random Effects Meta-analysis) xtitle(log Relative Risk)
merge 1:1 _n using temp.dta
twoway (line pr theta) (line p theta) , ///
  legend(pos(1) ring(0) col(1) label(1 "Random Effects") label( 2 "Fixed Effects")
) ///
  xtitle(log Relative Risk)
```