Bayesian Age-Period-Cohort Modeling
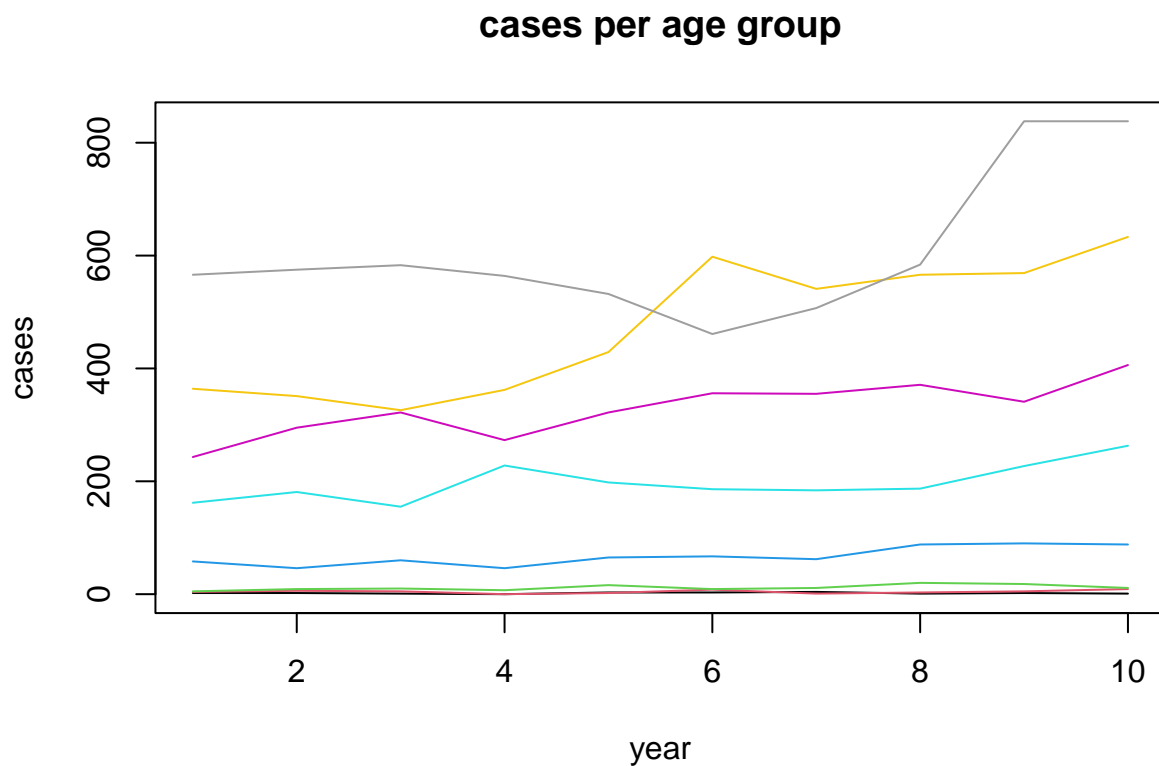
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2022-05-28

Data example

BAMP includes a data example.

```
data(apc)
plot(cases[,1],type="l",ylim=range(cases), ylab="cases", xlab="year", main="cases per age group")
for (i in 2:8)lines(cases[,i], col=i)
```

cases per age group

APC model with random walk first order prior

```
model1 <- bamp(cases, population, age="rw1", period="rw1", cohort="rw1",
               periods_per_agegroup = 5)
```

bamp() automatically performs a check for MCMC convergence using Gelman and Rubin's convergence diagnostic. We can manually check the convergence again:

```
checkConvergence(model1)
```

[1] TRUE

Now we have a look at the model results. This includes estimates of smoothing parameters and deviance and DIC:
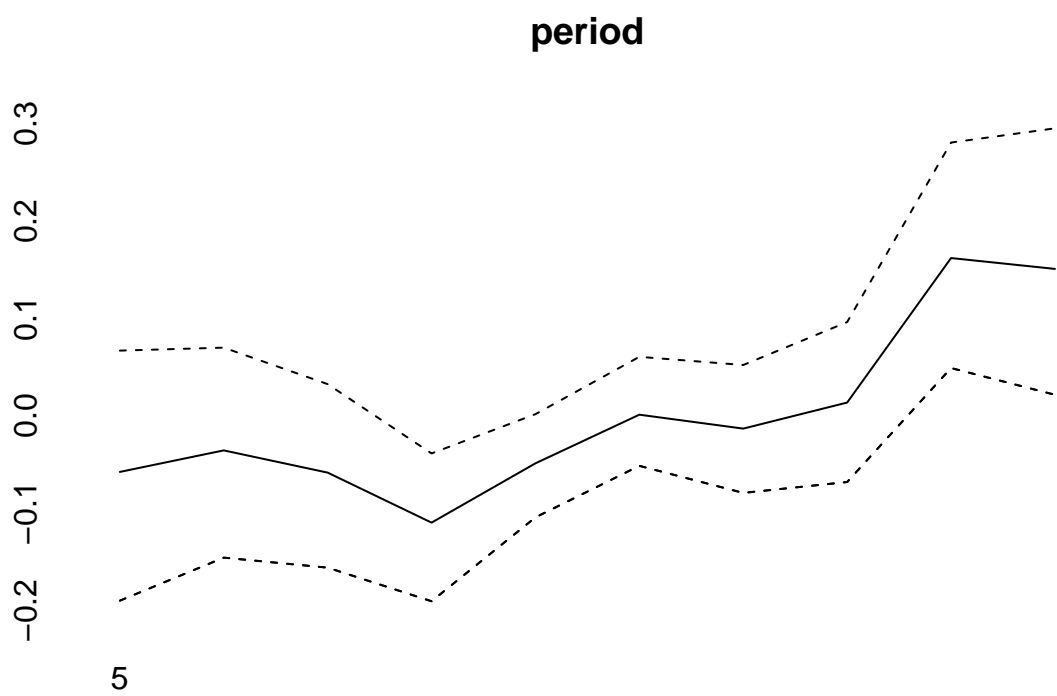
```
print(model1)
```
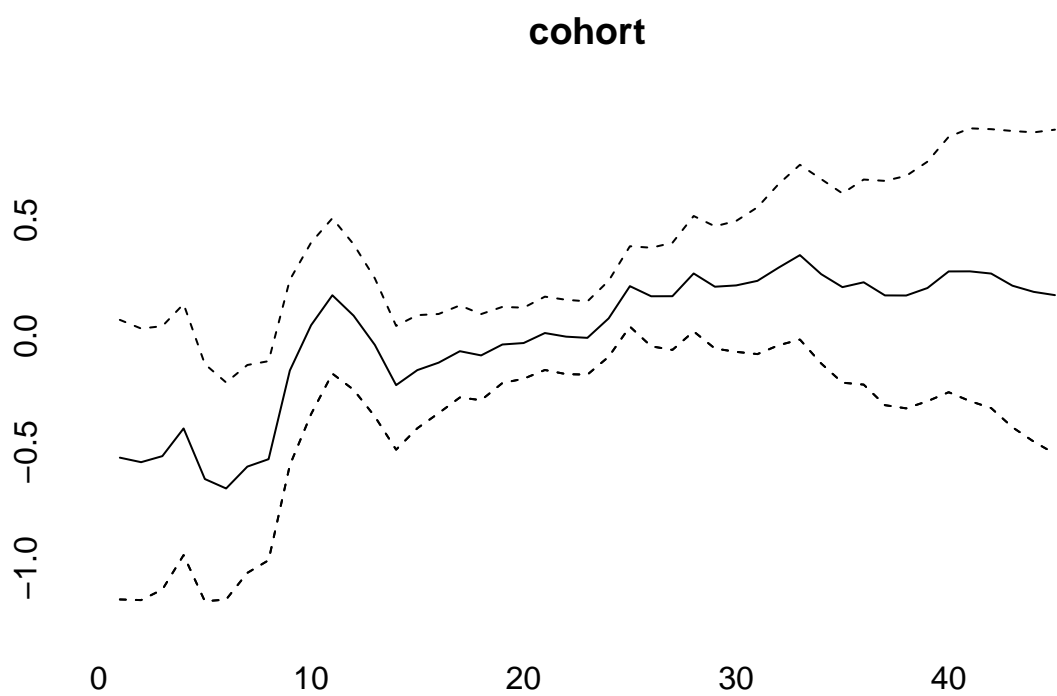
```
##
##   Model:
## age (rw1)  - period (rw1)  - cohort (rw1) model
## Deviance:     231.38
## pD:            36.96
## DIC:         268.34
##
##
##   Hyper parameters:               5%         50%         95%
## age                           0.352       0.901       1.901
## period                       71.122     204.007     632.733
## cohort                       34.012      58.064      96.034
##
##
## Markov Chains convergence checked succesfully using Gelman's R (potential scale reduction factor).
```

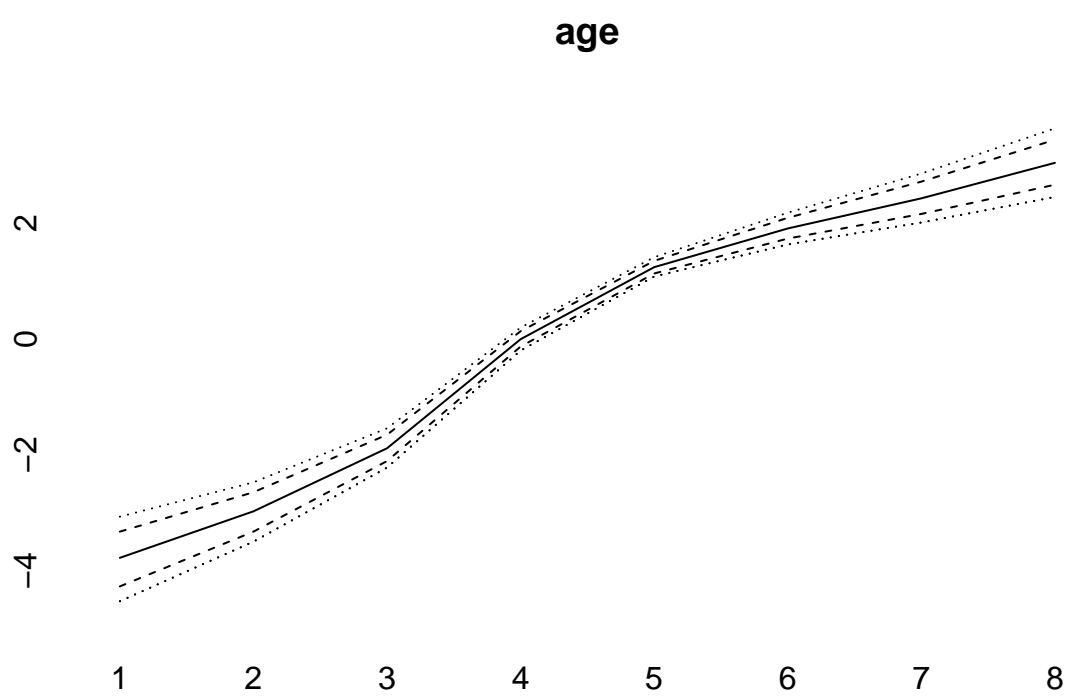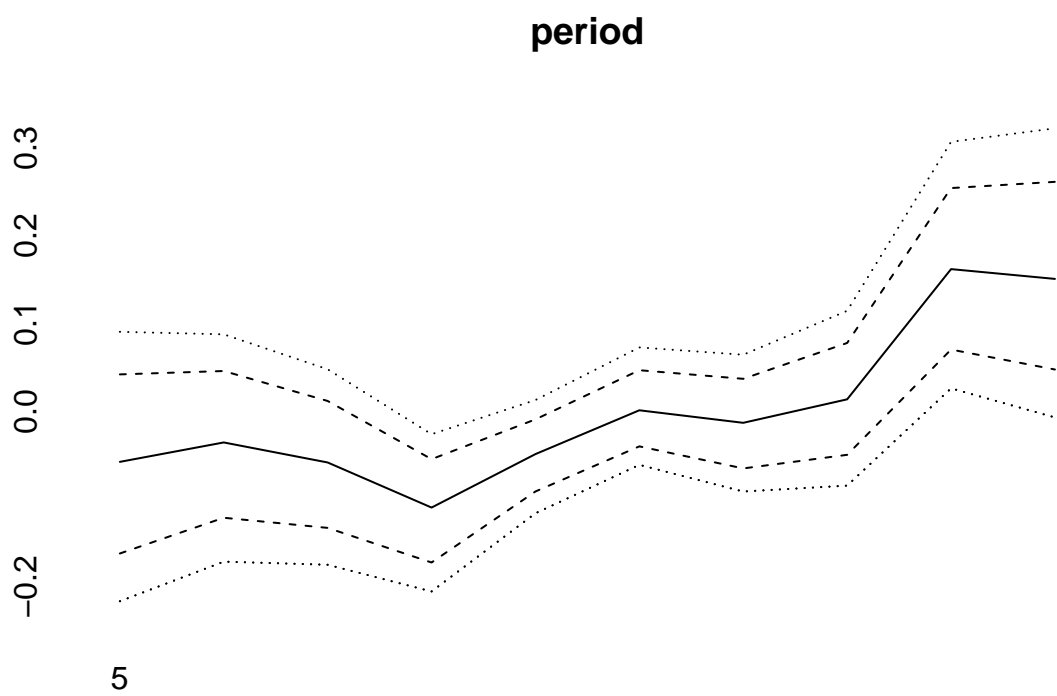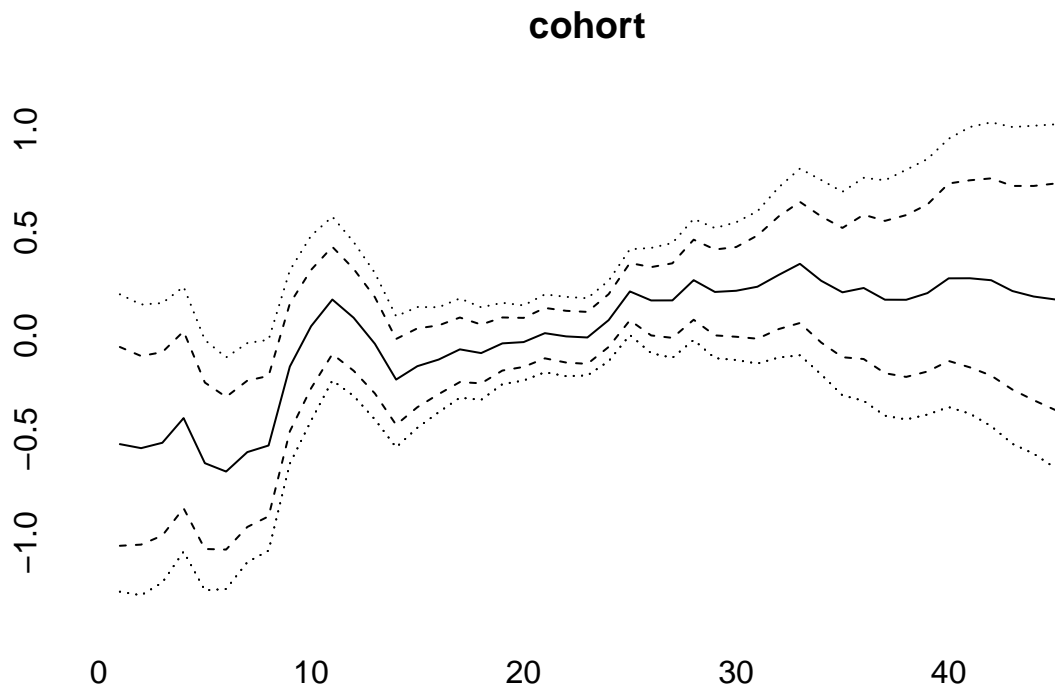We can plot the main APC effects using point-wise quantiles:

```
plot(model1)
```

period

5
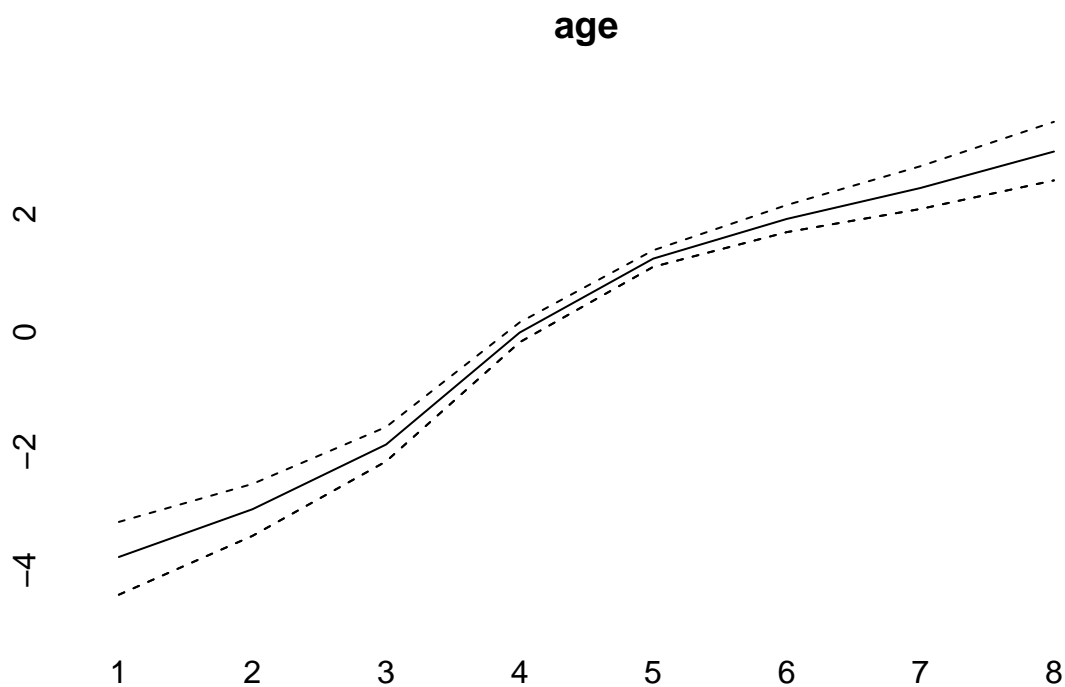
cohort

More quantiles are possible:

```
plot(model1, quantiles = c(0.025,0.1,0.5,0.9,0.975))
```

age

period

5

cohort

APC model with random walk second order prior

```
model2 <- bamp(cases, population, age="rw2", period="rw2", cohort="rw2",
               periods_per_agegroup = 5,
               mcmc.options=list("number_of_iterations"=200000, "burn_in"=100000, "step"=50, "tuning"=50(
               hyperpar=list("age"=c(1,.5), "period"=c(1,0.05), "cohort"=c(1,0.05)))
```

```
## Warning: MCMC chains did not converge!
```
```
checkConvergence(model2)
```

```
## Warning: MCMC chains did not converge!
```
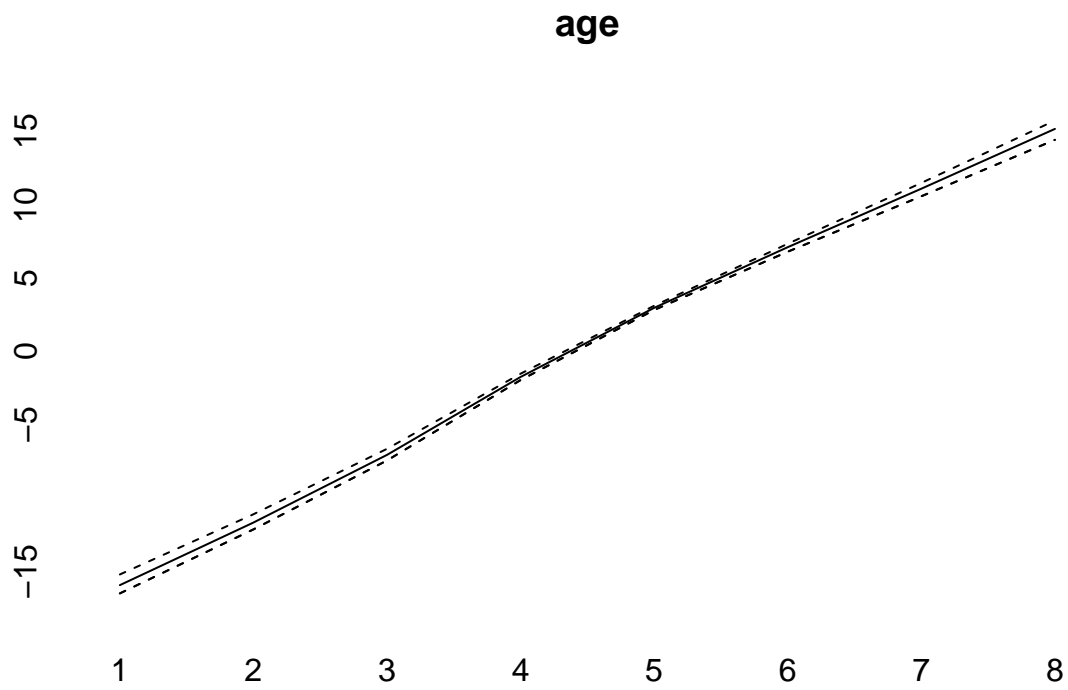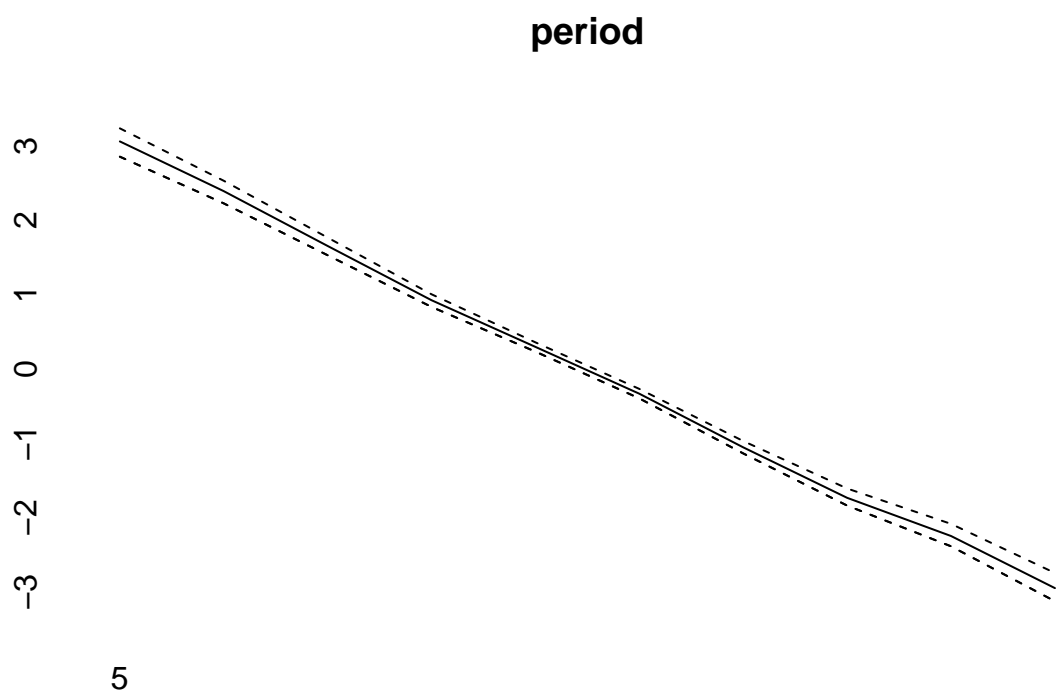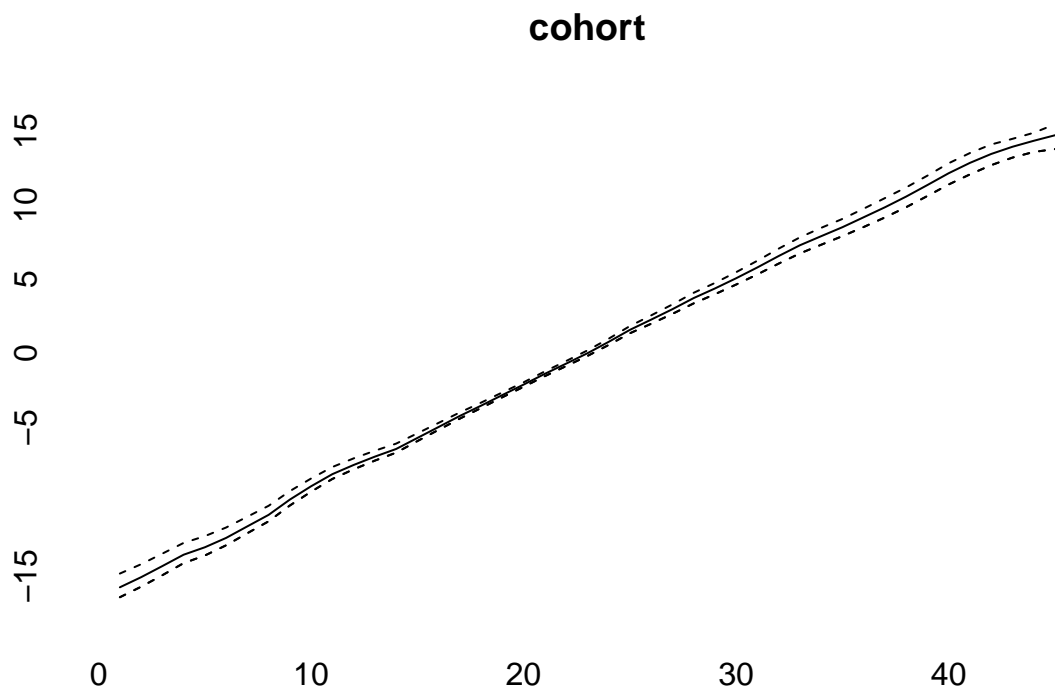```
[1] FALSE
```
```
print(model2)
```

```
##
## WARNING! Markov Chains have apparently not converged! DO NOT TRUST THIS MODEL!
##
##   Model:
## age (rw2)  - period (rw2)  - cohort (rw2) model
## Deviance:      233.97
## pD:             37.08
## DIC:           271.05
##
##
##   Hyper parameters:                    5%            50%           95%
```

```
## age                          1.039      2.959      6.678
## period                      16.754     41.586     90.127
## cohort                      22.644     44.290     81.658
plot(model2)
```

age

period

cohort


```r
model3<-bamp(cases, population, age="rw1", period=" ", cohort="rw2",
             periods_per_agegroup = 5)
```

```r
checkConvergence(model3)
```

```
## [1] TRUE
```

```r
print(model3)
```

```
##
##  Model:
## age (rw1) cohort (rw2) model
## Deviance:     276.56
## pD:            30.01
## DIC:          306.56
##
##
##  Hyper parameters:              5%          50%          95%
## age                         0.295        0.732        1.538
## cohort                     38.804       74.441      140.920
##
##
## Markov Chains convergence checked succesfully using Gelman's R (potential scale reduction factor).
```
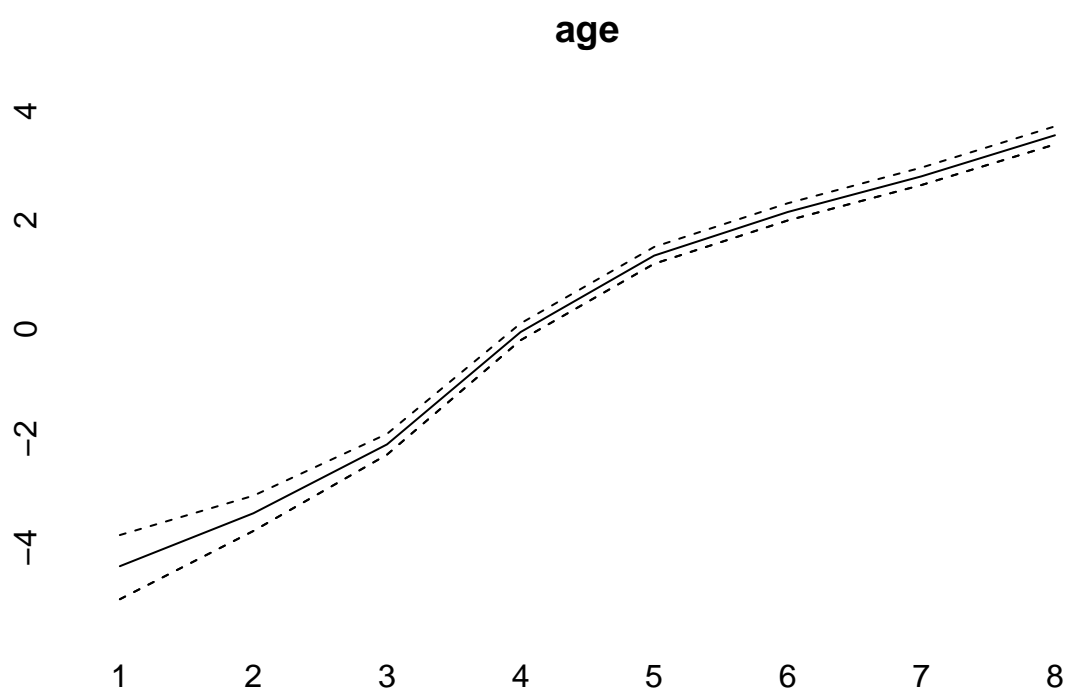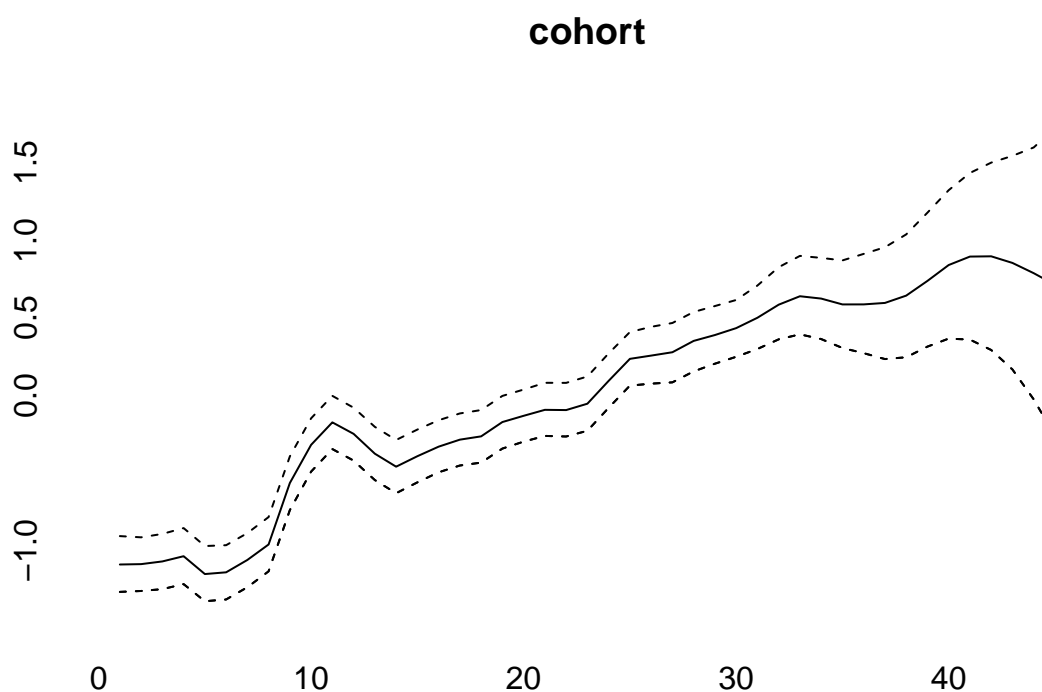
```r
plot(model3)
```
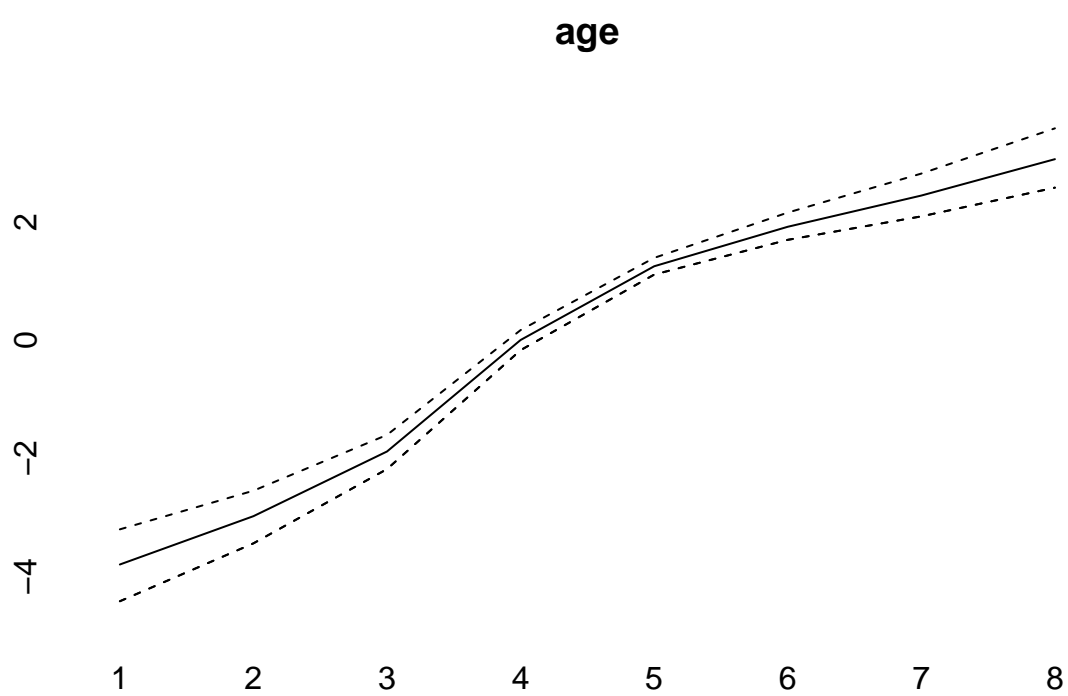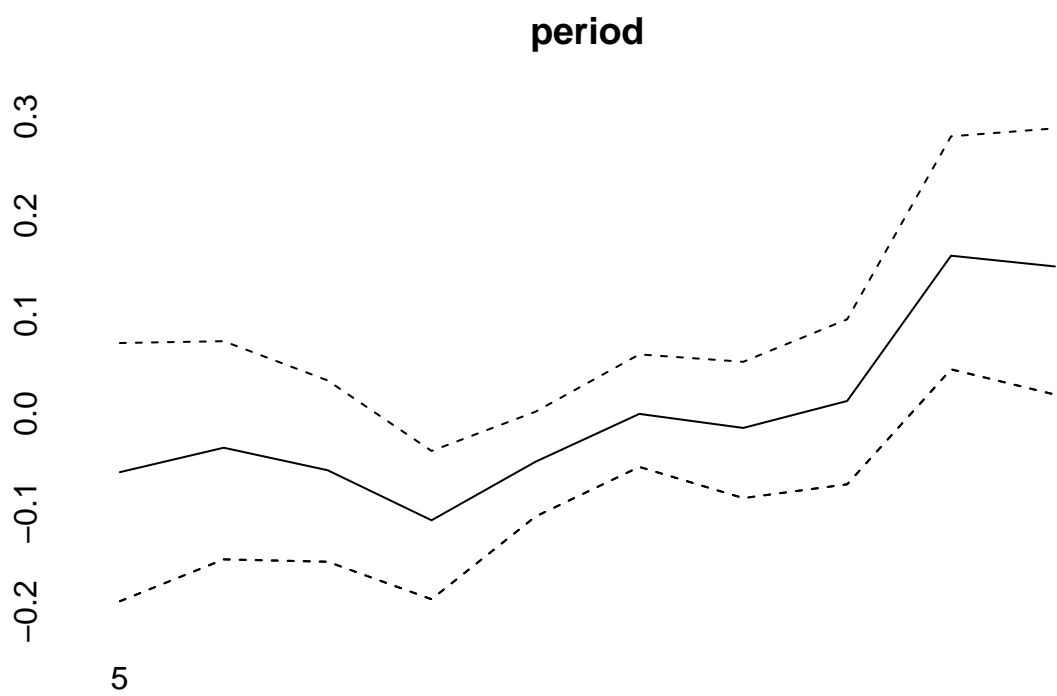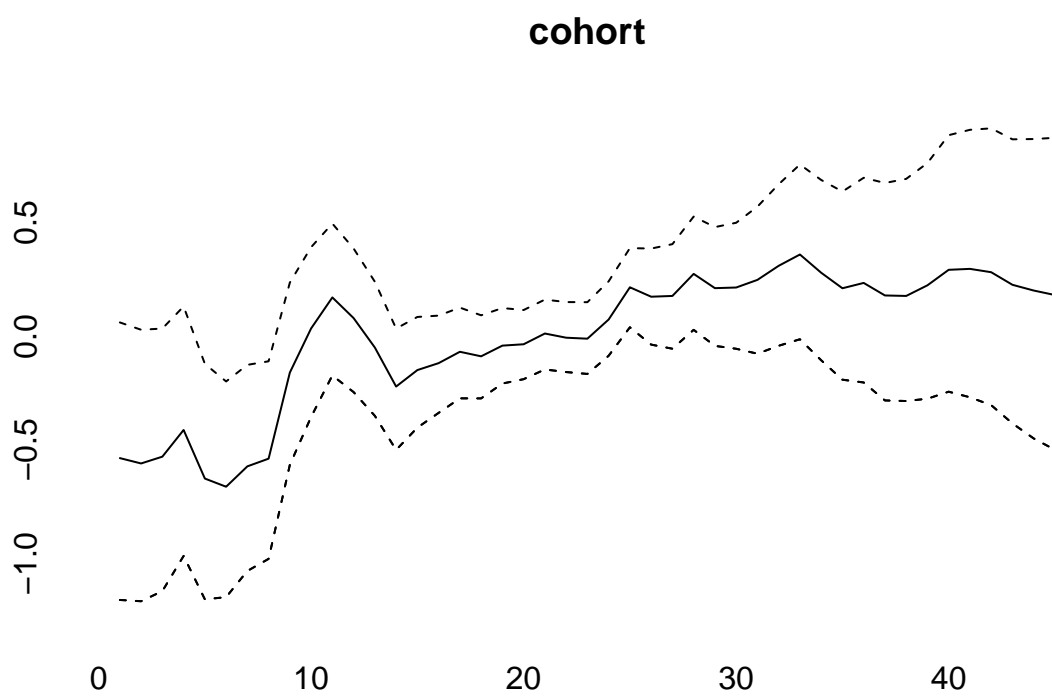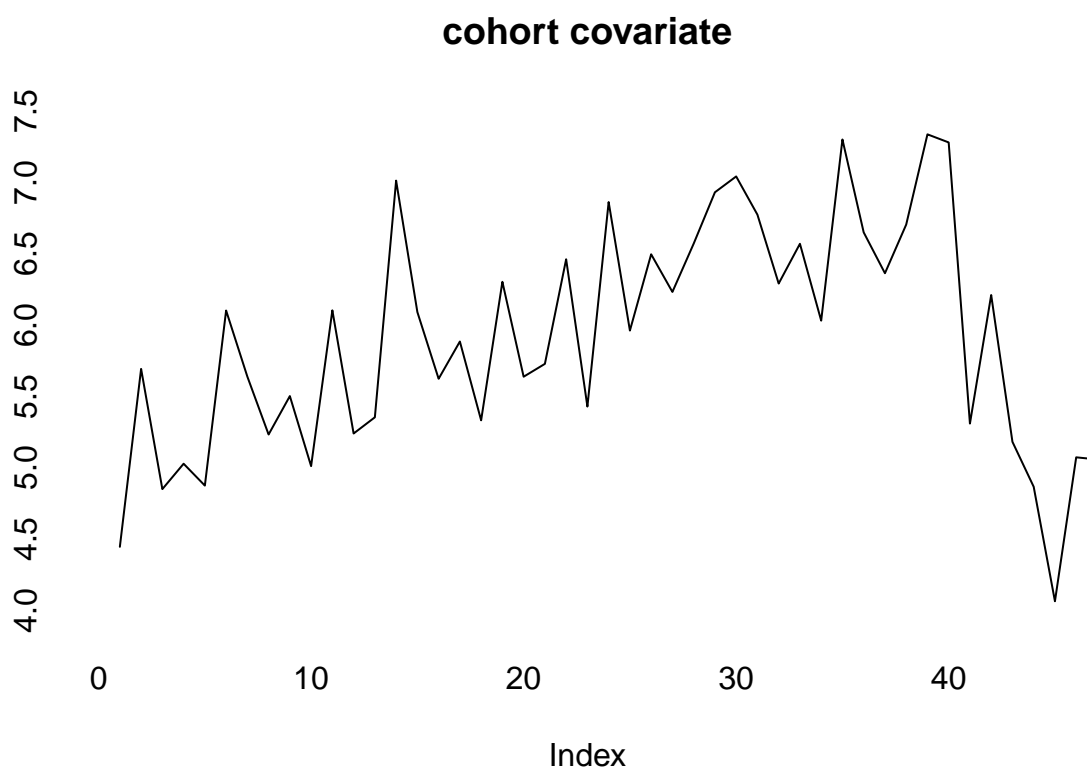
age

cohort


```
(model4<-bamp(cases, population, age="rw1", period="rw1", cohort="rw1",
              cohort_covariate = cov_c, periods_per_agegroup = 5))
```
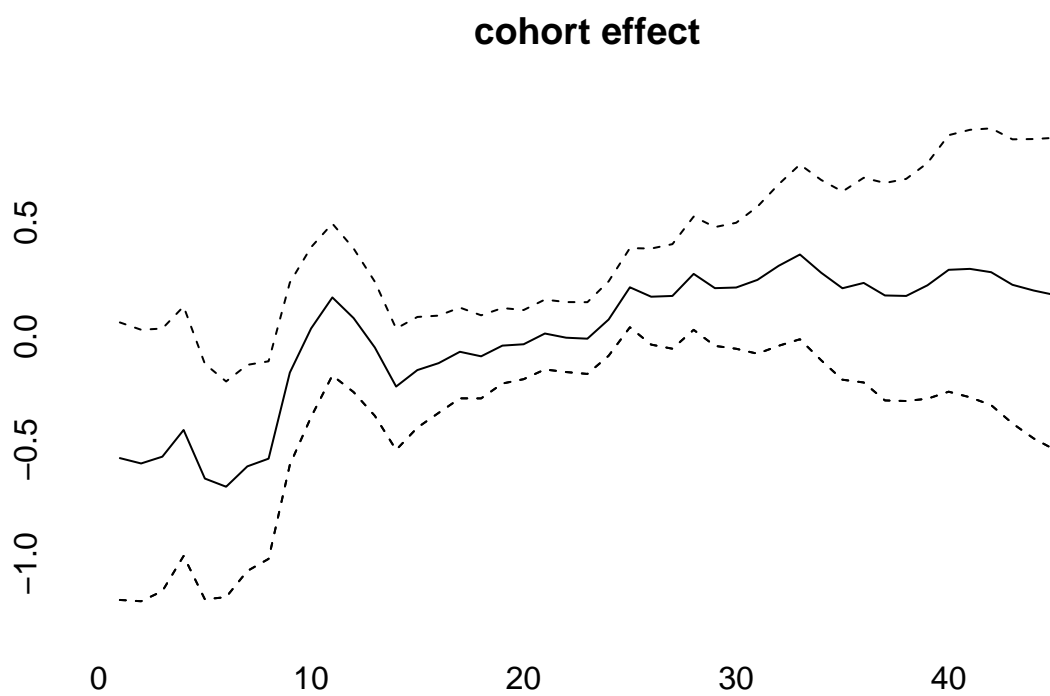
```
##
##  Model:
## age (rw1)  - period (rw1)  - cohort (rw1) model
## Deviance:      230.85
## pD:             36.49
## DIC:           267.34
##
##
##  Hyper parameters:                5%          50%          95%
## age                           0.345        0.888        1.874
## period                       71.100      207.259      657.609
## cohort                       34.497       59.004       97.443
##
##
## Markov Chains convergence checked succesfully using Gelman's R (potential scale reduction factor).
```

```
plot(model4)
```

age
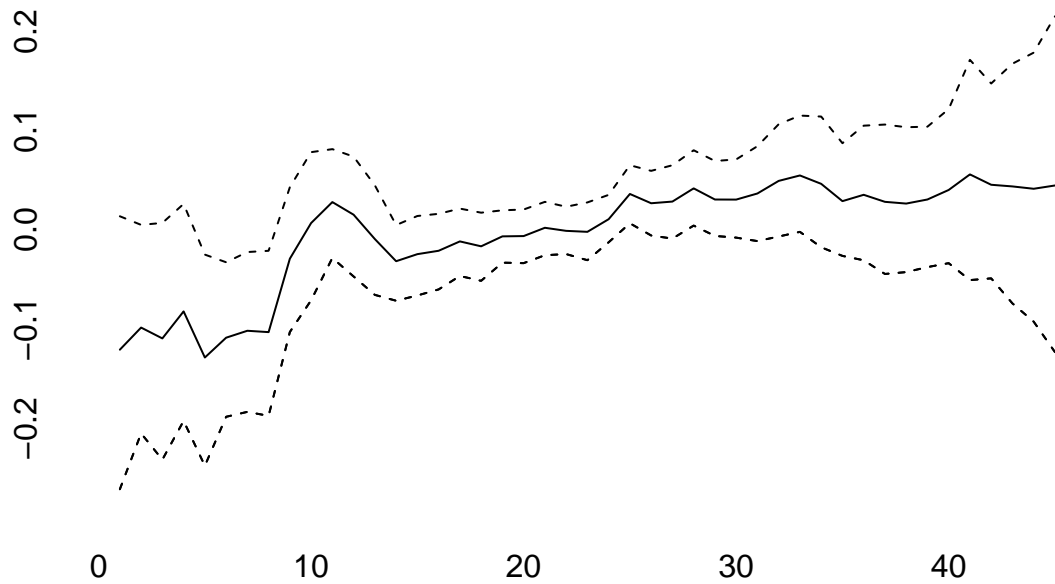
period

5

cohort
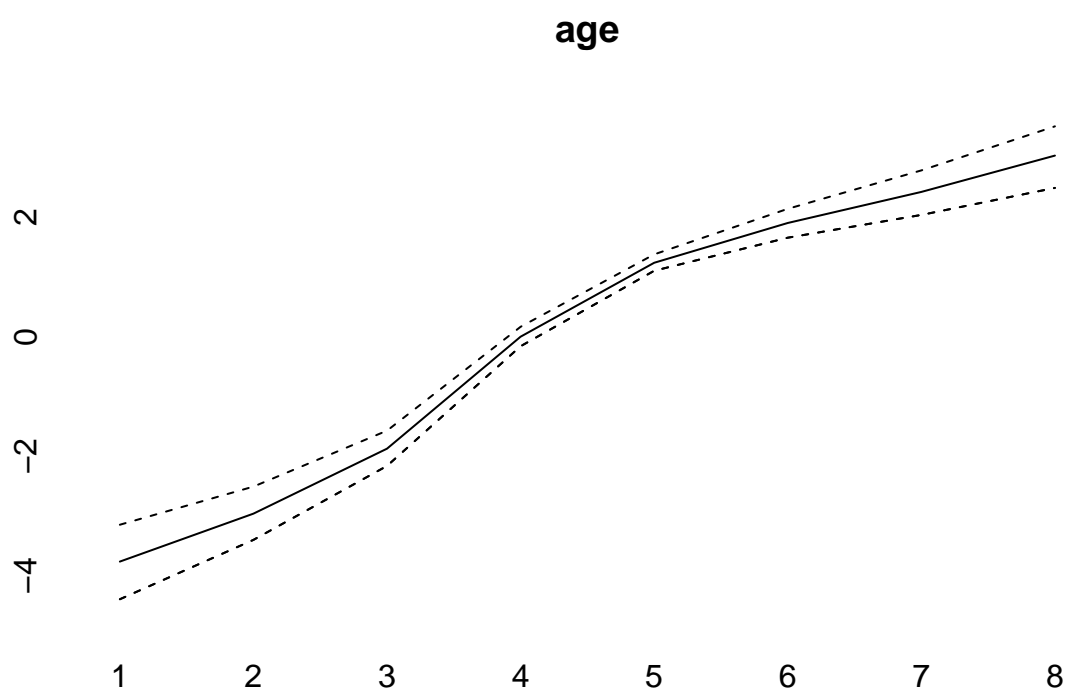
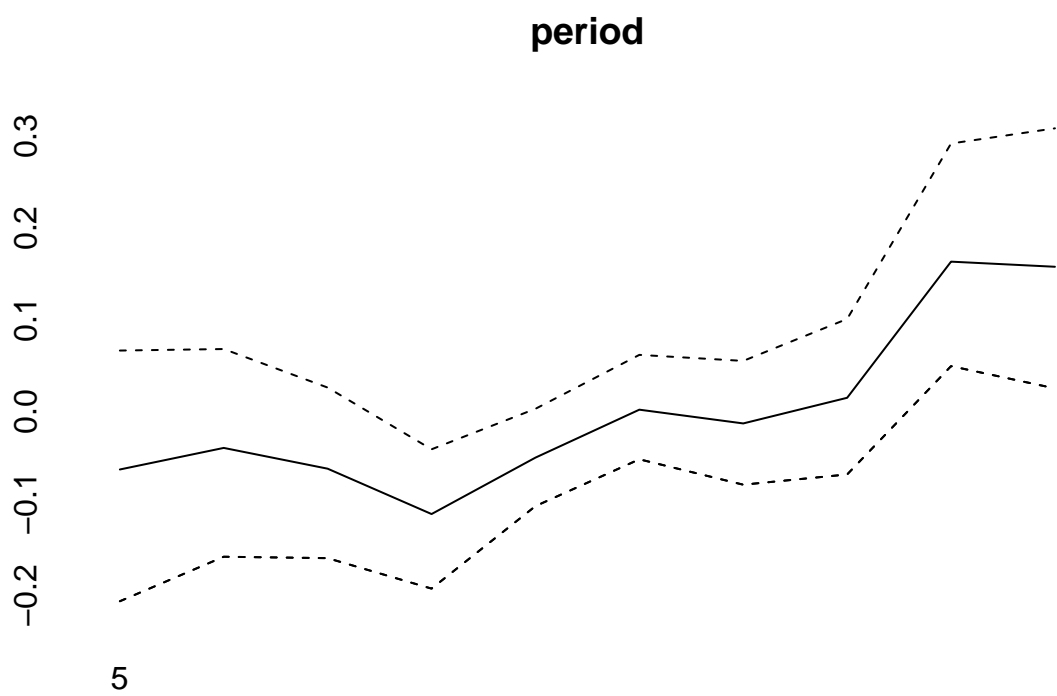# cohort covariate

Index

cohort effect

raw effect of cohort covariate
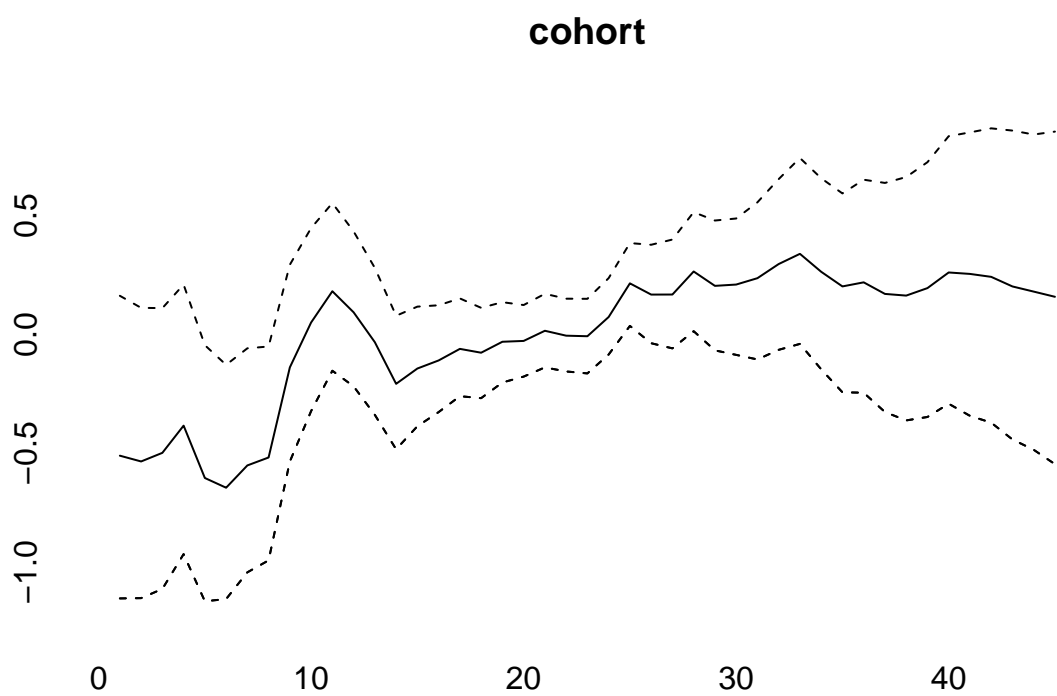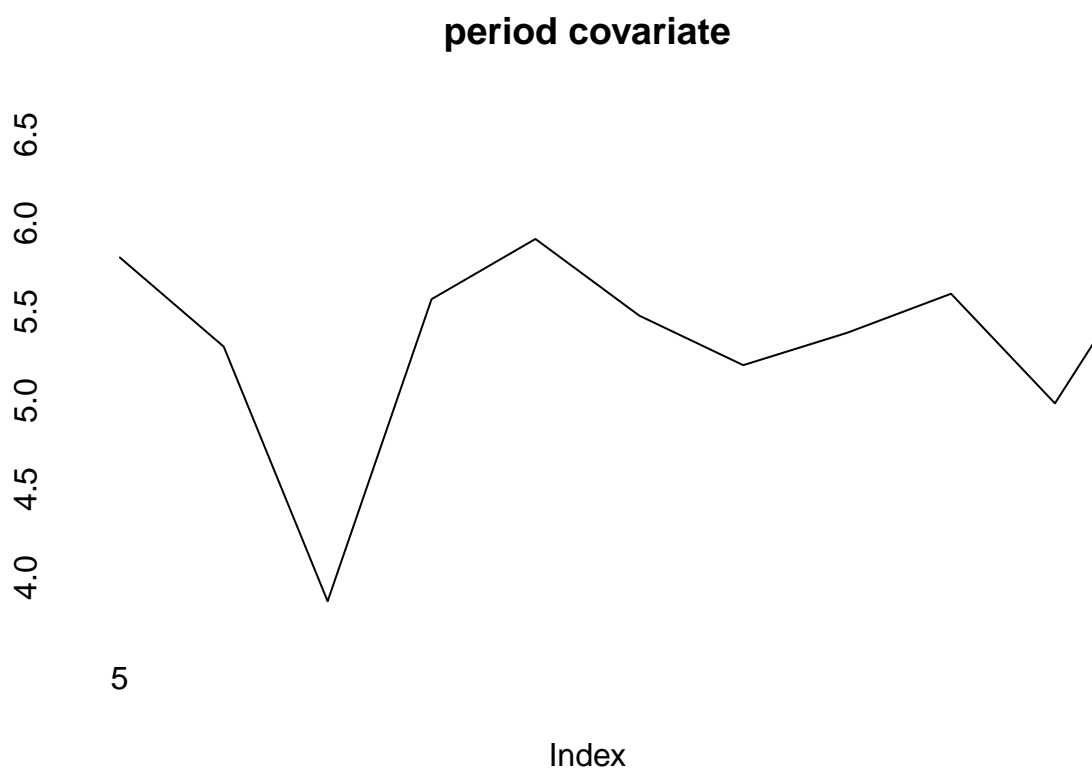


```
(model5<-bamp(cases, population, age="rw1", period="rw1", cohort="rw1",
            period_covariate = cov_p, periods_per_agegroup = 5))
```
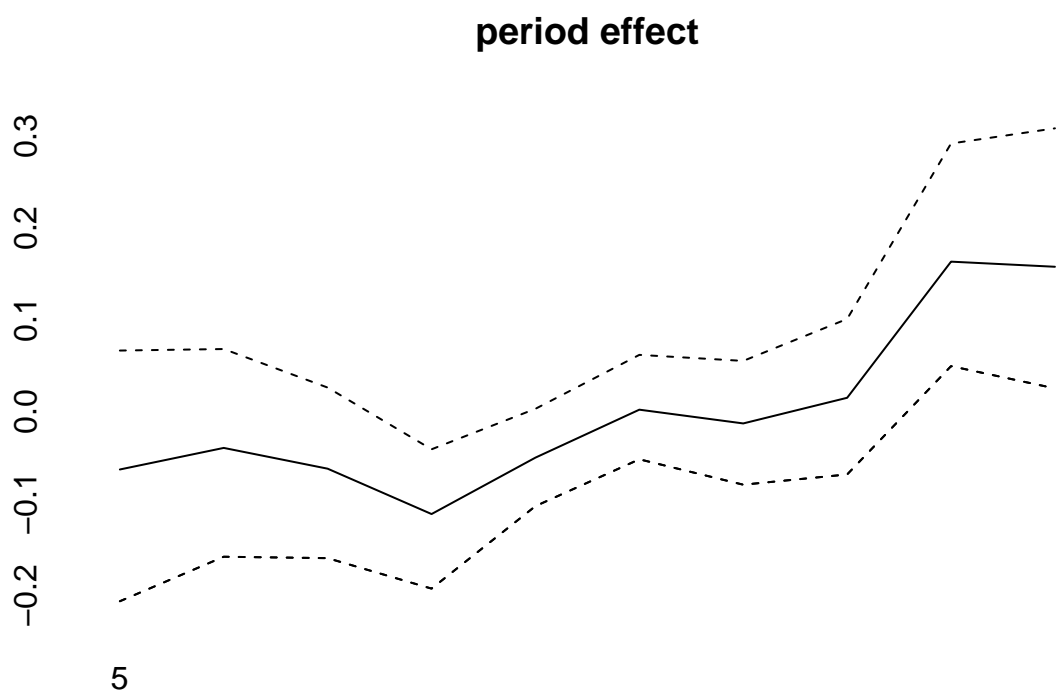
```
##
##  Model:
## age (rw1)  - period (rw1)  - cohort (rw1) model
## Deviance:     231.17
## pD:            36.66
## DIC:          267.83
##
##
##  Hyper parameters:              5%          50%          95%
## age                         0.362        0.915        1.923
## period                     67.008      201.350      639.755
## cohort                     35.331       59.181       97.973
##
##
## Markov Chains convergence checked succesfully using Gelman's R (potential scale reduction factor).
```

```
plot(model5)
```

age

period

cohort

period covariate

Index

period effect

5

raw period covariate effect

5