Cost-effectiveness efficiency frontier

Introduction

The line connecting successive points on a cost-effectiveness plane which each represent the effect and cost associated with different treatment alternatives. The gradient of a line segment represents the ICER of the treatment comparison between the two alternatives represented by that segment. The cost-effectiveness frontier consists of the set of points corresponding to treatment alternatives that are considered to be cost-effective at different values of the cost-effectiveness threshold. The steeper the gradient between successive points on the frontier, the higher is the ICER between these treatment alternatives and the more expensive alternative would be considered cost-effective only when a high value of the cost-effectiveness threshold is assumed. Points not lying on the cost-effectiveness frontier represent treatment alternatives that are not considered cost-effective at any value of the cost-effectiveness threshold.

R code

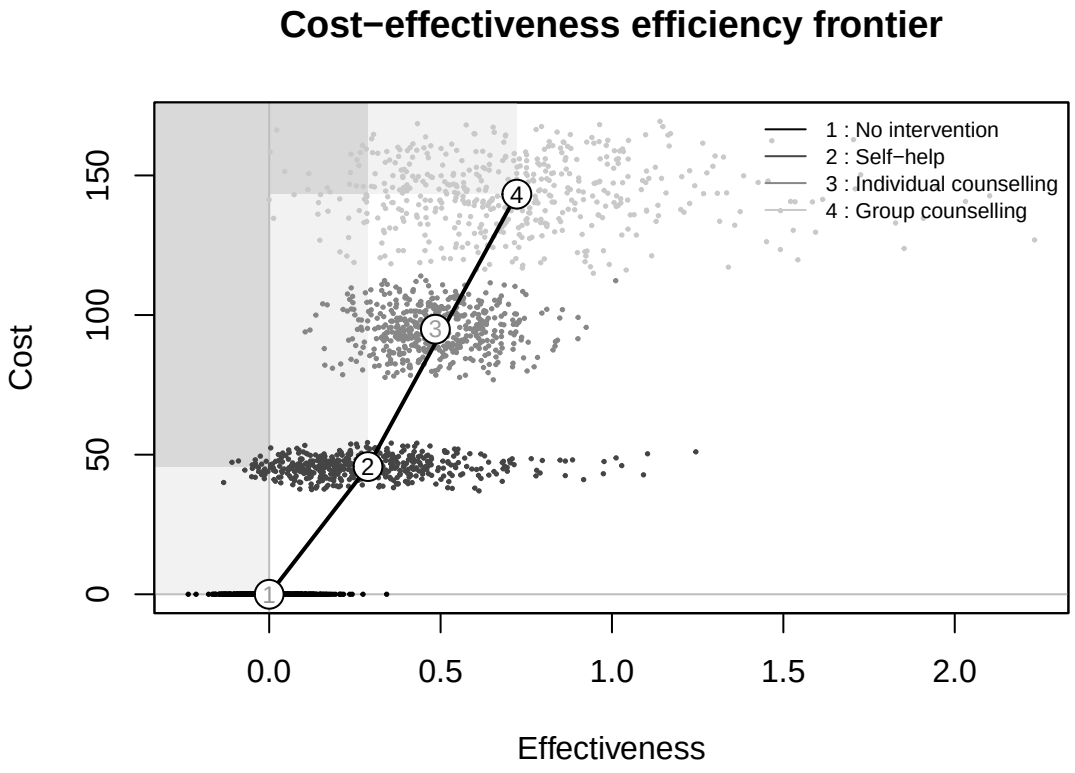
To create the plots in BCEA we first call the `bcea()` function.

```
data(Smoking)

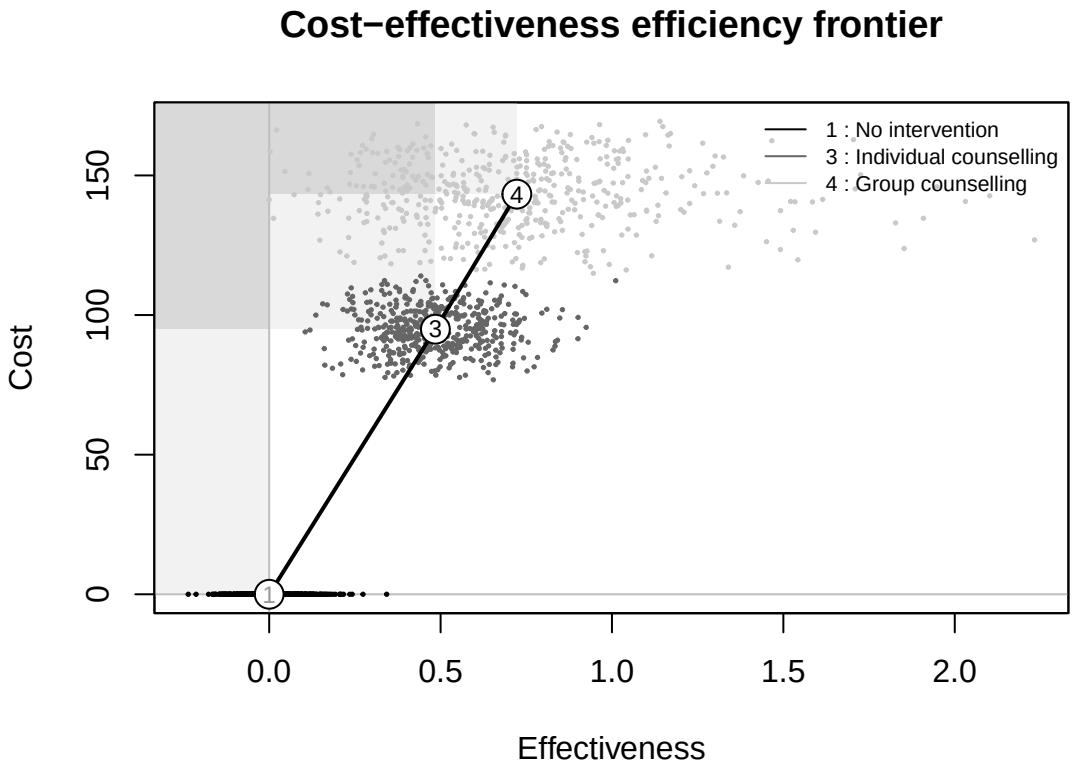
treats <- c("No intervention", "Self-help", "Individual counselling", "Group counselling")
bcea_smoke <- bcea(e, c, ref = 4, interventions = treats, Kmax = 500)
```

- base R

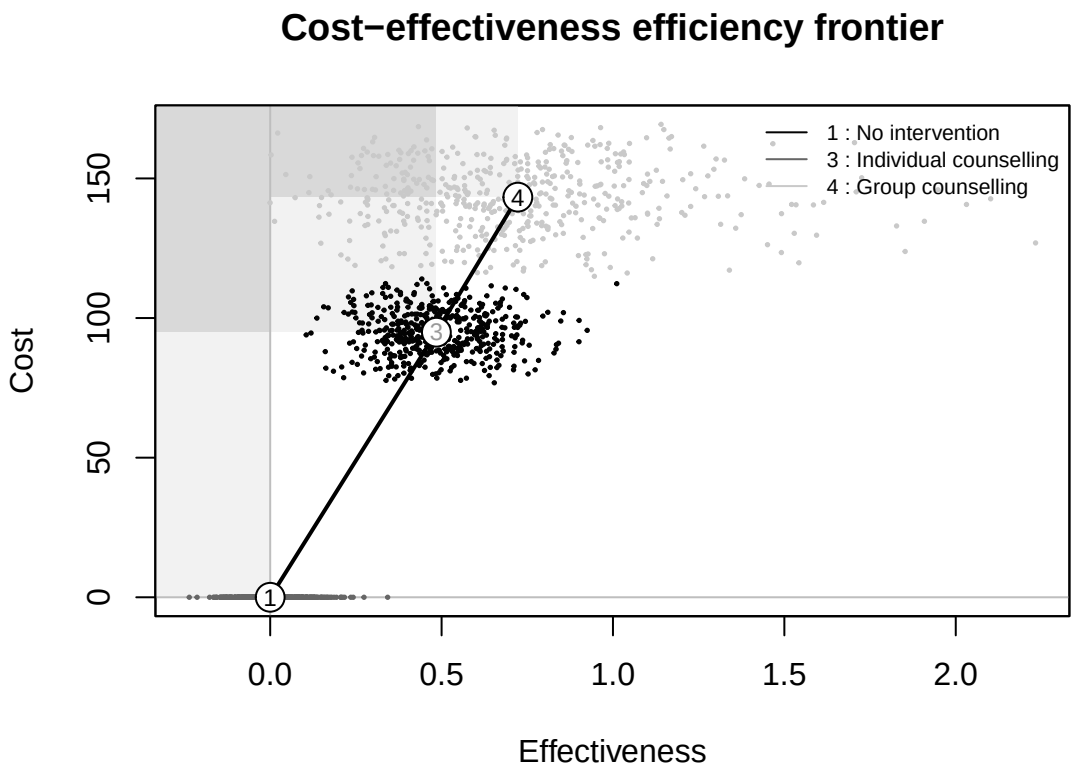
```
# all interventions
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness   Costs Increase slope Increase angle
#> Self-help               0.28824  45.733         158.66         1.5645
#> Group counselling       0.72252 143.301         224.67         1.5663
#>
#> Interventions not on the efficiency frontier:
#>                        Effectiveness  Costs     Dominance type
#> No intervention              0.00000  0.000 Extended dominance
#> Individual counselling       0.48486 94.919 Extended dominance
```



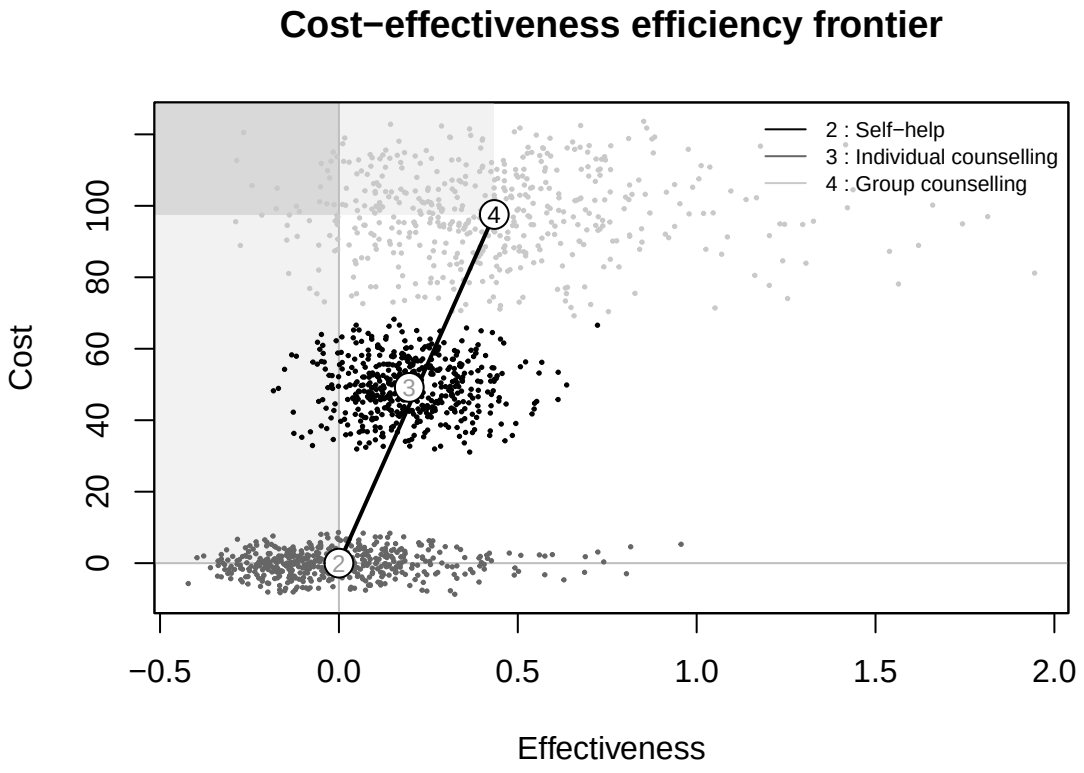

```
# subset
setComparisons(bcea_smoke) <- c(1,3)
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```



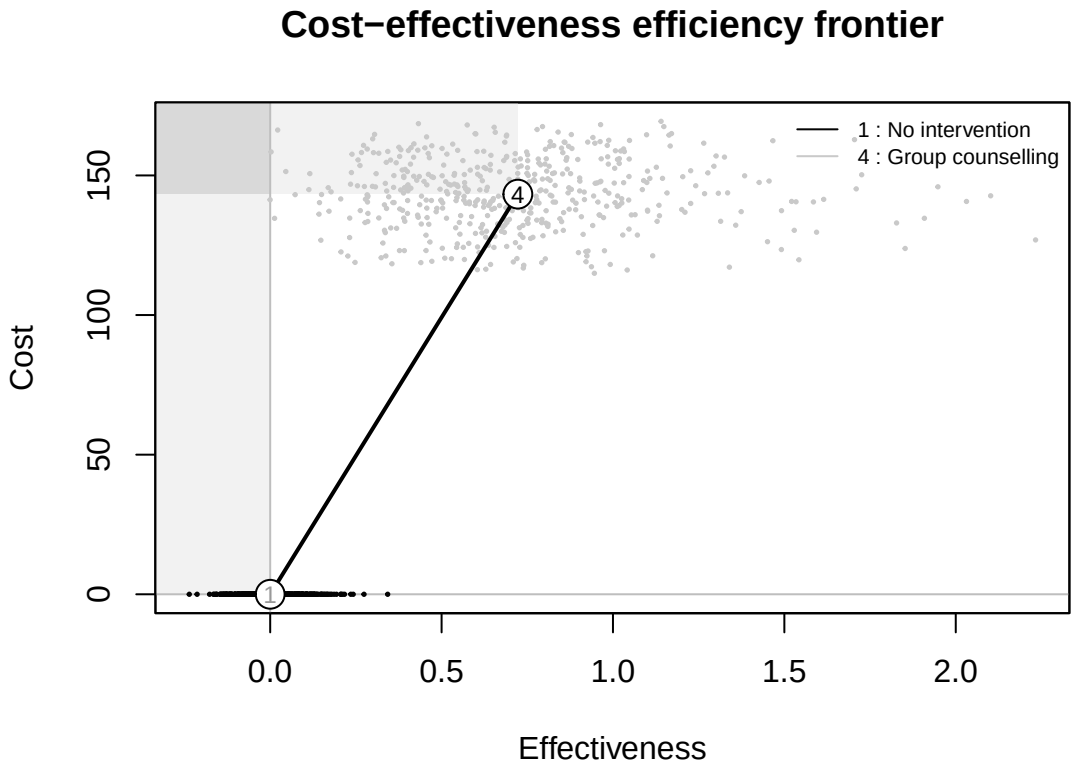

```
# check numbering and legend
setComparisons(bcea_smoke) <- c(3,1)
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness  Costs     Dominance type
#> No intervention       0.48486 94.919 Extended dominance
```




```
setComparisons(bcea_smoke) <- c(3,2)
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                        Effectiveness  Costs Increase slope Increase angle
#> Individual counselling       0.43428 97.568         224.67         1.5663
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness  Costs     Dominance type
#> No intervention       0.19662 49.186 Extended dominance
#> Self-help             0.00000  0.000 Extended dominance
```




```
setComparisons(bcea_smoke) <- 1
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>           Effectiveness Costs Increase slope Increase angle
#> Self-help       0.72252 143.3         198.33         1.5658
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```




```
# add interventions back in
setComparisons(bcea_smoke) <- c(1,3)
ceef.plot(bcea_smoke)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
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#> Interventions not on the efficiency frontier:
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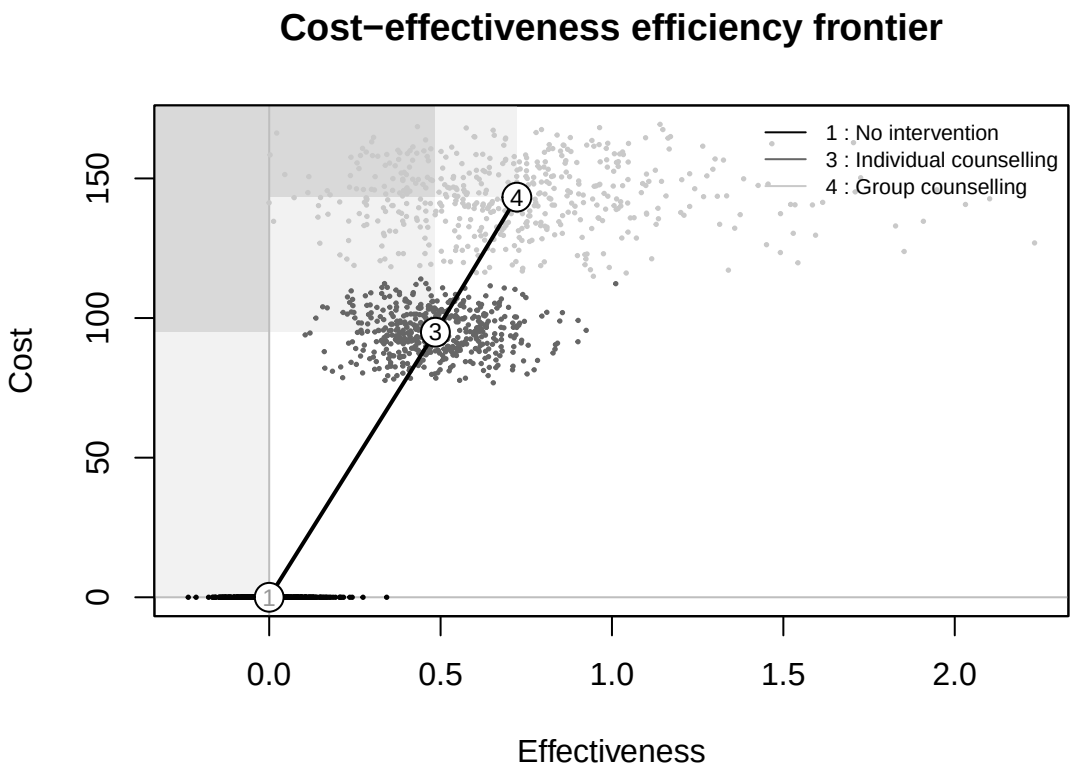
#> No intervention             0     0 Extended dominance
```



- ggplot

```
bcea_smoke <- bcea(e, c, ref = 4, interventions = treats, Kmax = 500)

# all interventions
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness   Costs Increase slope Increase angle
#> Self-help               0.28824  45.733         158.66         1.5645
#> Group counselling       0.72252 143.301         224.67         1.5663
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#> No intervention              0.00000  0.000 Extended dominance
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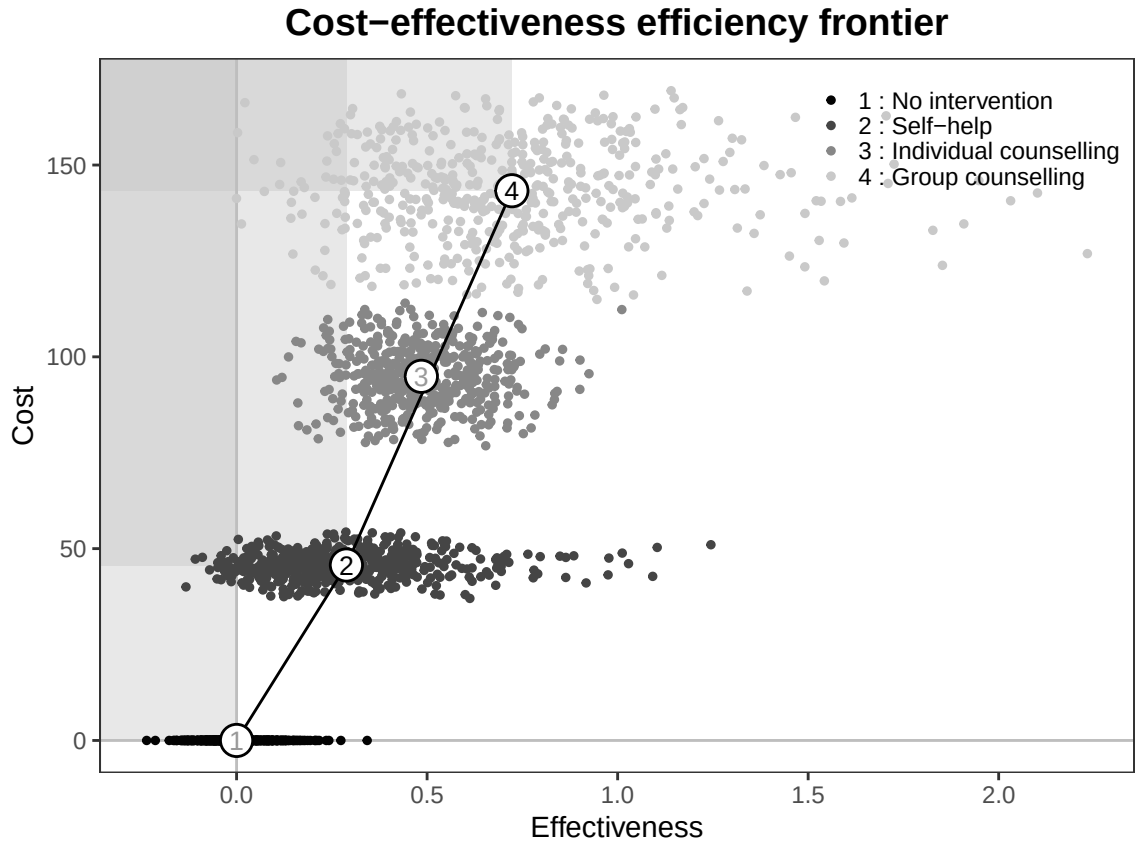
```




```
# subset
setComparisons(bcea_smoke) <- c(1,3)
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
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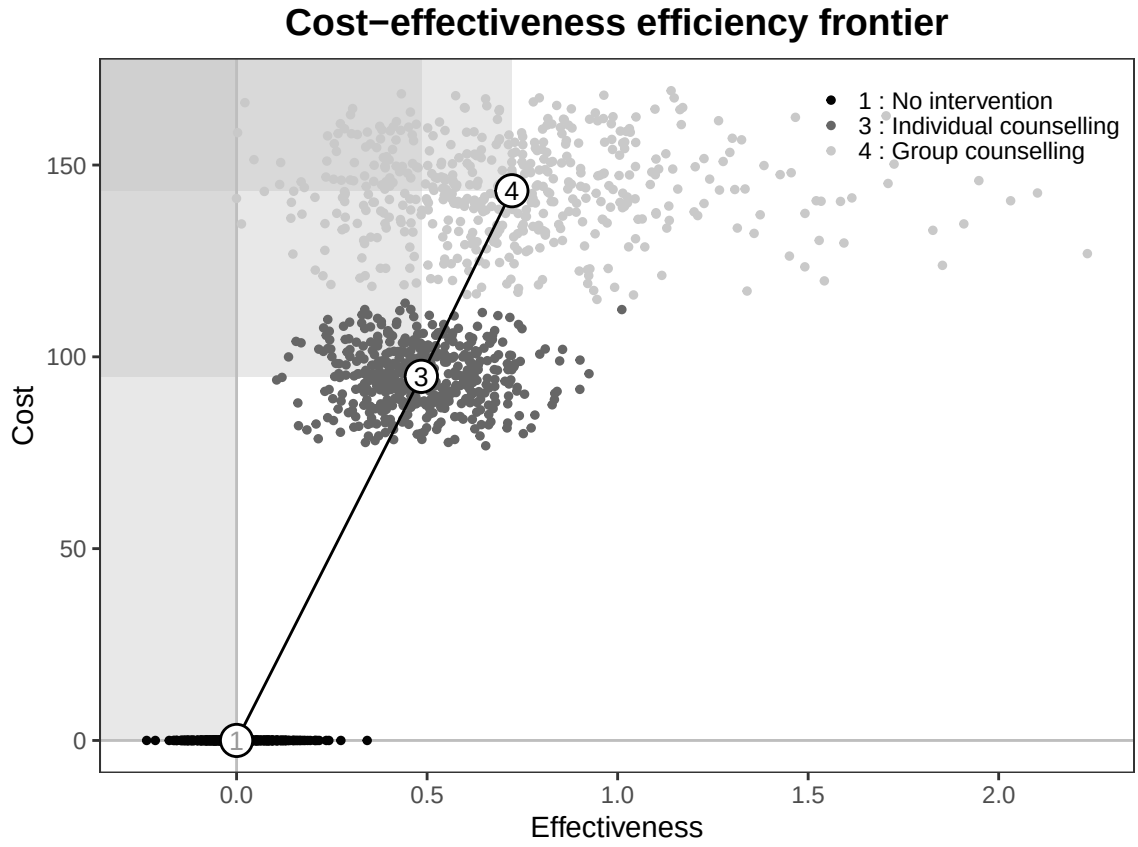
#> No intervention             0     0 Extended dominance
```




```
# check numbering and legend
setComparisons(bcea_smoke) <- c(3,1)
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
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#> Interventions not on the efficiency frontier:
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#> No intervention       0.48486 94.919 Extended dominance
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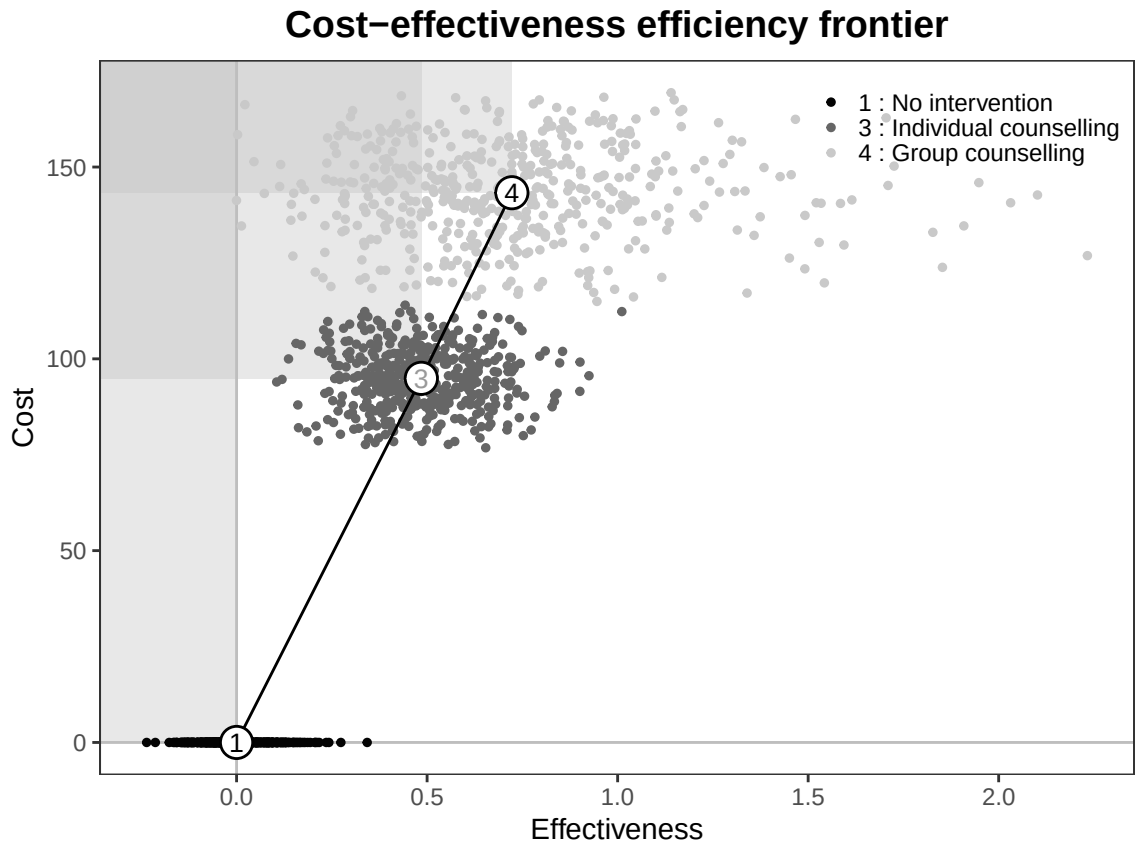


```
setComparisons(bcea_smoke) <- c(3,2)
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                        Effectiveness  Costs Increase slope Increase angle
#> Individual counselling       0.43428 97.568         224.67         1.5663
#>
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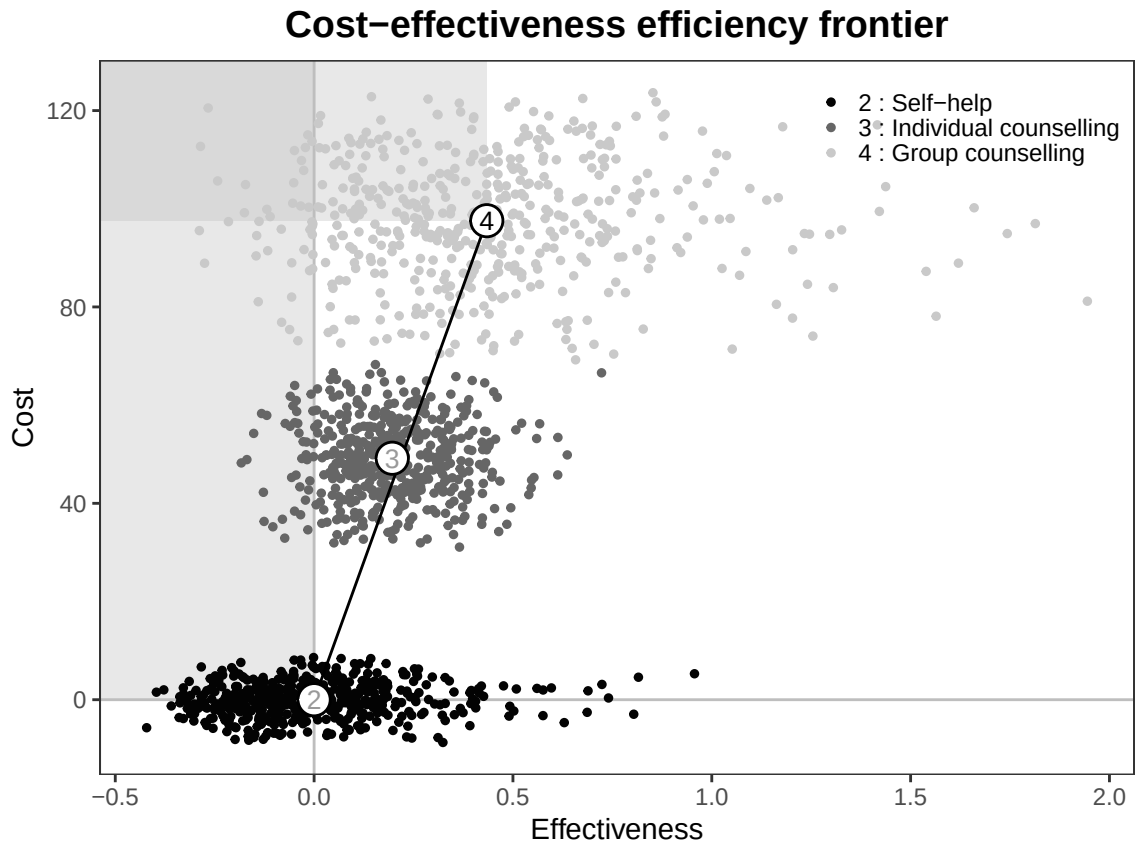
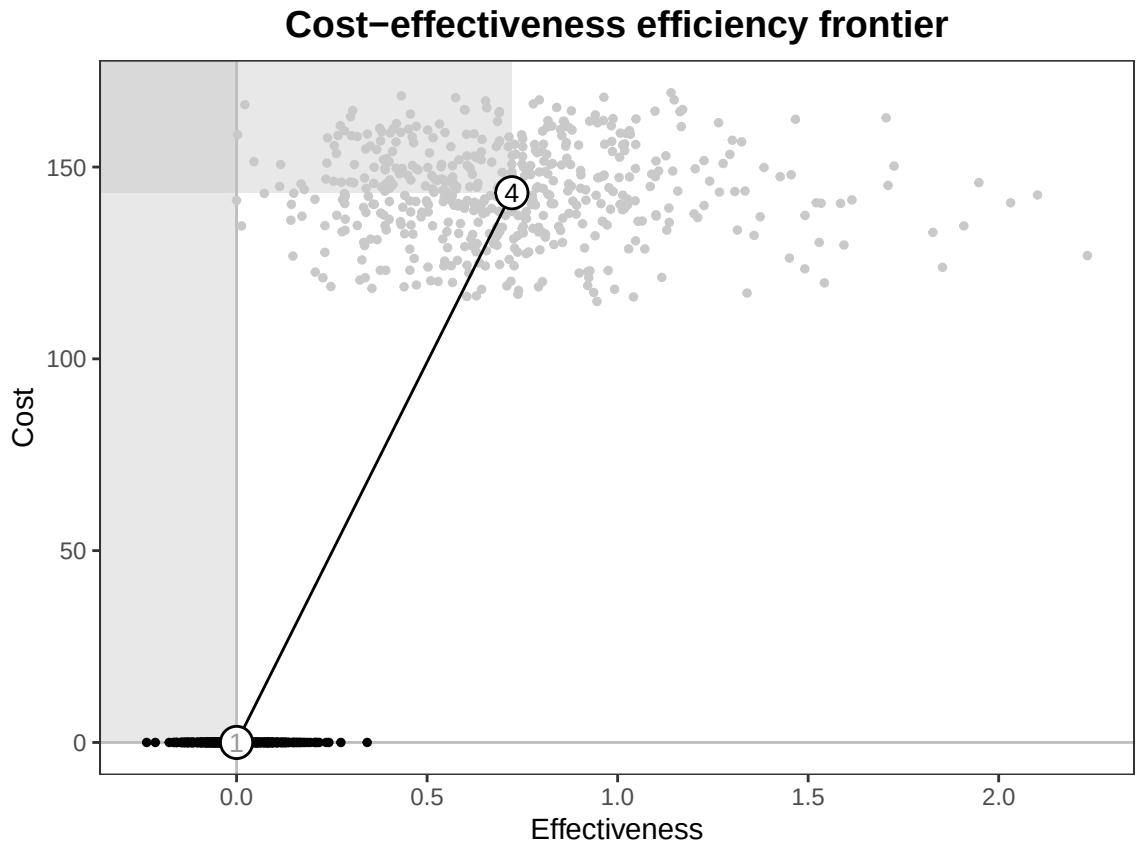
#>                  Effectiveness  Costs     Dominance type
#> No intervention       0.19662 49.186 Extended dominance
#> Self-help             0.00000  0.000 Extended dominance
```




```
setComparisons(bcea_smoke) <- 1
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>           Effectiveness Costs Increase slope Increase angle
#> Self-help       0.72252 143.3         198.33         1.5658
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention                 0     0 Extended dominance
```




```
# add interventions back in
setComparisons(bcea_smoke) <- c(1,3)
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
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#> Interventions not on the efficiency frontier:
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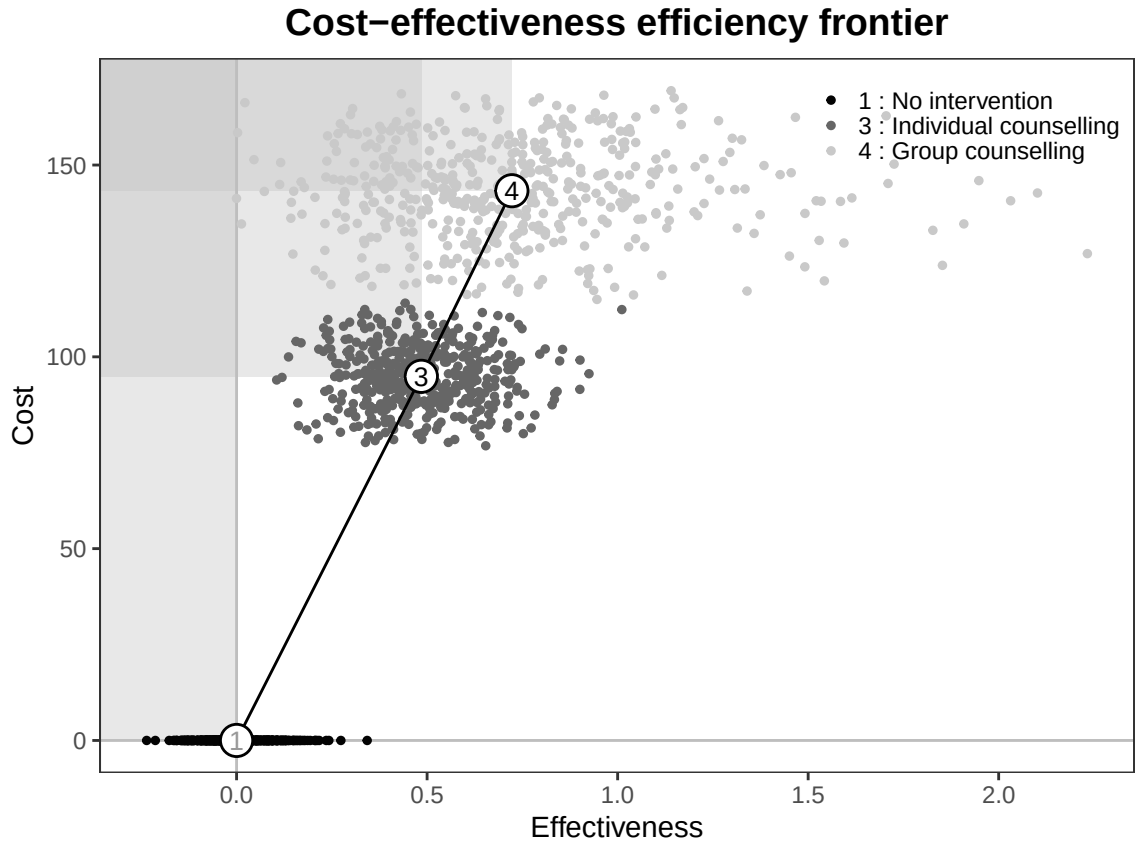
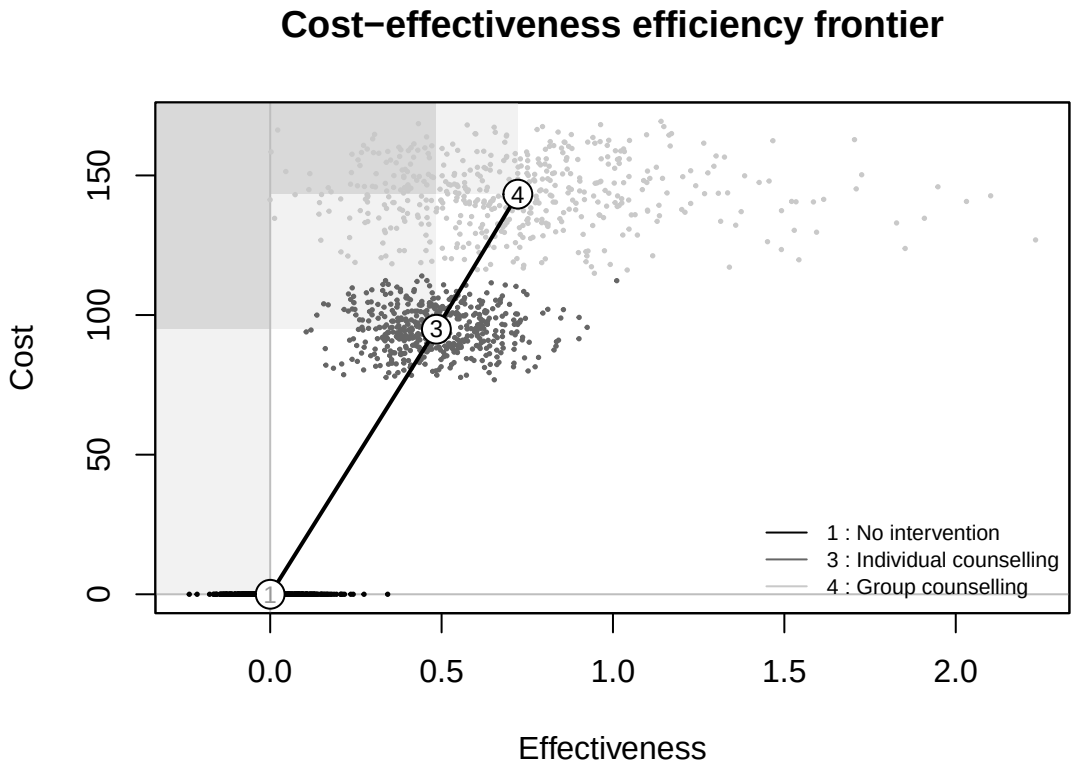
```

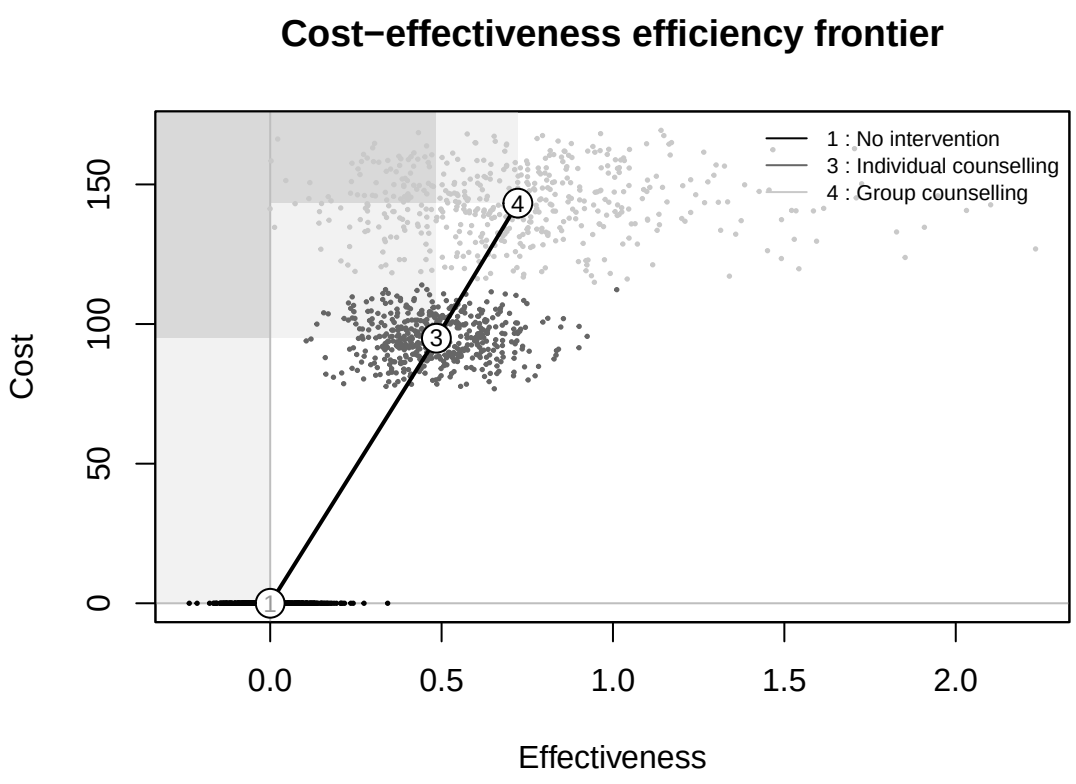


Check legend position argument:

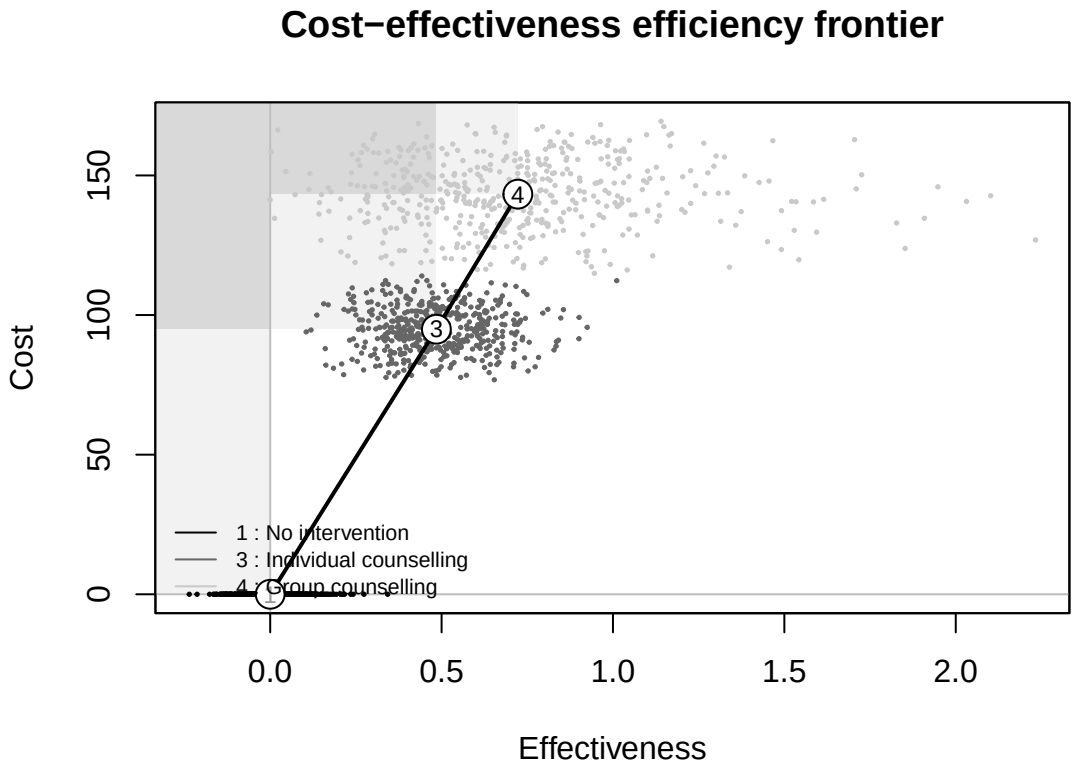
```
# base R
ceef.plot(bcea_smoke, pos = c(1,0))
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```



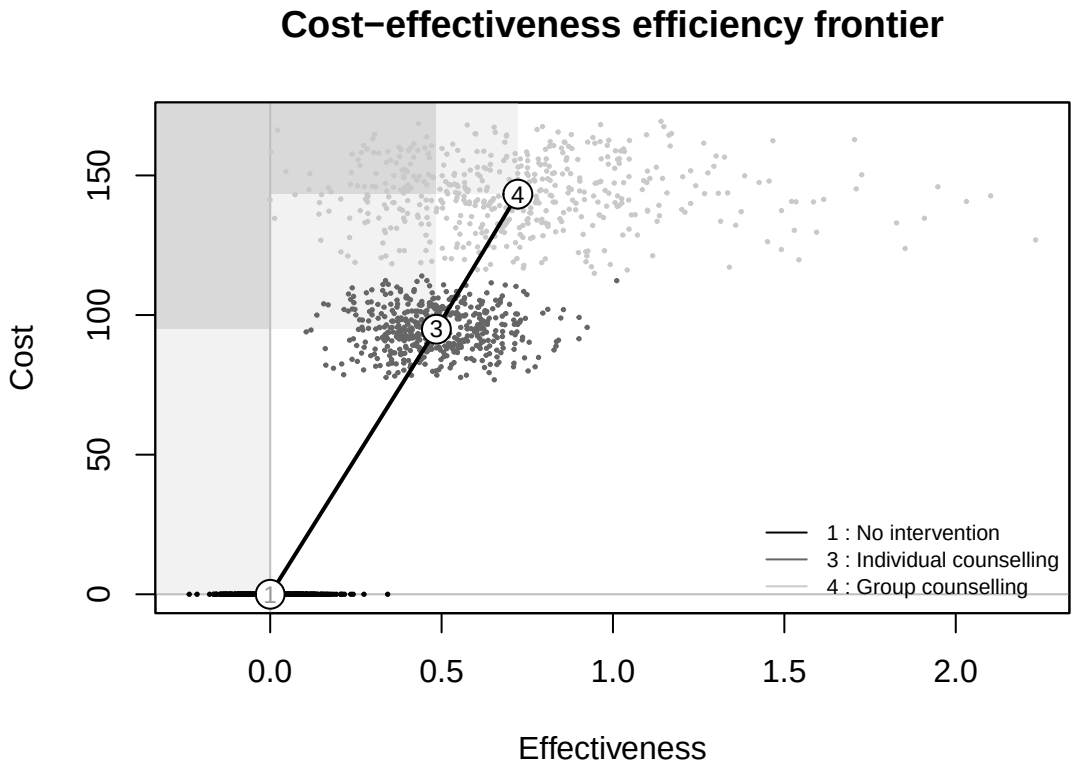

```
ceef.plot(bcea_smoke, pos = c(1,1))
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```



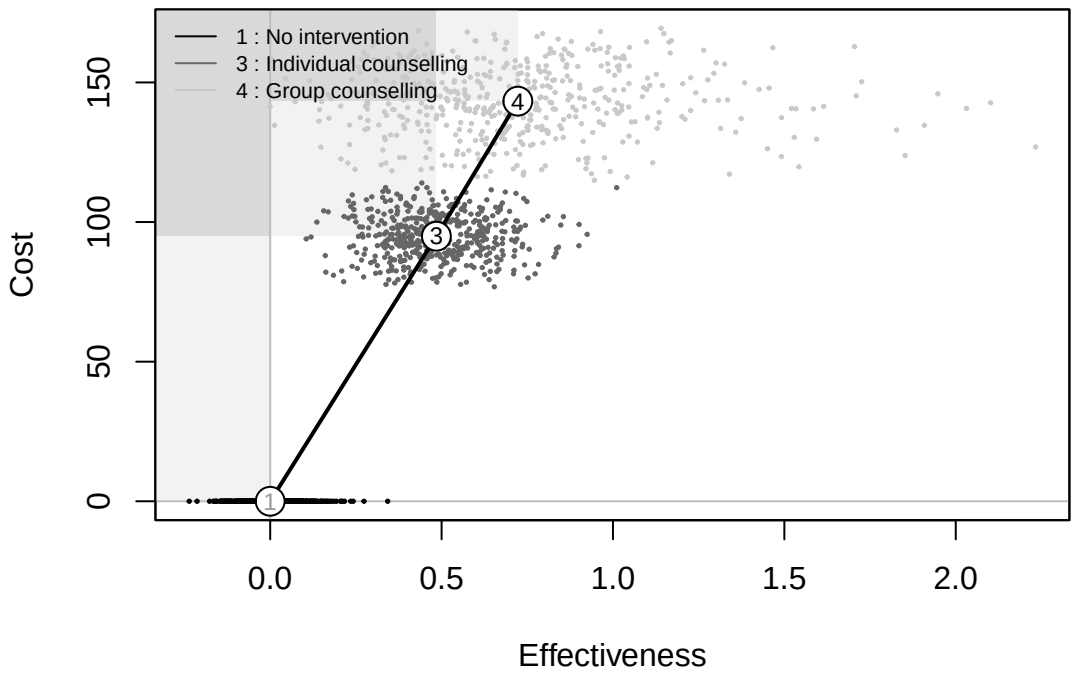

```
ceef.plot(bcea_smoke, pos = TRUE)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```



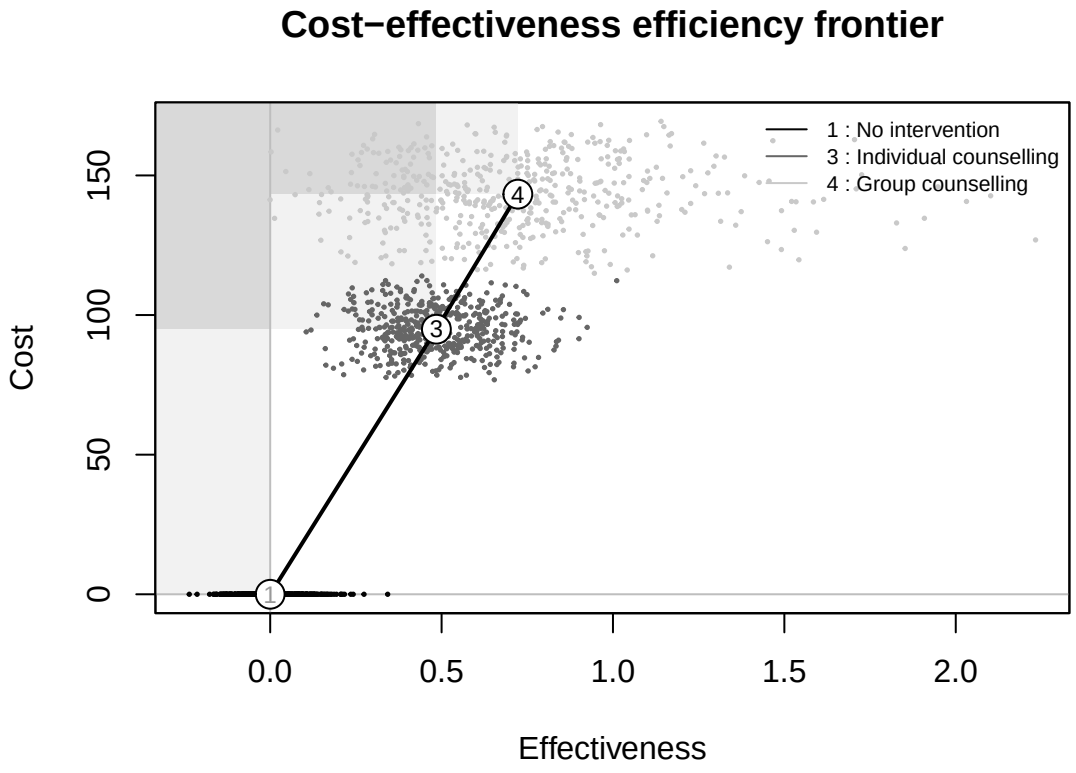

```
ceef.plot(bcea_smoke, pos = FALSE)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```



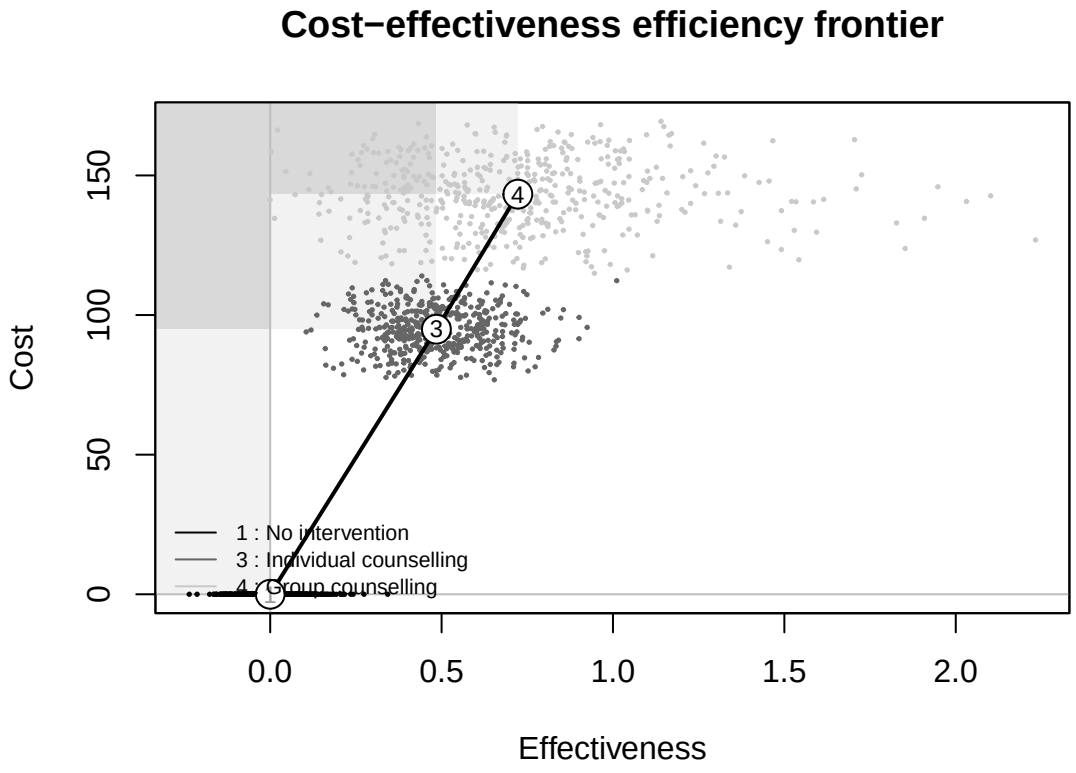

```
ceef.plot(bcea_smoke, pos = "topleft")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```



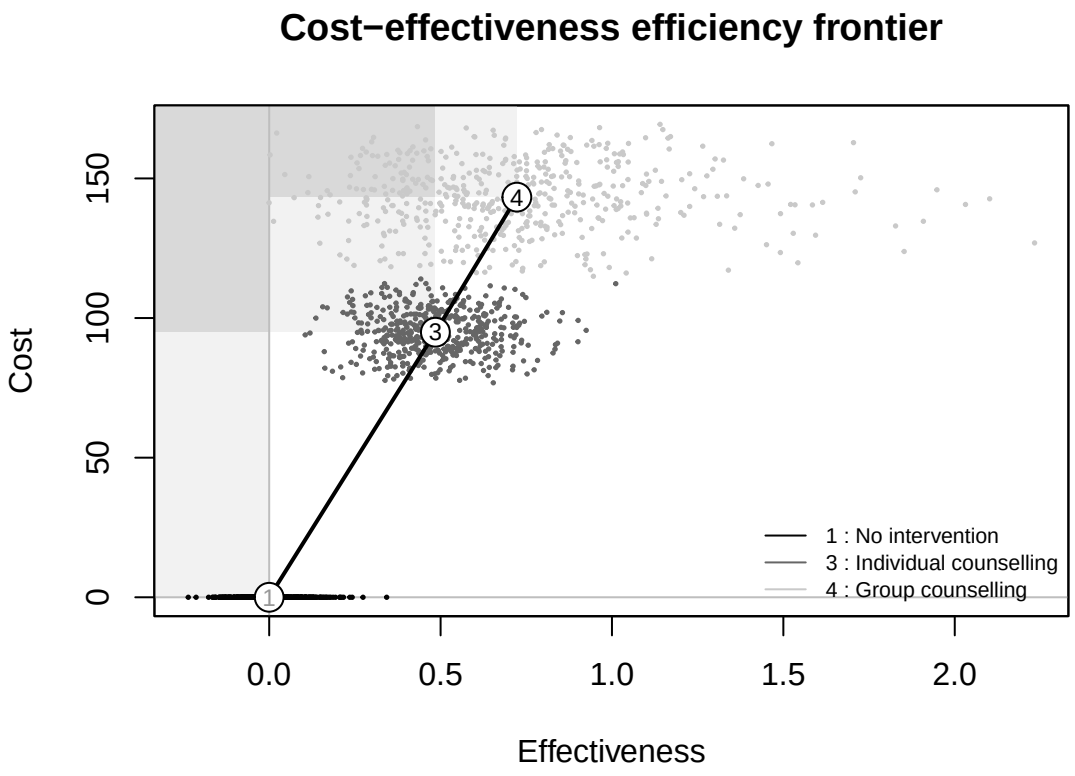

```
ceef.plot(bcea_smoke, pos = "topright")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```



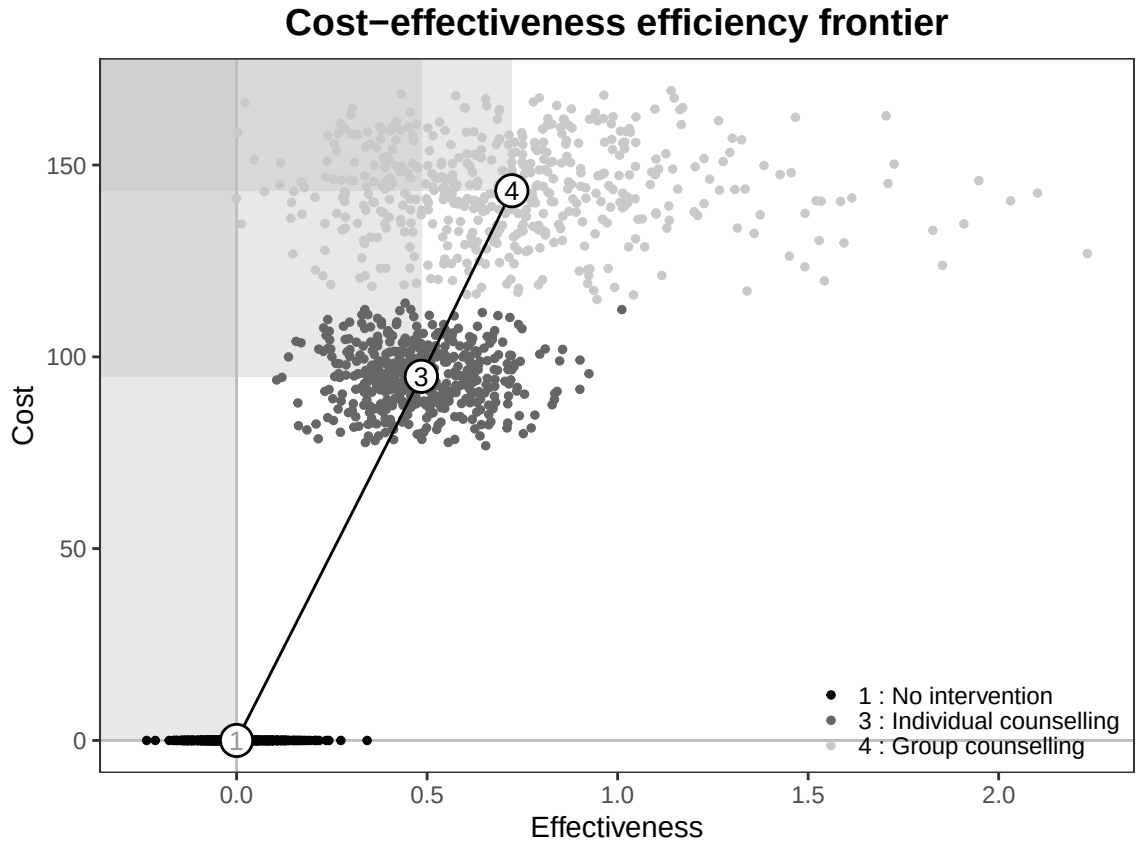

```
ceef.plot(bcea_smoke, pos = "bottomleft")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```



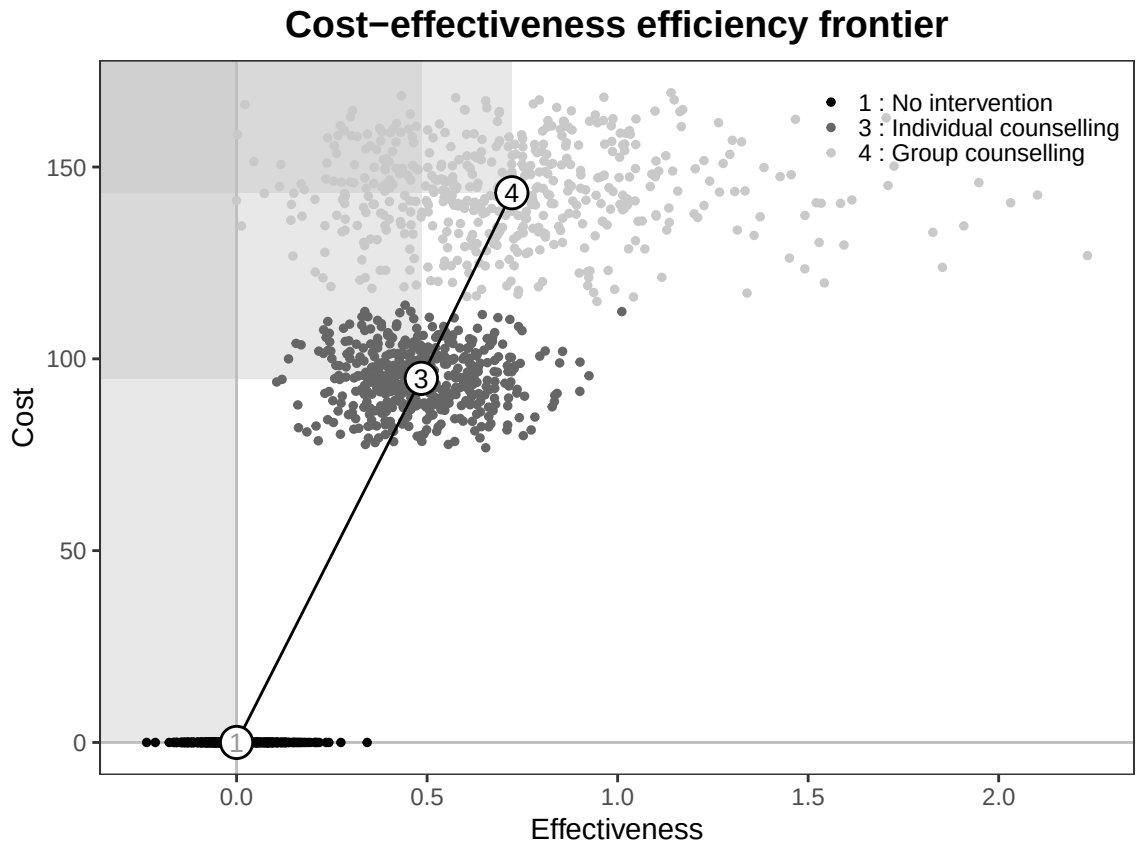

```
ceef.plot(bcea_smoke, pos = "bottomright")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```




```
# ggplot2
ceef.plot(bcea_smoke, graph = "ggplot", pos = c(1,0))
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```




```
ceef.plot(bcea_smoke, graph = "ggplot", pos = c(1,1))
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```




```
ceef.plot(bcea_smoke, graph = "ggplot", pos = TRUE)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
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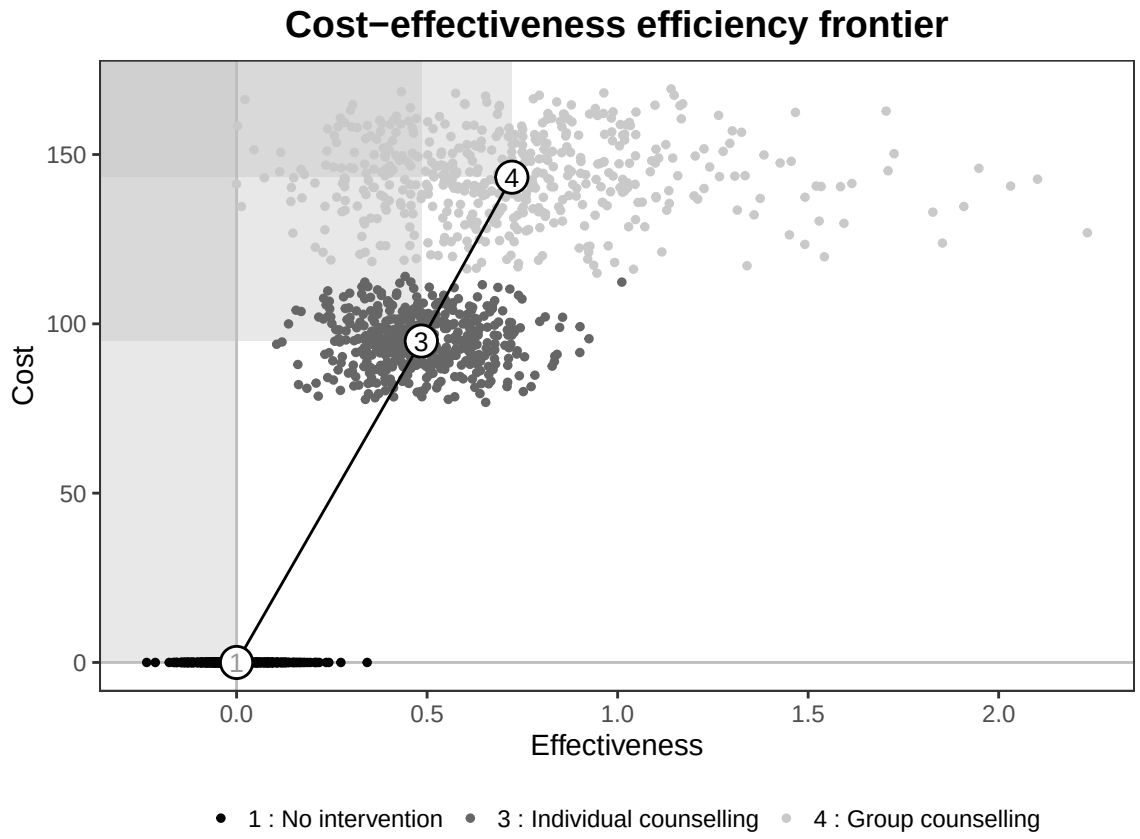
```




```
ceef.plot(bcea_smoke, graph = "ggplot", pos = FALSE)
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
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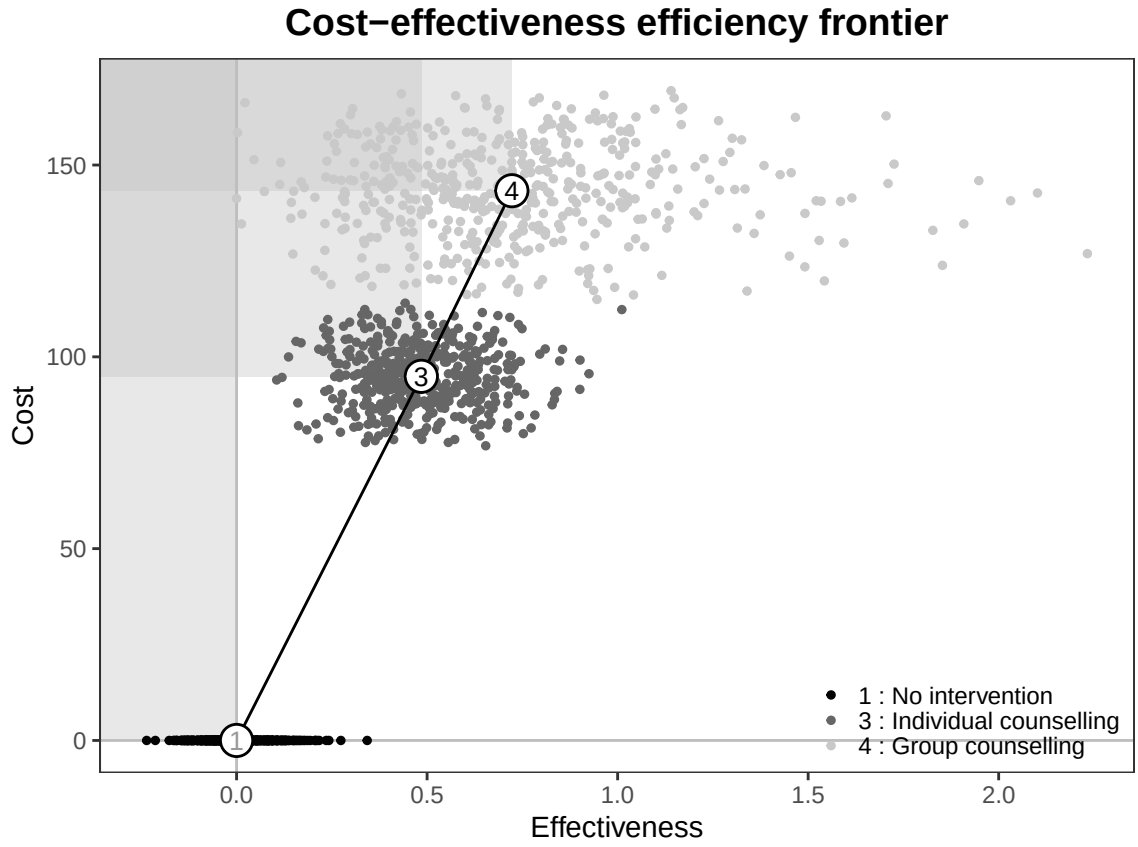
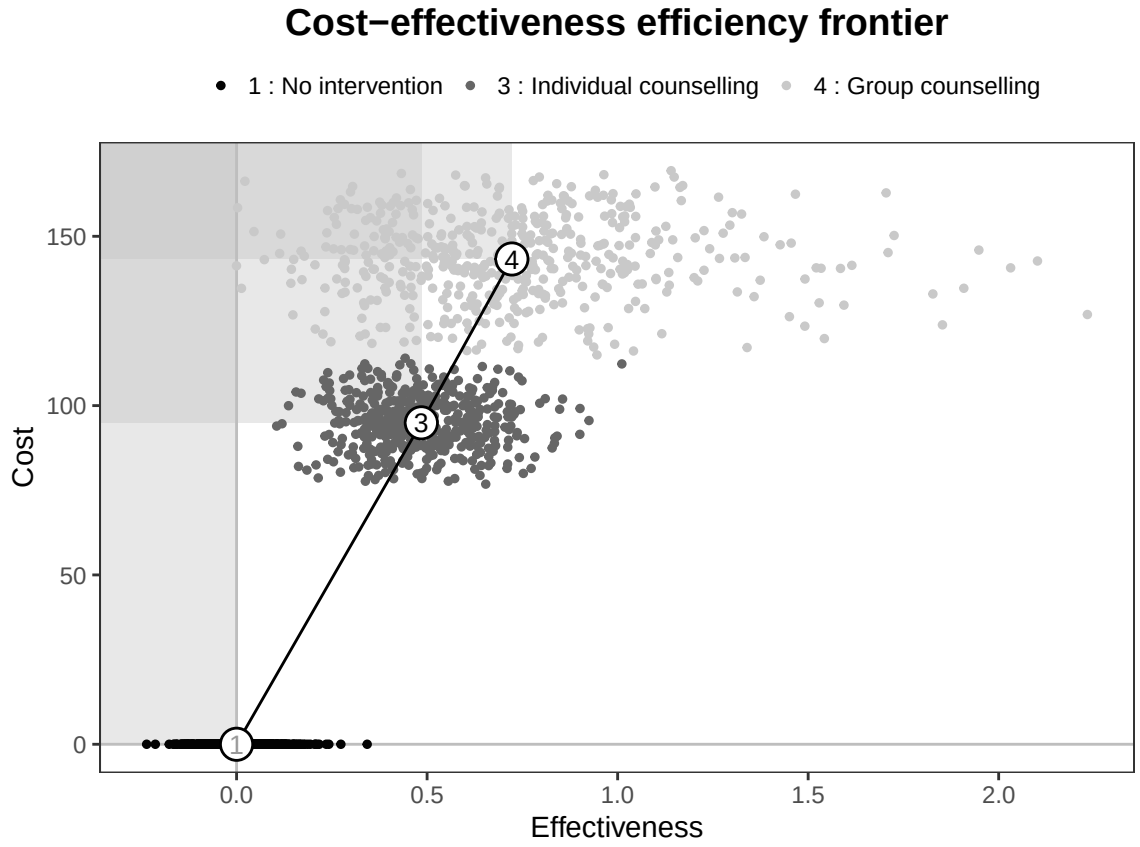
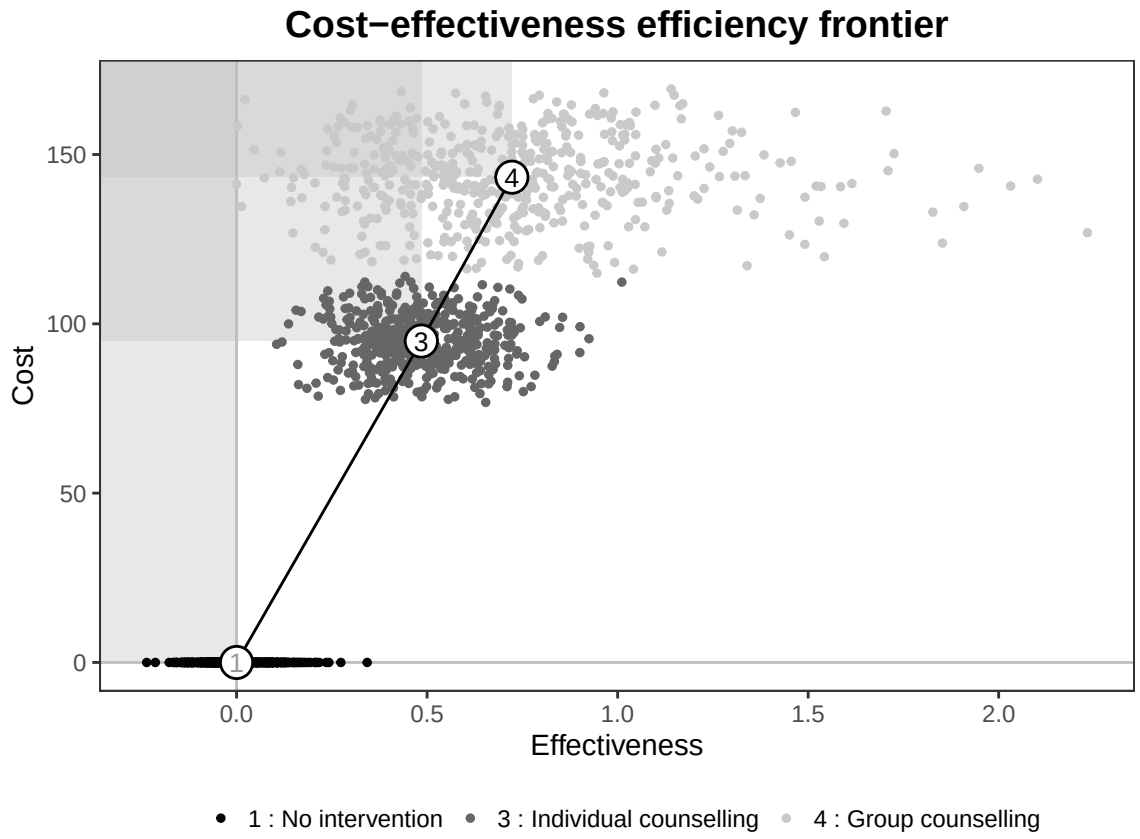
```



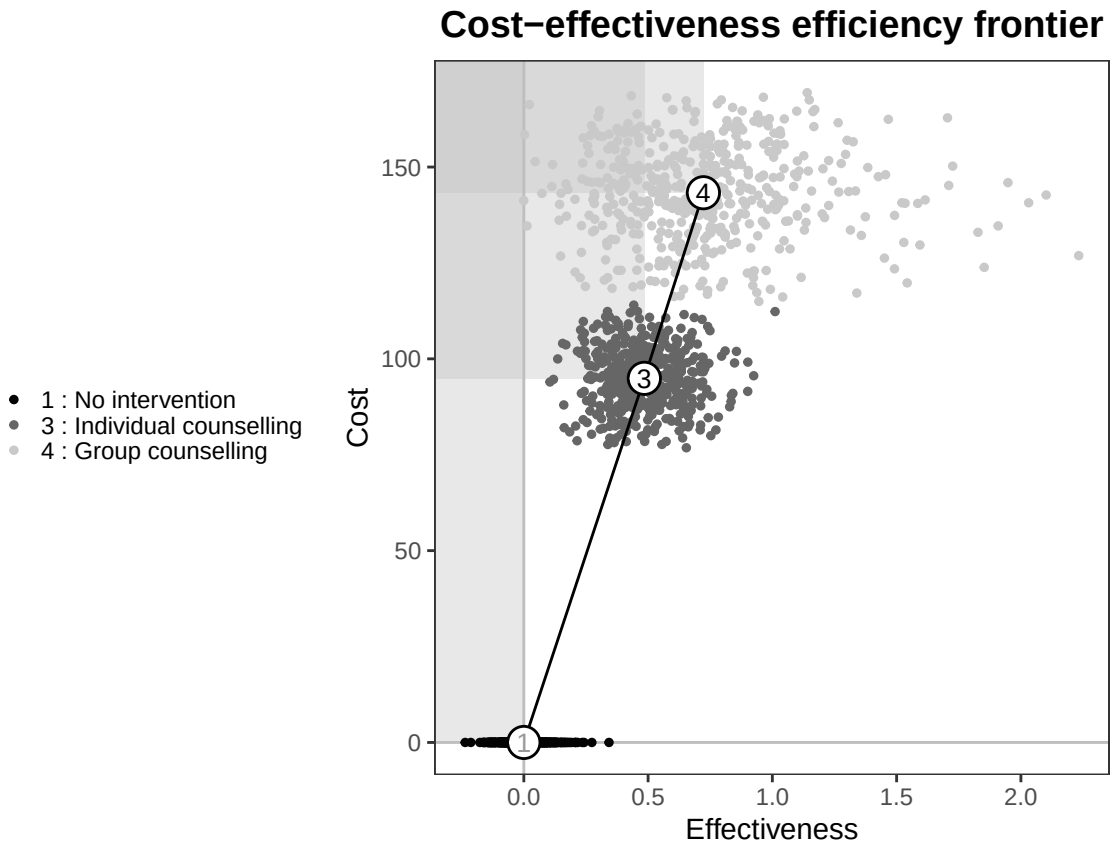

```
ceef.plot(bcea_smoke, graph = "ggplot", pos = "top")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                  Effectiveness Costs     Dominance type
#> No intervention              0     0 Extended dominance
```



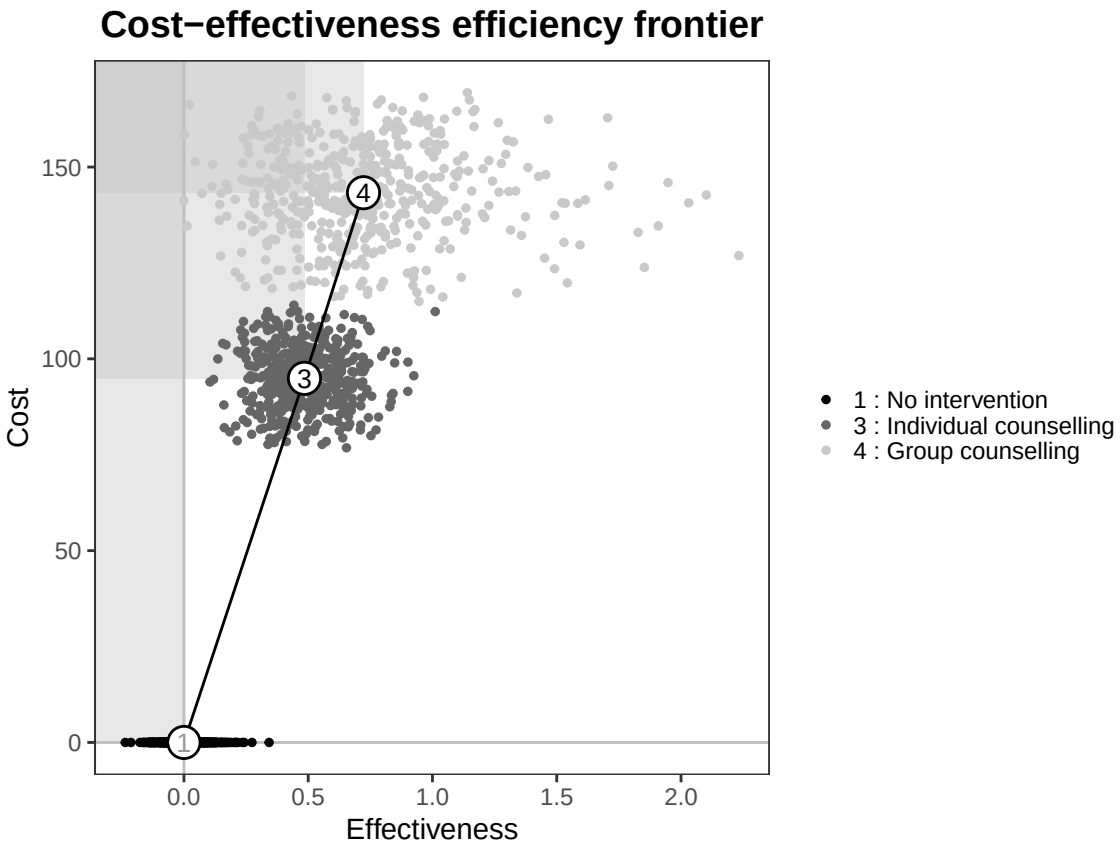

```
ceef.plot(bcea_smoke, graph = "ggplot", pos = "bottom")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```




```
ceef.plot(bcea_smoke, graph = "ggplot", pos = "left")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```

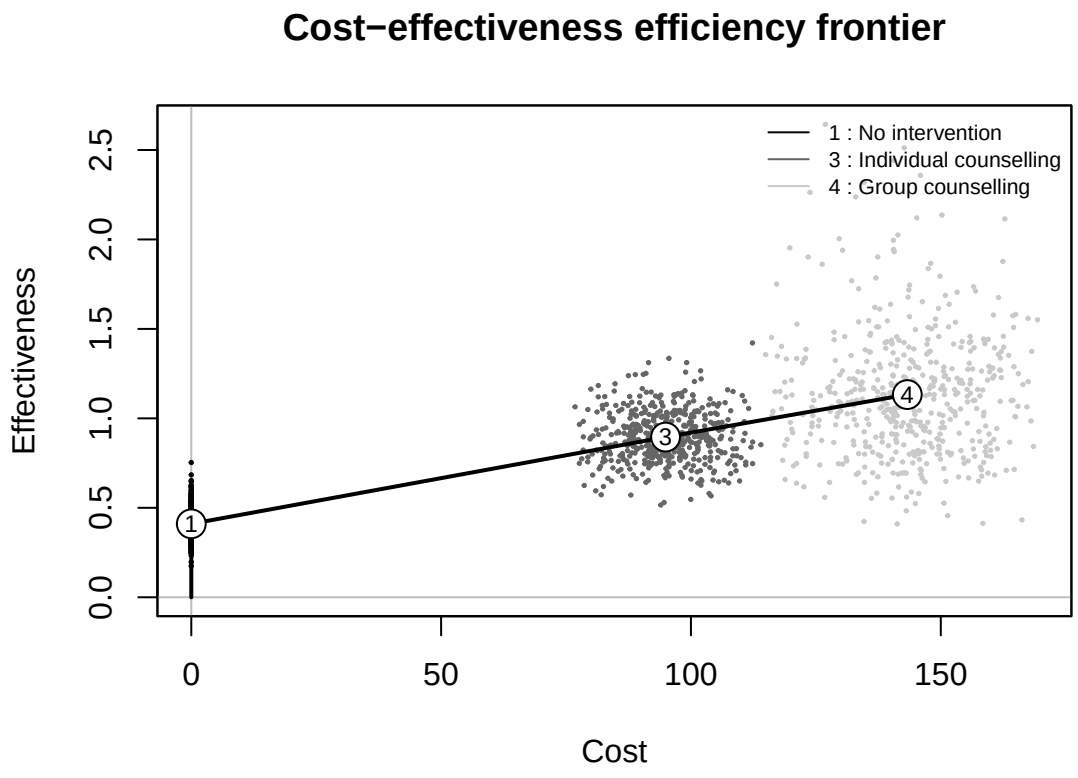



```
ceef.plot(bcea_smoke, graph = "ggplot", pos = "right")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Self-help                   0.48486  94.919         195.77         1.5657
#> Individual counselling      0.72252 143.301         203.57         1.5659
#>
#> Interventions not on the efficiency frontier:
#>                 Effectiveness Costs     Dominance type
#> No intervention             0     0 Extended dominance
```

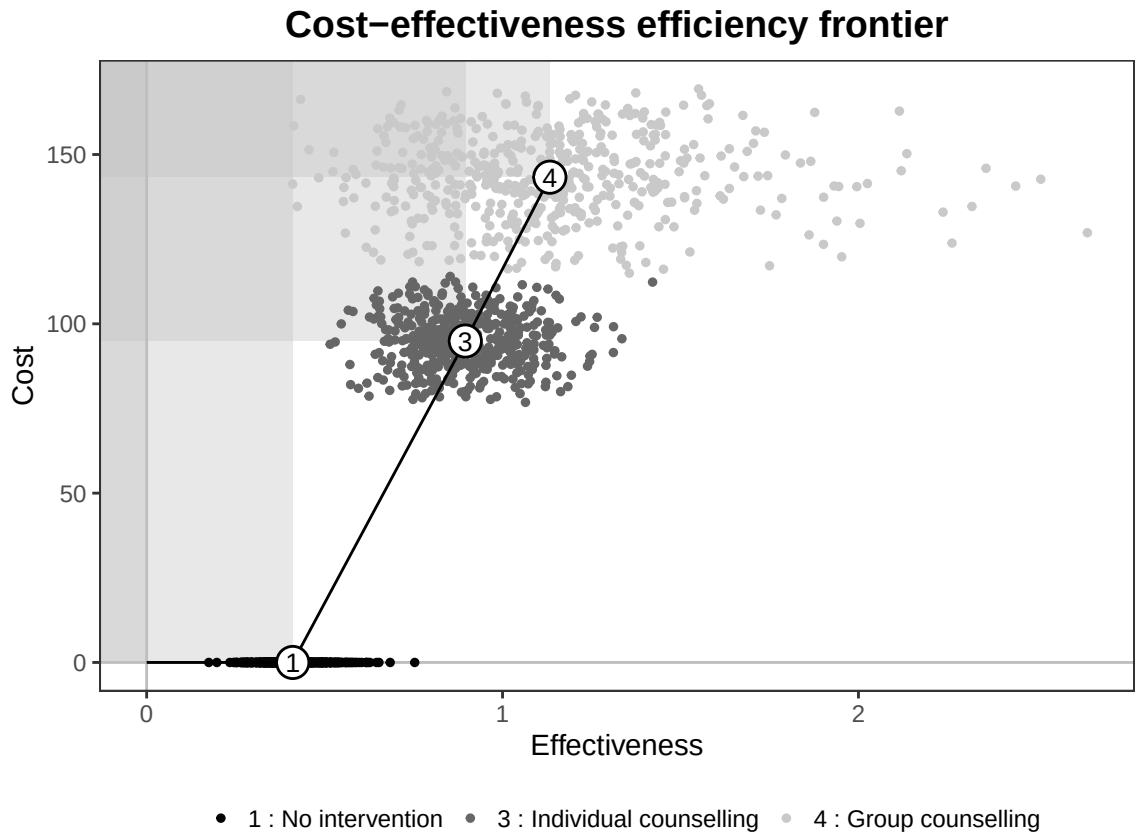


Flipping plot

```
ceef.plot(bcea_smoke,
          flip = TRUE,
          dominance = FALSE,
          start.from.origins = FALSE,
          print.summary = FALSE,
          graph = "base")
```

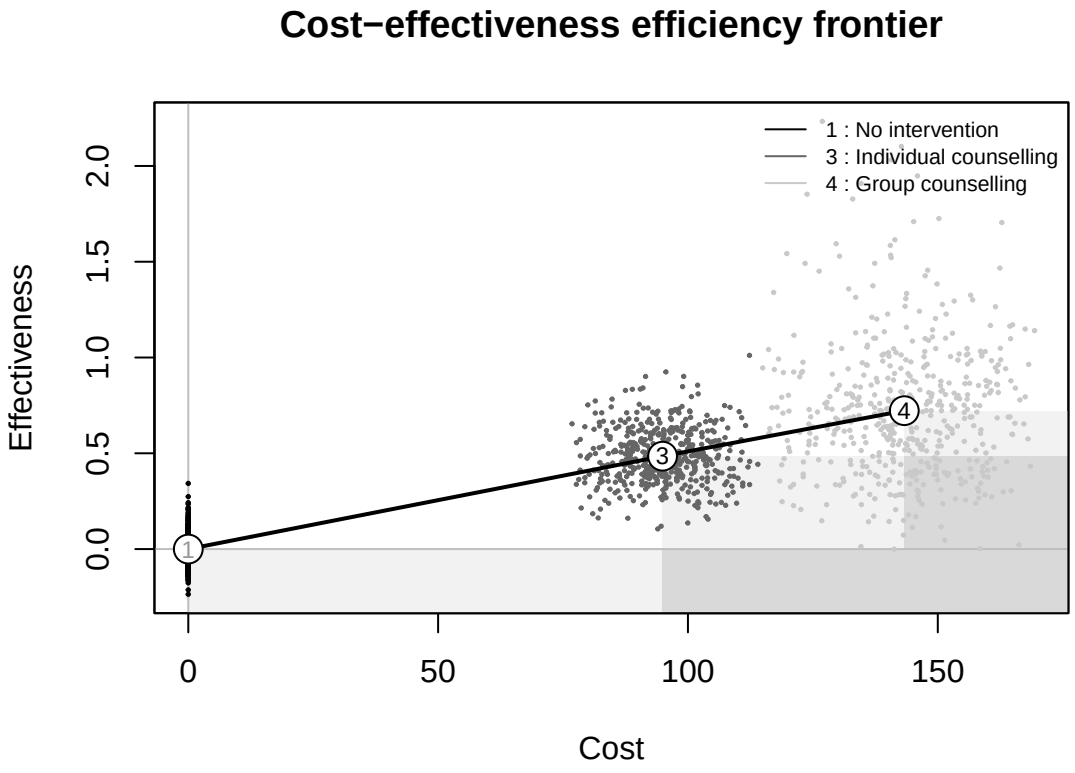



```
ceef.plot(bcea_smoke,
          dominance = TRUE,
          start.from.origins = FALSE,
          pos = TRUE,
          print.summary = FALSE,
          graph = "ggplot2")
```

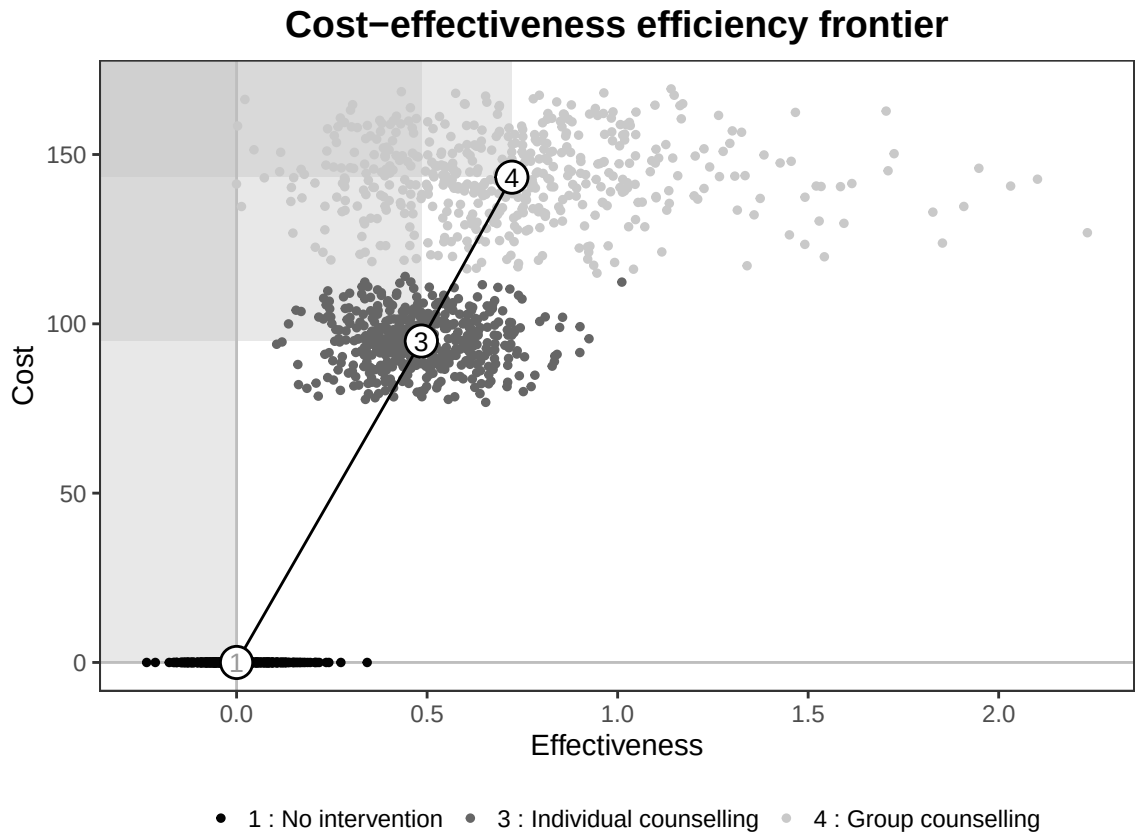


Start from origin or smallest (e,c).

```
ceef.plot(bcea_smoke,
          flip = TRUE,
          dominance = TRUE,
          start.from.origins = TRUE,
          print.summary = FALSE,
          graph = "base")
```




```
ceef.plot(bcea_smoke,
          dominance = TRUE,
          start.from.origins = TRUE,
          pos = TRUE,
          print.summary = FALSE,
          graph = "ggplot2")
```

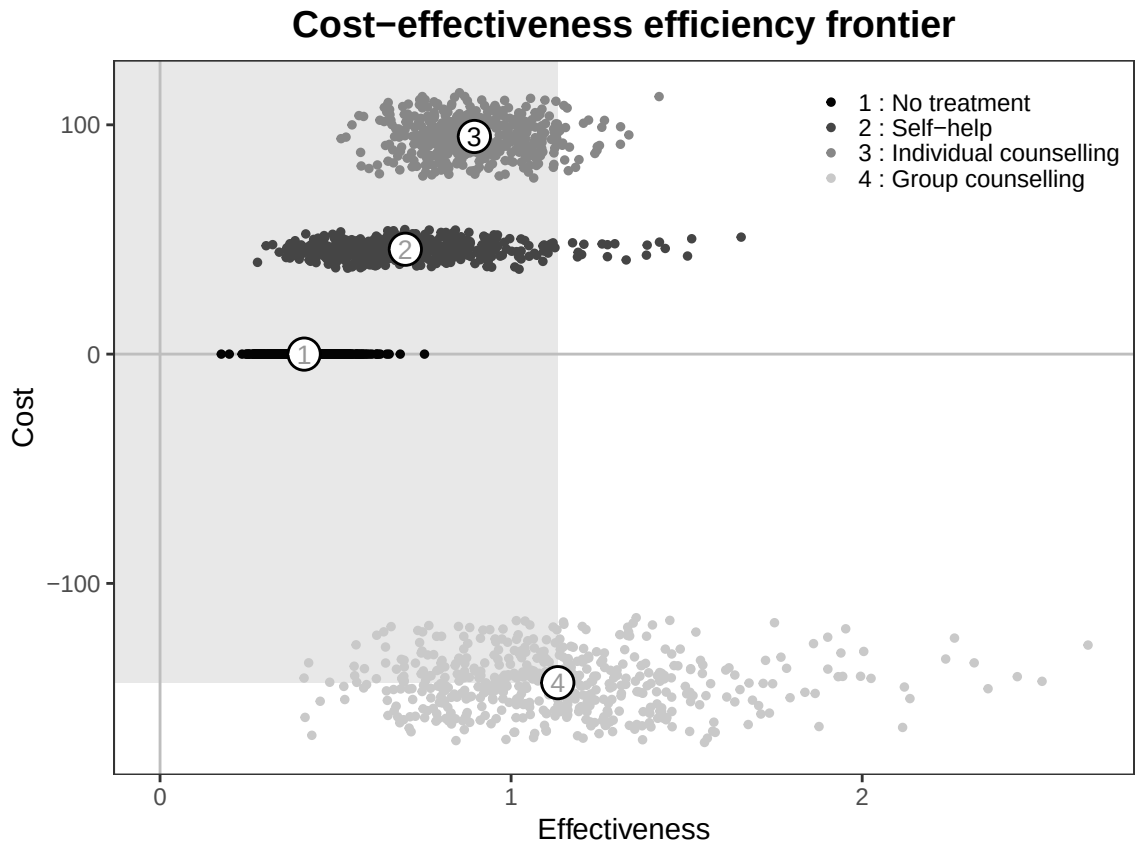


Negative cost or effectiveness

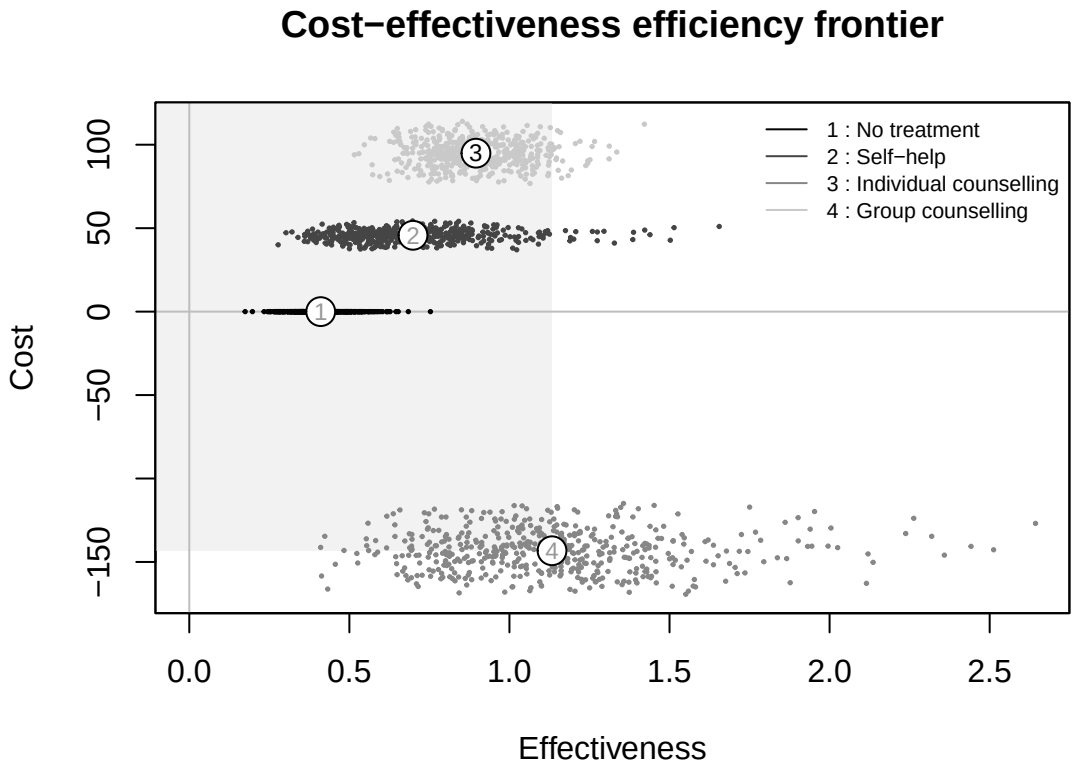
```
data("Smoking")

c[, 4] <- -c[, 4]
bcea_smoke <- bcea(e, c, ref = 3, interventions = treats, Kmax = 500)

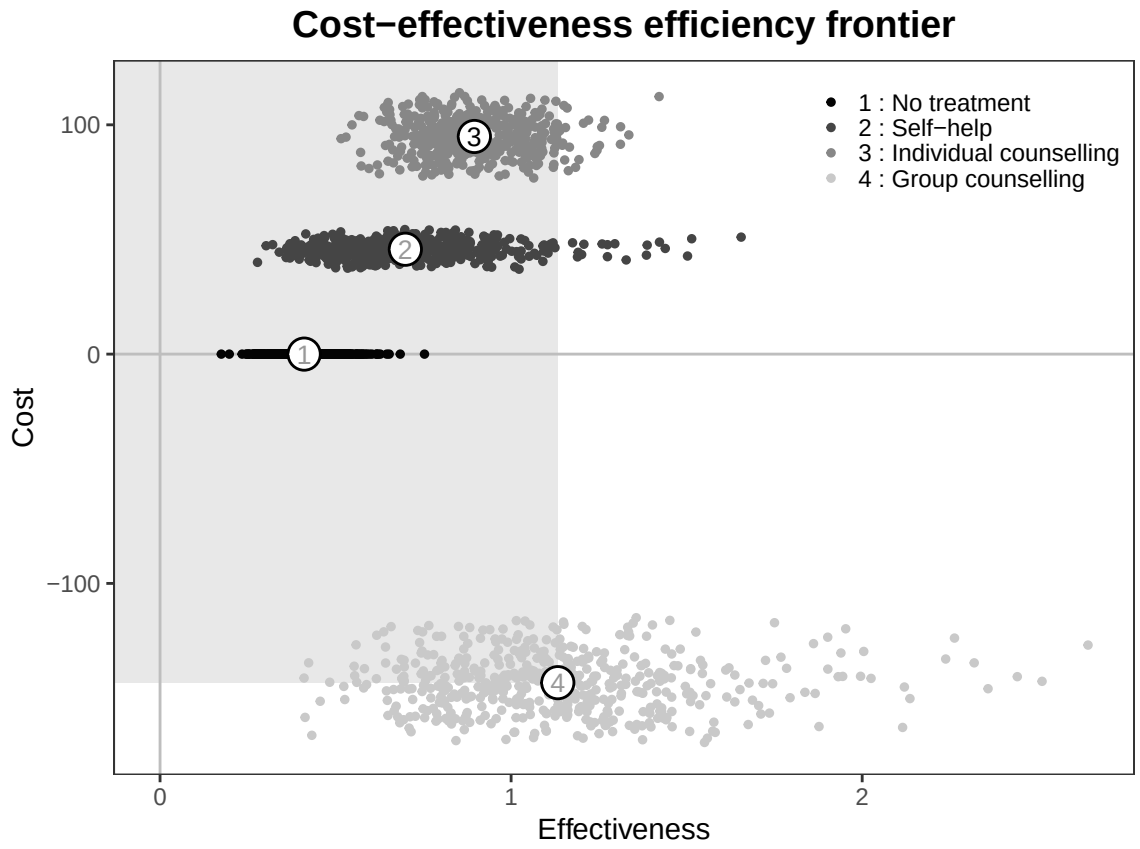
# all interventions
ceef.plot(bcea_smoke, graph = "ggplot")
#> Costs are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```



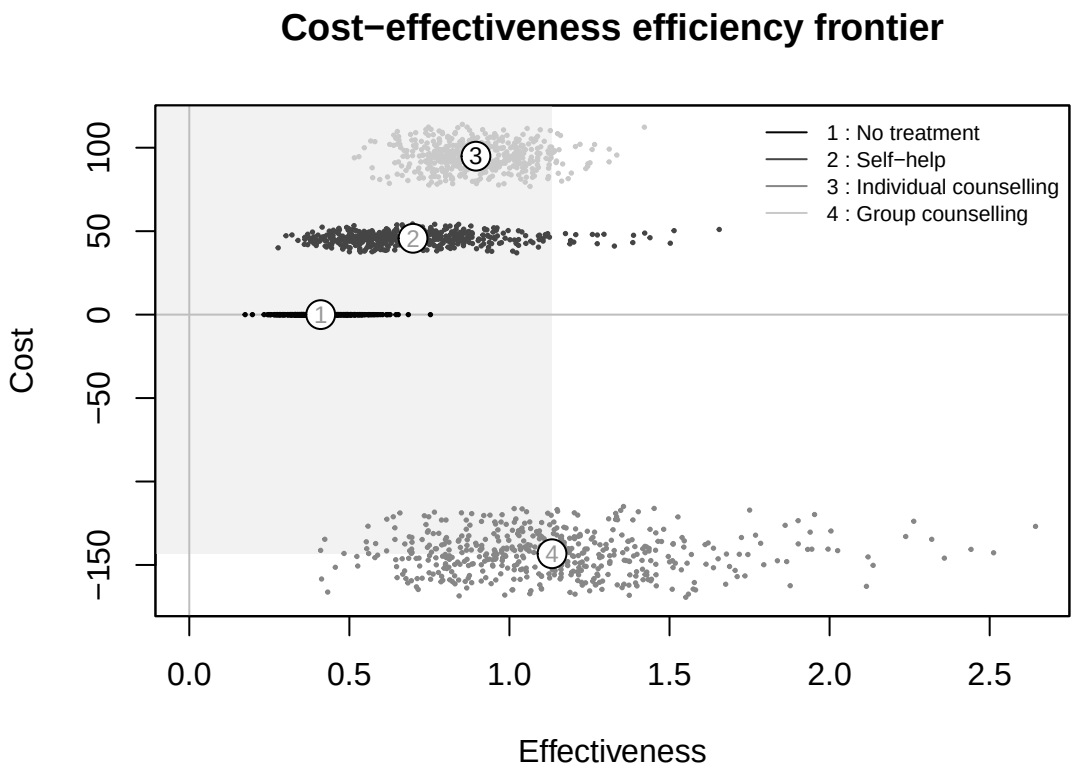

```
ceef.plot(bcea_smoke, graph = "base")
#> Costs are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```



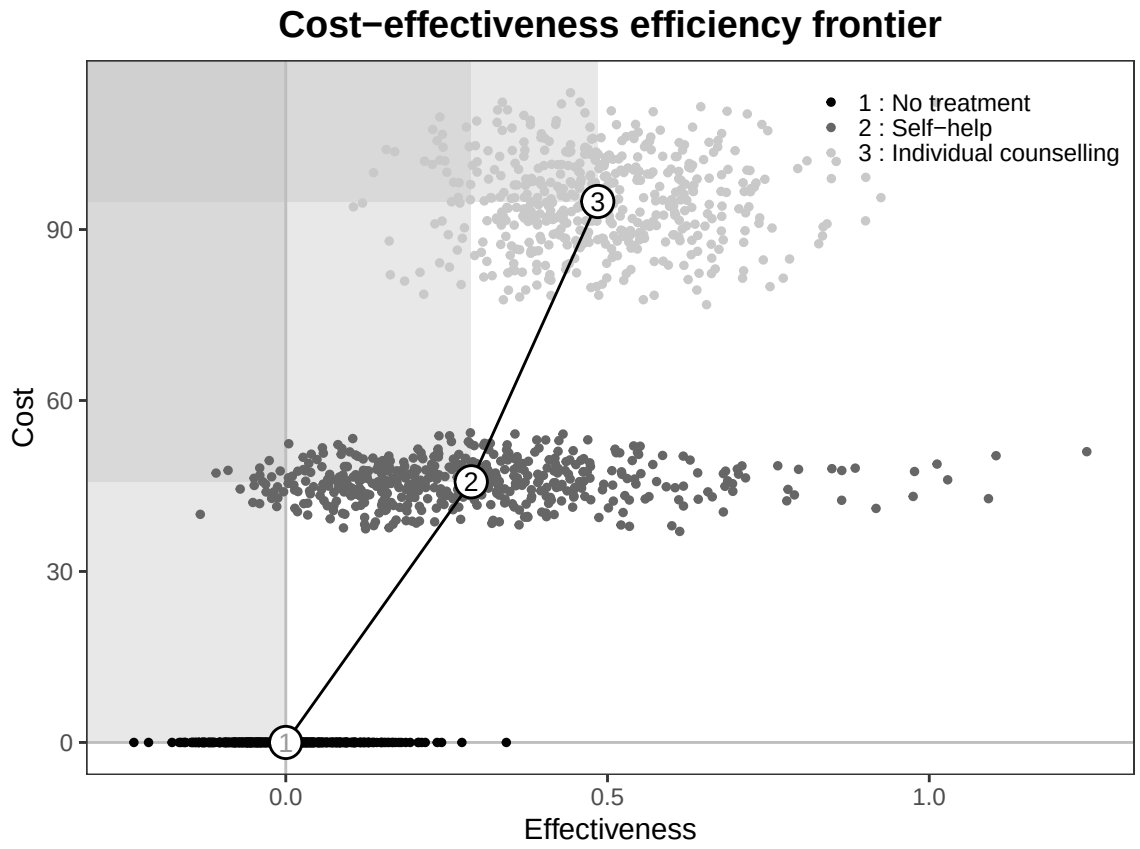

```
ceef.plot(bcea_smoke, start.from.origins = TRUE, graph = "ggplot")
#> Costs are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```



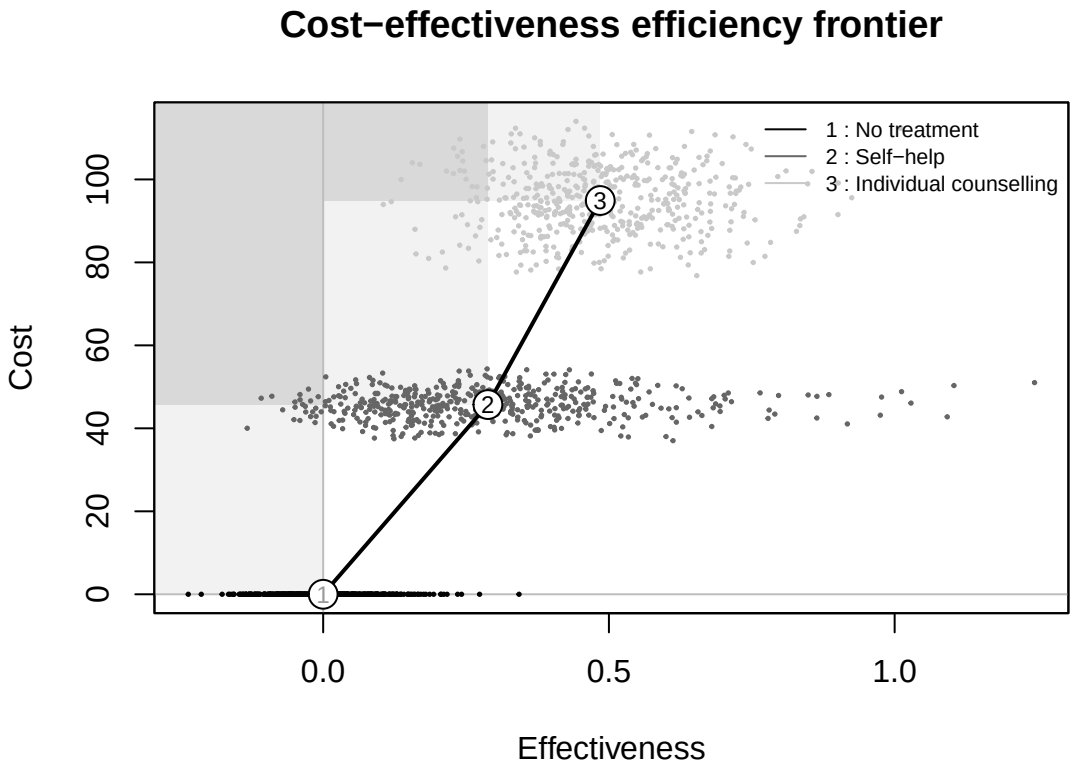

```
ceef.plot(bcea_smoke, start.from.origins = TRUE, graph = "base")
#> Costs are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```



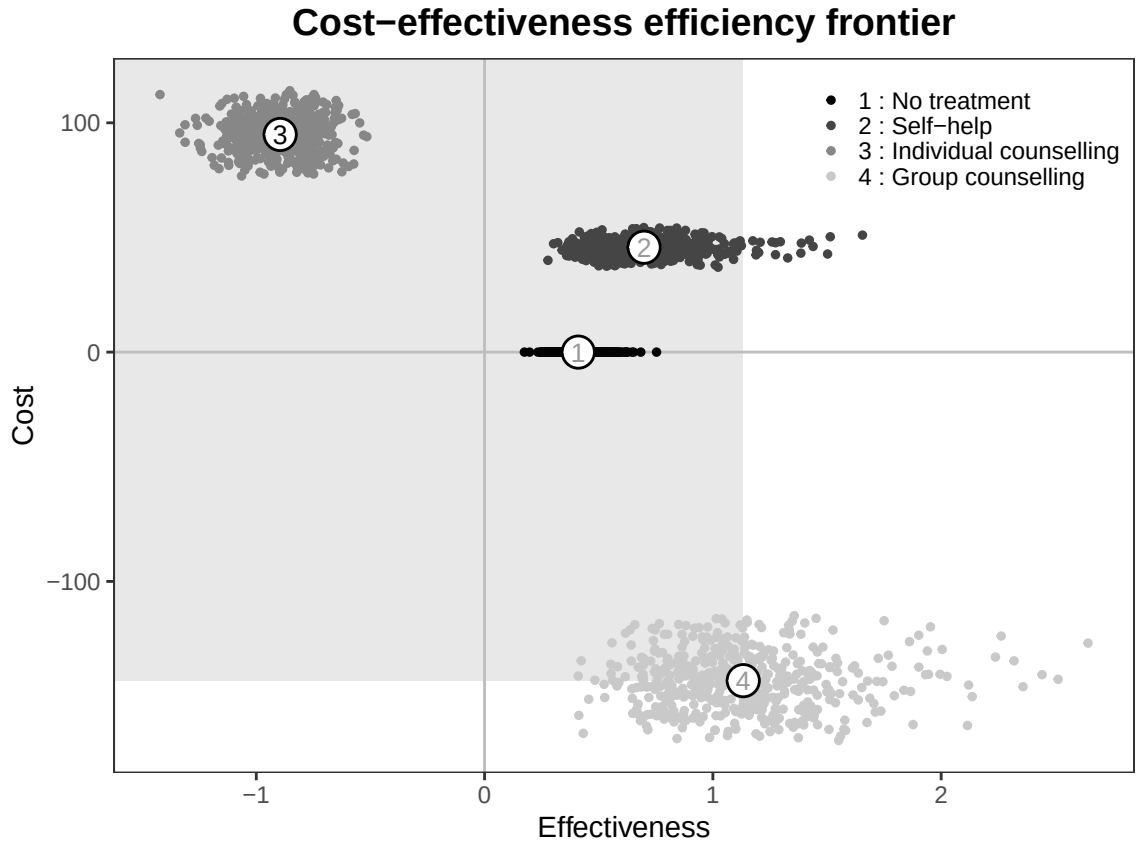

```
setComparisons(bcea_smoke) <- c(1,2)
ceef.plot(bcea_smoke, graph = "ggplot")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness  Costs Increase slope Increase angle
#> Self-help                   0.28824 45.733         158.66         1.5645
#> Individual counselling      0.48486 94.919         250.16         1.5668
#>
#> Interventions not on the efficiency frontier:
#>              Effectiveness Costs     Dominance type
#> No treatment             0     0 Extended dominance
```



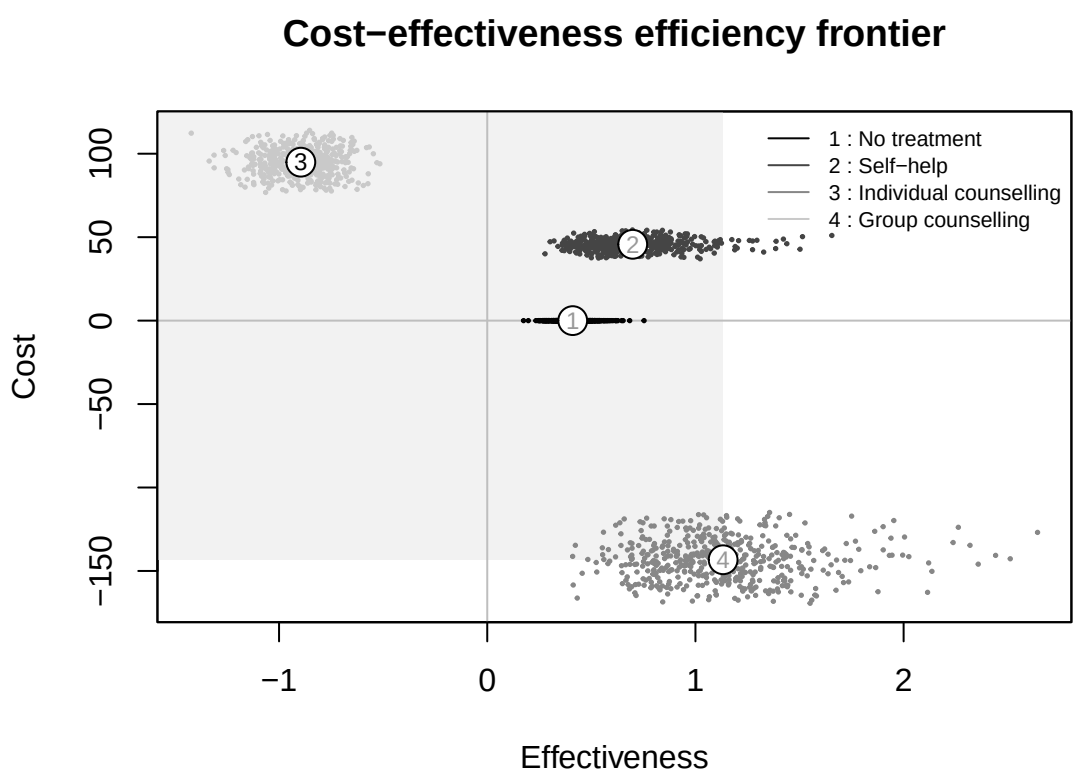

```
ceef.plot(bcea_smoke, graph = "base")
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness  Costs Increase slope Increase angle
#> Self-help                   0.28824 45.733         158.66         1.5645
#> Individual counselling      0.48486 94.919         250.16         1.5668
#>
#> Interventions not on the efficiency frontier:
#>              Effectiveness Costs     Dominance type
#> No treatment             0     0 Extended dominance
```



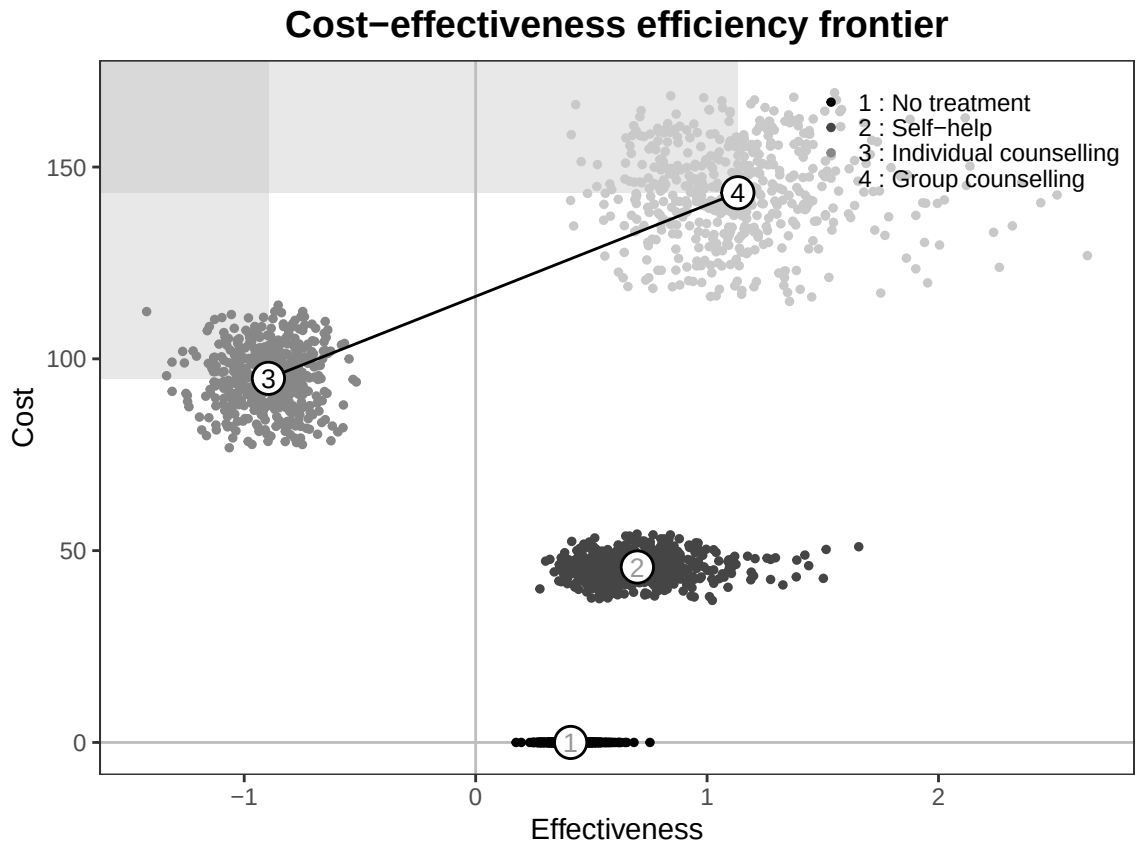

```
e[, 3] <- -e[, 3]
bcea_smoke <- bcea(e, c, ref = 3, interventions = treats, Kmax = 500)
ceef.plot(bcea_smoke, graph = "ggplot")
#> Costs and benefits are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```



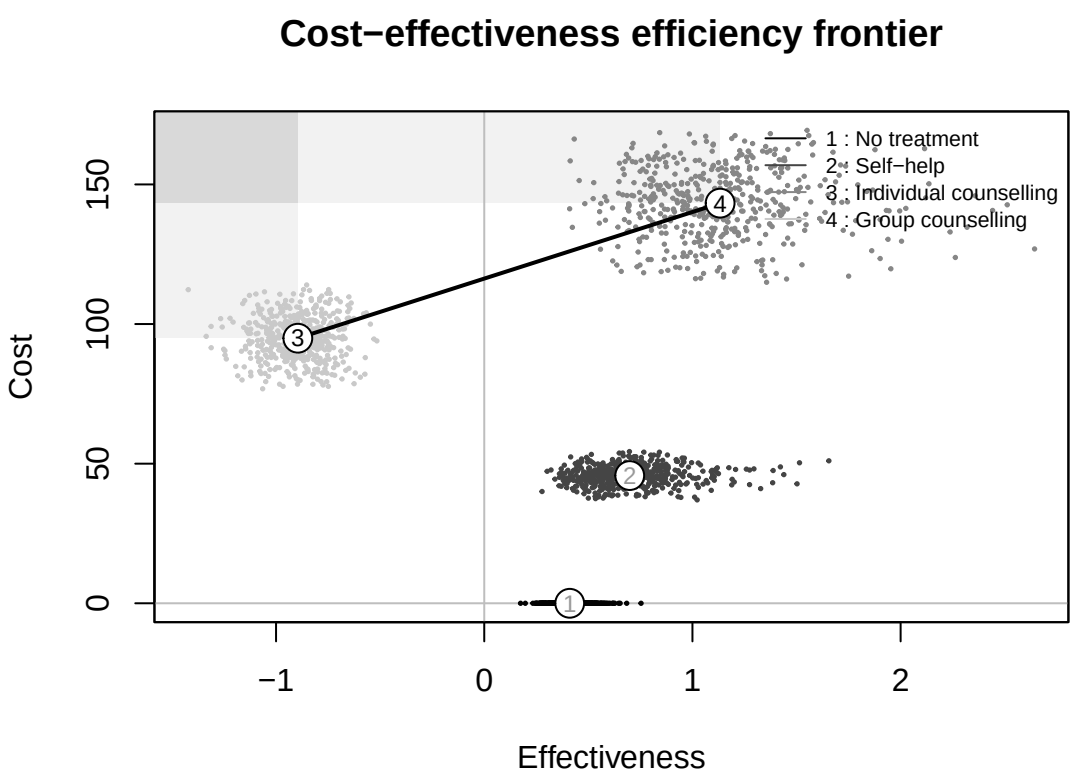

```
ceef.plot(bcea_smoke, graph = "base")
#> Costs and benefits are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                   Effectiveness  Costs Increase slope Increase angle
#> Group counselling         1.133 -143.3             NA             NA
#>
#> Interventions not on the efficiency frontier:
#>                         Effectiveness    Costs     Dominance type
#> No treatment                  0.41051    0.000 Absolute dominance
#> Self-help                     0.69875   45.733 Absolute dominance
#> Individual counselling        1.13303 -143.301 Extended dominance
```




```
data("Smoking")
e[, 3] <- -e[, 3]
bcea_smoke <- bcea(e, c, ref = 3, interventions = treats, Kmax = 500)
ceef.plot(bcea_smoke, graph = "ggplot")
#> Benefits are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Individual counselling      -0.89536  94.919             NA             NA
#> Group counselling            1.13303 143.301         23.852         1.5289
#>
#> Interventions not on the efficiency frontier:
#>              Effectiveness  Costs     Dominance type
#> No treatment       0.41051  0.000 Absolute dominance
#> Self-help          0.69875 45.733 Absolute dominance
```




```
ceef.plot(bcea_smoke, graph = "base")
#> Benefits are negative, the frontier will not start from the origins
#>
#> Cost-effectiveness efficiency frontier summary
#>
#> Interventions on the efficiency frontier:
#>                       Effectiveness   Costs Increase slope Increase angle
#> Individual counselling      -0.89536  94.919             NA             NA
#> Group counselling            1.13303 143.301         23.852         1.5289
#>
#> Interventions not on the efficiency frontier:
#>              Effectiveness  Costs     Dominance type
#> No treatment       0.41051  0.000 Absolute dominance
#> Self-help          0.69875 45.733 Absolute dominance
```


Cost−effectiveness efficiency frontier
1 : No treatment
2 : Self−help
3 : Individual counselling
4 : Group counselling
Cost
0
50
100
150
−1
0
1
2
Effectiveness