

# Travel Mode - Multinomial Logit Model

February 8, 2012

For multinomial models that include category-specific as well as global effects the function "mlogit" from the library "mlogit" can be used.

```
> library(mlogit)
```

The "Travel Mode"-data are stored in the "Edcat"-package and can be loaded by the following command.

```
> data(ModeChoice, package="Edcat")
```

For the use of the function "mlogit" an appropriate data set has to be built. This is done by use of the function "mlogit.data".

```
> travel.long <- mlogit.data(ModeChoice, choice="mode", shape="long", alt.levels=
+ c("air", "train", "bus", "car"))
```

Now the model can be fitted. In the formula first the category-specific effects and then, separated by "|", the global effects are specified.

```
> travel.kat.id <- mlogit(mode ~ invt + gc|hinc, data=travel.long)
> summary(travel.kat.id)
```

Call:

```
mlogit(formula = mode ~ invt + gc | hinc, data = travel.long,
        method = "nr", print.level = 0)
```

Frequencies of alternatives:

```
      air  train   bus   car
0.27619 0.30000 0.14286 0.28095
```

nr method

4 iterations, 0h:0m:0s

g'(-H)<sup>-1</sup>g = 0.00216

successive function values within tolerance limits

Coefficients :

	Estimate	Std. Error	t-value	Pr(> t )	
train:(intercept)	3.5250366	0.6549825	5.3819	7.371e-08	***
bus:(intercept)	2.2782769	0.7176686	3.1746	0.001501	**
car:(intercept)	1.5334957	0.7065856	2.1703	0.029985	*
invt	-0.0031266	0.0009548	-3.2746	0.001058	**

```

gc                -0.0016225  0.0055279 -0.2935  0.769130
train:hinc        -0.0569409  0.0124103 -4.5882  4.471e-06 ***
bus:hinc          -0.0355771  0.0131492 -2.7056  0.006817 **
car:hinc          -0.0023652  0.0104475 -0.2264  0.820898
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Log-Likelihood: -250.17
McFadden R^2: 0.11839
Likelihood ratio test : chisq = 67.186 (p.value = 3.9423e-13)

```

Now the same model is fitted with the package "VGAM".

```
> library(VGAM)
```

At first the data need to be prepared adequately to be ready for use with the function "vglm".

```

> travelmode <- matrix(ModeChoice$mode, byrow = T, ncol = 4)
> colnames(travelmode) <- c("air", "train", "bus", "car")
> travelhinc <- matrix(ModeChoice$hinc, byrow = T, ncol = 4)
> travelhinc <- travelhinc[,1]
> travelinvt <- matrix(ModeChoice$invt, byrow = T, ncol = 4)
> colnames(travelinvt) <- c("invtair", "invttrain", "invtbus", "invtcar")
> travelgc <- matrix(ModeChoice$gc, byrow = T, ncol = 4)
> colnames(travelgc) <- c("gcair", "gctrain", "gcbus", "gccar")
> travelinvt <- sweep(travelinvt[,-1], 1, travelinvt[,1])
> travelgc <- sweep(travelgc[,-1], 1, travelgc[,1])
> Invt <- travelinvt[,1]
> Gc <- travelgc[,1]
> traveldat <- cbind(travelhinc, travelinvt, Invt, travelgc, Gc)
> traveldat <- as.data.frame(traveldat)

```

Now the model can be fitted.

```

> fit <- vglm(travelmode ~ Invt + Gc + travelhinc,
+             multinomial(parallel = FALSE ~ travelhinc, refLevel = 1),
+             xij = list(Invt ~ invttrain + invtbus + invtcar,
+                       Gc ~ gctrain + gcbus + gccar),
+             form2 = ~ Invt + invttrain + invtbus + invtcar +
+                   Gc + gctrain + gcbus + gccar + travelhinc,
+             data = traveldat, trace = TRUE)

```

```

VGLM   linear loop 1 : deviance = 501.4629
VGLM   linear loop 2 : deviance = 500.3338
VGLM   linear loop 3 : deviance = 500.3317
VGLM   linear loop 4 : deviance = 500.3317

```

```
> summary(fit)
```

Call:

```
vglm(formula = travelmode ~ Invt + Gc + travelhinc, family = multinomial(parallel = FALSE
```

```

travelhinc, refLevel = 1), data = traveldat, form2 = ~Invt +
invtttrain + invtbus + invtcar + Gc + gctrain + gcbus + gccar +
travelhinc, xij = list(Invt ~ invtttrain + invtbus + invtcar,
Gc ~ gctrain + gcbus + gccar), trace = TRUE)

```

Pearson Residuals:

	Min	1Q	Median	3Q	Max
log(mu[,2]/mu[,1])	-2.7819	-0.54900	-0.25782	0.71847	3.3016
log(mu[,3]/mu[,1])	-2.1395	-0.40759	-0.22128	-0.13141	4.3081
log(mu[,4]/mu[,1])	-2.0047	-0.65888	-0.24440	0.86597	5.1282

Coefficients:

	Value	Std. Error	t value
(Intercept):1	3.5250538	0.6549818	5.38191
(Intercept):2	2.2782935	0.7176672	3.17458
(Intercept):3	1.5334984	0.7065854	2.17029
Invt	-0.0031266	0.0009548	-3.27460
Gc	-0.0016225	0.0055279	-0.29352
travelhinc:1	-0.0569415	0.0124103	-4.58824
travelhinc:2	-0.0355781	0.0131491	-2.70574
travelhinc:3	-0.0023652	0.0104474	-0.22639

Number of linear predictors: 3

Names of linear predictors:

```
log(mu[,2]/mu[,1]), log(mu[,3]/mu[,1]), log(mu[,4]/mu[,1])
```

Dispersion Parameter for multinomial family: 1

Residual Deviance: 500.3317 on 622 degrees of freedom

Log-likelihood: -250.1658 on 622 degrees of freedom

Number of Iterations: 4

```
> summary(travel.kat.id)
```

Call:

```
mlogit(formula = mode ~ invt + gc | hinc, data = travel.long,
method = "nr", print.level = 0)
```

Frequencies of alternatives:

air	train	bus	car
0.27619	0.30000	0.14286	0.28095

nr method

4 iterations, 0h:0m:0s

g'(-H)<sup>-1</sup>g = 0.00216

successive fonction values within tolerance limits

Coefficients :

	Estimate	Std. Error	t-value	Pr(> t )	
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invt	-0.0031266	0.0009548	-3.2746	0.001058	**
gc	-0.0016225	0.0055279	-0.2935	0.769130	
train:hinc	-0.0569409	0.0124103	-4.5882	4.471e-06	***
bus:hinc	-0.0355771	0.0131492	-2.7056	0.006817	**
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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Log-Likelihood: -250.17

McFadden R<sup>2</sup>: 0.11839

Likelihood ratio test : chisq = 67.186 (p.value = 3.9423e-13)

At last we compare the coefficients of the two fitted models.

> *summary(travel.kat.id)\$CoefTable*

	Estimate	Std. Error	t-value	Pr(> t )
train:(intercept)	3.525036582	0.6549824780	5.3818792	7.371222e-08
bus:(intercept)	2.278276953	0.7176686437	3.1745527	1.500676e-03
car:(intercept)	1.533495711	0.7065856497	2.1702899	2.998489e-02
invt	-0.003126577	0.0009547997	-3.2745899	1.058154e-03
gc	-0.001622510	0.0055279076	-0.2935124	7.691305e-01
train:hinc	-0.056940856	0.0124103406	-4.5881784	4.471305e-06
bus:hinc	-0.035577091	0.0131492259	-2.7056415	6.817260e-03
car:hinc	-0.002365193	0.0104474472	-0.2263895	8.208985e-01

> *summary(fit)\$coef3*

	Value	Std. Error	t value
(Intercept):1	3.525053759	0.6549818022	5.381911
(Intercept):2	2.278293544	0.7176672465	3.174582
(Intercept):3	1.533498382	0.7065854109	2.170294
Invt	-0.003126583	0.0009547997	-3.274596
Gc	-0.001622528	0.0055279012	-0.293516
travelhinc:1	-0.056941460	0.0124102999	-4.588242
travelhinc:2	-0.035578093	0.0131491108	-2.705741
travelhinc:3	-0.002365198	0.0104474488	-0.226390