APPENDIX A

```
cost per km car=
	efficiency car*fuel cost per km*ckc
	~	euro/km
	~		|

rescheduling costs no transfer[traveltype]=
	no transfer on time arrival*avg early arrival no transfer*time value early arrival
train\
		[traveltype]+(1-no transfer on time arrival
	)*avg late arrival no transfer*time value late arrival train
	[traveltype]*rcnt
	~	euro
	~		|

rescheduling costs train[traveltype]=
	(rescheduling costs no transfer[traveltype]*(1-avg number of transfers[traveltype])+\
		rescheduling	costs	transfer[traveltype]*avg	number	of
transfers[traveltype])*rct
	~	euro
	~		|

rescheduling costs transfer[traveltype]=
	transfer on time arrival*avg early arrival transfer*time value early arrival
train[traveltype\
		]+(1-transfer on time arrival
	)*avg late arrival transfer*time value late arrival train[traveltype]*rctr
	~	euro
	~		|

aaed=
	GET XLS CONSTANTS('?sens', 'Blad1' , 'B3' )
	~	Dmnl
	~		|

saetc=
	GET XLS CONSTANTS('?sens', 'Blad1' , 'B2' )
	~	Dmnl
	~		|

avg train trip value[traveltype]=
	in train time[traveltype]*in train time value[traveltype]+waiting time*waiting time
value\
		[traveltype]+transfer time[traveltype
	]*transfer time value[traveltype]+access and egress time*acces and egress
value[traveltype\
		]*attv
	~	euro/trip
	~		|

access and egress time=
	(bike access ratio*cycling access eggres time+bus tram metro access ratio*bus tram
metro access eggres time\
		+car acc egr passenger ratio
	*car access eggres time+car access driver ratio*car driver access eggres time+walking
access ratio\
		*walking access eggres time
	)*access and egress movements per trip*aet
	~	Hour/trip
	~		|

atd=
	GET XLS CONSTANTS('?sens', 'Blad1' , 'B43' )
	~	Dmnl
	~		|

station access and egress transport cost=
	2*(avg bus tram metro access cost*bus tram metro access ratio+avg car driver access
cost\
		*car access driver ratio+avg car passenger access cost
	*car acc egr passenger ratio+avg cycling access costs*bike access ratio+avg walking
access costs\
		*walking access ratio)*saetc
```

```
        ~       euro/trip
        ~               |

aet=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B17' )
        ~       Dmnl
        ~               |

tf=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B44' )
        ~       Dmnl
        ~               |

ms=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B29' )
        ~       Dmnl
        ~               |

attv=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B14' )
        ~       Dmnl
        ~               |

rct=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B21' )
        ~       trip
        ~               |

avg access and egress distance=
        (avg car dist driver acc egr*car access driver ratio+avg dist acc egr car pass*car acc
egr passenger ratio\
                +avg dist bus tram metro
        *bus  tram  metro  access  ratio+avg  dist  walking*walking  access  ratio+avg  distance
cycling\
                *bike access ratio)*2*aaed
        ~       km/trip
        ~               |

avg train delay=
        (avg first order delay per train+second order delays)*train per trip*atd
        ~       Hour/trip
        ~               |

train headway1=
        km track per train/cumulative avg train speed*th1
        ~       Hour/train
        ~               |

modal split[traveltype]=
        (price   weight*train   to   car   trip   price   attractiveness[traveltype]+time   value
weight*train to car time value attractiveness
        [traveltype]+predictability weight*train to car arrival predictability[traveltype])*\
                ms
        ~       Dmnl
        ~               |

ckc=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B5' )
        ~       Dmnl
        ~               |

pct=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B6' )
        ~       Dmnl
        ~               |

rcnt=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B22' )
        ~       Dmnl
        ~               |

th1=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B34' )
        ~       Dmnl
        ~               |

train frequency=
```

```
        1/train headway1*tf
        ~       train/Hour
        ~               |

parking costs per trip=
        yearly parking levies/number of trips by car*pct
        ~       euro/trip
        ~               |

avg trip distance[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B4' )
        ~       km
        ~               |

rctr=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B23' )
        ~       Dmnl
        ~               |

delay caused by incidents=
        average FHT*total trains affected by incidents*effect of FHT on delay
        ~       Hour/Month
        ~               |

effect of FHT on delay=
        0.43
        ~       TAO/train
        ~               |

trains affected by infra incidents=
        ínfra incidents*train frequency*average FHT
        ~       train/Month
        ~               |

trains affected by other incidents=
        other incidents*train frequency*average FHT
        ~       train/Month
        ~               |

trains affected by equipment incidents=
        1
        ~       train/TAO
        ~               |

equipment incidents=
        train services per month*equipment reliability*trains affected by equipment incidents
        ~       train/Month
        ~               |

avg first order delay per train=
        delay caused by incidents/train services per month
        ~       Hour/train
        ~       0.033
        |

total trains affected by incidents=
        equipment  incidents+trains  affected  by  infra  incidents+trains  affected  by  other
incidents
        ~       train/Month
        ~               |

cumulative avg train speed=
        SUM(avg train scheduled speed[traveltype!])/4
        ~       km/Hour
        ~               |

spread of delay factor=
        effect of headway on spread of delay/train headway1
        ~       Dmnl
        ~               |

cde=
        1
        ~       1/Hour
        ~               |

ínfra incidents=
```

```
        infra reliability/proportion of infra need replacement
        ~       TAO/Month
        ~       98
        |

km track per train=
        infra for passenger transport/equipment in use*cde
        ~       km/train
        ~               |

effect of headway on spread of delay=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B42' )
        ~       Hour/train
        ~               |

infra reliability=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B38' )
        ~       TAO/Month
        ~               |

infra passenger ratio=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B35' )
        ~       Dmnl
        ~               |

infra for passenger transport=
        total infra*infra passenger ratio
        ~       km
        ~               |

sum total mobility=
        SUM(total mobility train[traveltype!])
        ~       km
        ~               ~       :SUPPLEMENTARY
        |

equipment reliability=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B37' )
        ~       TAO/train
        ~               |

train per trip=
        1
        ~       train/trip
        ~               |

maintenance speed=
        1
        ~       Month
        ~               |

hours train services provided per month=
        24*30
        ~       Hour/Month
        ~               |

average FHT=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B41' )
        ~       Hour/TAO
        ~               |

new equipment=
        equipment  diff/equipment  acquiring  rate+IF  THEN  ELSE(  equipment  diff/equipment
acquiring rate\
                =0, 0 , end of service equipment )
        ~       train/Month
        ~               |

second order delays=
        avg first order delay per train*spread of delay factor
        ~       Hour/train
        ~               |

start infra maintenance speed=
        1
        ~       Month
        ~               |
```

```
start of infra maintenance=
        infra maintenace needed/start infra maintenance speed
        ~       km/Month
        ~               |

percentage train on time=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B27' )
        ~       Dmnl
        ~               |

proportion infra maintenance needed=
        MAX(proportion of infra need replacement-infra quality goal,0)
        ~       Dmnl
        ~               |

other incidents=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B40' )
        ~       TAO/Month
        ~               |

infrastructure in good condition= INTEG (
        completion of infra maintenance-infra deterioration,
                6830-infrastructure in need of replacement-infrastructure in maintenance)
        ~       km
        ~               |

infrastructure in maintenance= INTEG (
        start of infra maintenance-completion of infra maintenance,
                0)
        ~       km
        ~               |

completion of infra maintenance=
        infrastructure in maintenance/maintenance speed
        ~       km/Month
        ~               |

train services per month=
        equipment in use*hours train services provided per month
        ~       train/Month
        ~               |

infra quality goal=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B39' )
        ~       Dmnl
        ~               |

base life expectency of infra=
        20*12
        ~       Month
        ~               |

infra maintenace needed=
        proportion infra maintenance needed*total infra
        ~       km
        ~               |

infrastructure in need of replacement= INTEG (
        infra deterioration-start of infra maintenance,
                350)
        ~       km
        ~               |

proportion of infra need replacement=
        infrastructure in need of replacement/(infrastructure in good condition+infrastructure
in need of replacement\
                )
        ~       Dmnl
        ~               |

infra deterioration=
        infrastructure in good condition/base life expectency of infra
        ~       km/Month
        ~               |

equipment diff=
```

```
        MAX(gross equipment needed-equipment stock,0)
        ~       train
        ~               |

net equipment needed=
        equipment capacity needed/passenger capacity equipment
        ~       train/Hour
        ~               |

gross equipment needed=
        net equipment needed/equipment utilization
        ~       train
        ~               |

passenger capacity equipment=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B32' )
        ~       passenger/train
        ~               |

equipment utilization=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B36' )
        ~       Dmnl/Hour
        ~               |

"95 percent delay value train"=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B28' )
        ~       Hour
        ~               |

life expectency equipment=
        12*30
        ~       Month
        ~               |

equipment stock= INTEG (
        new equipment-end of service equipment,
                425)
        ~       train
        ~               |

equipment acquiring rate=
        12
        ~       Month
        ~               |

equipment in use=
        equipment stock*equipment utilization
        ~       train/Hour
        ~               |

end of service equipment=
        equipment stock/life expectency equipment
        ~       train/Month
        ~               |

value of norm for train=
        "95 percent delay value train"/("95 norm time train"-norm train on time)
        ~       Hour
        ~               |

train to car trip price attractiveness[traveltype]=
        (1/train trip cost[traveltype])^elasticity of quality difference/(1/car trip
cost[traveltype\
                ]+1/train trip cost[traveltype])^elasticity of quality difference
        ~       Dmnl
        ~               |

train to car time value attractiveness[traveltype]=
        (1/avg train trip value[traveltype])^elasticity of quality difference/(1/avg in car
time value\
                [traveltype]+1/avg train trip value[traveltype])^elasticity of quality
difference
        ~       Dmnl
        ~               |

elasticity of quality difference=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B16' )
```

```
        ~       Dmnl
        ~               |

train to car arrival predictability[traveltype]=
        (1/rescheduling       costs       train[traveltype])^elasticity       of       quality
difference/(1/rescheduling costs train\
                [traveltype]+1/car rescheduling costs[traveltype]
        )^elasticity of quality difference
        ~       Dmnl
        ~               |

car late arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, car late arrival )
        ~       Dmnl
        ~               |

car on time arrival=
        cumulative arrival distribution(car depart norm time)
        ~       Dmnl
        ~               |

car avg early arrival1[traveltype]=
        car early arrival avg norm time*value of norm[traveltype]
        ~       Hour
        ~               |

car avg late arrival1[traveltype]=
        car late arrival avg norm time*value of norm[traveltype]
        ~       Hour
        ~               |

car early depart norm= INTEG (
        car early depart norm adj,
                0.12)
        ~       Dmnl
        ~               |

car depart norm time=
        car early depart norm+norm car on time
        ~       Dmnl
        ~               |

car early arrival=
        car on time arrival/2
        ~       Dmnl
        ~               |

car early arrival avg norm time=
        car depart norm time-car early arrival norm time+car early depart norm
        ~       Dmnl
        ~               |

car early arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, car early arrival )
        ~       Dmnl
        ~               |

car early depart adj speed=
        1
        ~       1/Month
        ~               |

car rescheduling costs[traveltype]=
        car on time arrival*car avg early arrival1[traveltype]*time value early arrival train\
                [traveltype]+(1-car  on  time  arrival)*car  avg  late  arrival1[traveltype]*time
value late arrival train\
                [traveltype]
        ~       euro
        ~               |

car early depart norm adj=
        (1-car early depart norm)*car on time arrival diff*car early depart adj speed
        ~       1/Month
        ~               |

car late arrival=
        (1-car on time arrival)/2+car on time arrival
```

```
        ~       Dmnl
        ~               |

car late arrival avg norm time=
        car late arrival norm time-car depart norm time
        ~       Dmnl
        ~               |

predictability weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B9' )
        ~       Dmnl
        ~               |

car on time arrival diff=
        desired on time arrival-car on time arrival
        ~       Dmnl
        ~               |

transfer made early arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, transfer made early arrival )
        ~       Dmnl
        ~               |

transfer made late arrival=
        (1-transfer on time arrival connection)/2+transfer on time arrival connection
        ~       Dmnl
        ~               |

transfer early arrival avg norm time=
        transfer depart norm time-transfer made early arrival norm time+transfer early depart
norm
        ~       Dmnl
        ~               |

avg late arrival transfer missed=
        avg late arrival transfer made+train headway
        ~       Hour
        ~               |

transfer made early arrival=
        transfer on time arrival connection/2
        ~       Dmnl
        ~               |

avg early arrival transfer=
        transfer connection made*avg early arrival transfer made+(1-transfer connection made\
                )*avg early arrival transfer missed
        ~       Hour
        ~               |

transfer made late arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, transfer made late arrival )
        ~       Dmnl
        ~               |

transfer on time arrical diff=
        desired on time arrival-transfer on time arrival
        ~       Dmnl
        ~               |

transfer late arrival avg norm time=
        transfer made late arrival norm time-transfer depart norm time
        ~       Dmnl
        ~               |

avg early arrival transfer made=
        transfer early arrival avg norm time*value of norm for train
        ~       Hour
        ~               |

avg early arrival transfer missed=
        train headway-avg early arrival transfer made
        ~       Hour
        ~               |

transfer early depart norm= INTEG (
        transfer early depart norm adj,
```

```
                0.2)
        ~       Dmnl
        ~               |

avg late arrival transfer=
        transfer connection made*avg late arrival transfer made+(1-transfer connection made)\
                *avg late arrival transfer missed
        ~       Hour
        ~               |

avg late arrival transfer made=
        transfer late arrival avg norm time*value of norm for train
        ~       Hour
        ~               |

transfer early depart norm adj=
        (1-transfer early depart norm)*transfer on time arrical diff*early depart adj speed
        ~       1/Month
        ~               |

early depart adj speed=
        1
        ~       1/Month
        ~               |

early depart norm adj=
        (1-no transfer early depart norm)*no transfer on time arrival diff*early depart adj
speed
        ~       1/Month
        ~               |

transfer connection made=
        cumulative arrival distribution(norm avg schld transf time noninst+transfer depart
norm time\
                )
        ~       Dmnl
        ~               |

transfer depart norm time=
        norm train on time+transfer early depart norm
        ~       Dmnl
        ~               |

transfer time[traveltype]=
        avg transfer time noninstant*avg number of transfers[traveltype]
        ~       Hour/trip
        ~               |

transfer on time arrival connection=
        cumulative arrival distribution(transfer depart norm time)
        ~       Dmnl
        ~               |

no transfer early depart norm= INTEG (
        early depart norm adj,
                0.2)
        ~       Dmnl
        ~               |

avg number of transfers[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B15' )
        ~       Dmnl/trip
        ~       OViN2011 - avg 0.3
                spitskort 0.15, spitslang 0.59, buitenspitskort 0.13, buitenspitslang 0.74
        |

transfer on time arrival=
        transfer connection made*transfer on time arrival connection
        ~       Dmnl
        ~               |

no transfer on time arrival diff=
        desired on time arrival-no transfer on time arrival
        ~       Dmnl
        ~               |

avg early arrival no transfer=
```

```
        no transfer early arrival avg norm time*value of norm for train
        ~       Hour
        ~               |

no transfer early arrival avg norm time=
        no transfer depart norm time-no transfer early arrival norm time+no transfer early
depart norm
        ~       Dmnl
        ~               |

desired on time arrival=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B24' )
        ~       Dmnl
        ~               |

avg late arrival no transfer=
        no transfer late arrival avg norm time*value of norm for train
        ~       Hour
        ~               |

no transfer early arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, no transfer early arrival )
        ~       Dmnl
        ~               |

no transfer depart norm time=
        no transfer early depart norm+norm train on time
        ~       Dmnl
        ~               |

no transfer late arrival=
        (1-no transfer on time arrival)/2+no transfer on time arrival
        ~       Dmnl
        ~               |

no transfer early arrival=
        no transfer on time arrival/2
        ~       Dmnl
        ~               |

no transfer late arrival avg norm time=
        no transfer late arrival norm time-no transfer depart norm time
        ~       Dmnl
        ~               |

no transfer on time arrival=
        cumulative arrival distribution(no transfer depart norm time)
        ~       Dmnl
        ~               |

no transfer late arrival norm time=
        LOOKUP INVERT(cumulative arrival distribution, no transfer late arrival )
        ~       Dmnl
        ~               |

equipment capacity needed=
        MAX(req peak cap, req off peak cap )
        ~       passenger/Hour
        ~               |

total infra=
        infrastructure in good condition+infrastructure in maintenance+infrastructure in need
of replacement
        ~       km
        ~               |

pass req cap offpeak short dist=
        trips   per   hour   offpeak   short   dist*trip   per   passenger   per   hour*in   train
time[offpeakshort\
                ]
        ~       passenger/Hour
        ~               |

pass req cap offpeak long dist=
        trips   per   hour   offpeak   long   dist*trip   per   passenger   per   hour*in   train
time[offpeaklong\
                ]
```

```
        ~       passenger/Hour
        ~               |

pass req cap peak short dist=
        trips per hour peak short dist*in train time[peakshort]*trip per passenger per hour
        ~       passenger/Hour
        ~               |

pass req cap peak long dist=
        trip per hour peak long dist*trip per passenger per hour*in train time[peaklong]
        ~       passenger/Hour
        ~               |

numbr trip offpeak long dist=
        mobility train offpeak long dist/avg train trip distance[offpeaklong]
        ~       trip
        ~               |

numbr trip offpeak short dist=
        mobility train offpeak short dist/avg train trip distance[offpeakshort]
        ~       trip
        ~               |

numbr trip peak long dist=
        mobility train peak long dist/avg train trip distance[peaklong]
        ~       trip
        ~               |

numbr trips peak short dist=
        mobility train peak short dist/avg train trip distance[peakshort]
        ~       trip
        ~               |

trips per hour peak short dist=
        numbr trips peak short dist/peak hours per year
        ~       trip/Hour
        ~               |

trip per hour peak long dist=
        numbr trip peak long dist/peak hours per year
        ~       trip/Hour
        ~               |

mobility train peak long dist=
        total mobility train[peaklong]
        ~       km
        ~       in 2011 21.4%
        |

req off peak cap=
        pass req cap offpeak short dist+pass req cap offpeak long dist
        ~       passenger/Hour
        ~               |

req peak cap=
        pass req cap peak long dist+pass req cap peak short dist
        ~       passenger/Hour
        ~               |

offpeak hours per year=
        16*360
        ~       Hour
        ~               |

mobility train offpeak long dist=
        total mobility train[offpeaklong]
        ~       km
        ~       in 2011 30.7%
        |

mobility train offpeak short dist=
        total mobility train[offpeakshort]
        ~       km
        ~       in 2011 23.9%
        |

mobility train peak short dist=
```

```
        total mobility train[peakshort]
        ~       km
        ~       in 2011 23.9%
        |

trips per hour offpeak short dist=
        numbr trip offpeak short dist/offpeak hours per year
        ~       trip/Hour
        ~               |

total mobility train[traveltype]=
        Mobility Choice Travelers KM Train[traveltype]+Mobility Train Captives[traveltype]
        ~       km
        ~               |

trip per passenger per hour=
        1
        ~       passenger/Hour
        ~               |

peak hours per year=
        360*4
        ~       Hour
        ~               |

trips per hour offpeak long dist=
        numbr trip offpeak long dist/offpeak hours per year
        ~       trip/Hour
        ~               |

Mobility Car Captives[traveltype]= INTEG (
        car captv mob growth[traveltype]+PT feasibility loss rate[traveltype]-PT feasibility
acquiring rate\
                [traveltype],
                init mobility car captive[traveltype])
        ~       km
        ~               |

mobility choice pass diff[traveltype]=
        Mobility Choice Travelers[traveltype]-total mobility choice pass[traveltype]
        ~       km
        ~               |

car captv mob growth[traveltype]=
        Mobility Car Captives[traveltype]*mobility growth
        ~       km/Month
        ~               |

init mobility choice travelers km car[traveltype]=
        6.09e+009,5.14e+009,1.12e+010,1.25e+010
        ~       km
        ~       5.9e+009,5.17e+009,1.05e+010,1.25e+010
        |

init mobility choice travelers km train[traveltype]=
        1.02e+009,1.1e+009,1.46e+009,2.6e+009
        ~       km
        ~       1.21e+009,1.07e+009,2.15e+009,2.57e+009
        |

Mobility Choice Travelers KM Train[traveltype]= INTEG (
        conv rate choice pass car2train[traveltype]+mob choice pass train adj[traveltype]-conv
rate choice pass car train2car\
                [traveltype],
                init mobility choice travelers km train[traveltype])
        ~       km
        ~               |

choice trav mob growth[traveltype]=
        Mobility Choice Travelers[traveltype]*mobility growth
        ~       km/Month
        ~               |

mob choice pass car adj[traveltype]=
        (1-mobility   choice   pass   train2car   frac[traveltype])*mobility   choice   pass
diff[traveltype\
                ]/TIME STEP
```

```
        ~       km/Month
        ~               |

actual modal split[traveltype]=
        Mobility Choice Travelers KM Train[traveltype]/(Mobility Choice Travelers KM
Car[traveltype\
                ]+Mobility Choice Travelers KM Train[traveltype])
        ~       Dmnl
        ~               |

modal split diff[traveltype]=
        modal split[traveltype]-actual modal split[traveltype]
        ~       Dmnl
        ~               |

conv rate choice pass car2train[traveltype]=
        MAX( modal split diff[traveltype] , 0 )*Mobility Choice Travelers KM Car[traveltype]\
                /pass trip adj time
        ~       km/Month
        ~               |

mobility choice pass train2car frac[traveltype]=
        Mobility Choice Travelers KM Train[traveltype]/total mobility choice pass[traveltype\
                ]
        ~       Dmnl
        ~               |

Mobility Choice Travelers[traveltype]= INTEG (
        choice trav mob growth[traveltype]+choice trav to train captv conv rate[traveltype]+\
                PT feasibility acquiring rate[traveltype]+PT feasibility loss
rate[traveltype]+train captv to choice trav conv rate\
                [traveltype],
                init mobility choice travelers[traveltype])
        ~       km
        ~               |

Mobility Choice Travelers KM Car[traveltype]= INTEG (
        conv rate choice pass car train2car[traveltype]+mob choice pass car adj[traveltype]-\
                conv rate choice pass car2train[traveltype],
                init mobility choice travelers km car[traveltype])
        ~       km
        ~               |

conv rate choice pass car train2car[traveltype]=
        MIN(modal split diff[traveltype], 0)*-1*Mobility Choice Travelers KM Train[traveltype\
                ]/pass trip adj time
        ~       km/Month
        ~               |

total mobility choice pass[traveltype]=
        Mobility Choice Travelers KM Car[traveltype]+Mobility Choice Travelers KM
Train[traveltype\
                ]
        ~       km
        ~               |

Mobility Train Captives[traveltype]= INTEG (
        choice trav to train captv conv rate[traveltype]+train captv mob growth[traveltype]-\
                train captv to choice trav conv rate[traveltype],
                init mobility train captive[traveltype])
        ~       km
        ~               |

train captv mob growth[traveltype]=
        mobility growth*Mobility Train Captives[traveltype]
        ~       km/Month
        ~               |

mob choice pass train adj[traveltype]=
        mobility choice pass train2car frac[traveltype]*mobility choice pass diff[traveltype\
                ]/TIME STEP
        ~       km/Month
        ~               |

init mobility train captive[traveltype]=
        1.56e+009,1.37e+009,2.77e+009,3.3e+009
        ~       km
```

```
        ~               |

init mobility car captive[traveltype]=
        1.56e+010,1.37e+010,2.77e+010,3.3e+010
        ~       km
        ~               |

init mobility choice travelers[traveltype]=
        7.11e+009,6.24e+009,1.26e+010,1.5e+010
        ~       km
        ~               |

PT feasibility acquiring rate[traveltype]=
        0
        ~       km/Month
        ~               |

PT feasibility loss rate[traveltype]=
        0
        ~       km/Month
        ~               |

choice trav to train captv conv rate[traveltype]=
        0
        ~       km/Month
        ~               |

mobility growth=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B31' )
        ~       1/Month
        ~               |

train captv to choice trav conv rate[traveltype]=
        0
        ~       km/Month
        ~               |

pass trip adj time=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B30' )
        ~       Month
        ~               |

avg speed car driver=
        30.4
        ~       km/Hour
        ~               |

avg in car time value[traveltype]=
        avg car trip length[traveltype]*value in car time[traveltype]
        ~       euro
        ~               |

cycling access eggres time=
        avg distance cycling/avg cycling speed
        ~       Hour/trip
        ~               |

avg speed walking=
        6
        ~       km/Hour
        ~               |

acces and egress value[traveltype]=
        in train time value[traveltype]*access and egress weight
        ~       euro/Hour
        ~               |

access and egress movements per trip=
        2
        ~       Dmnl
        ~               |

access and egress weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B12' )
        ~       Dmnl
        ~       van dalen - paper reistijdwaardering p2.
        |
```

```
car to train time value ratios[traveltype]=
        0.63,1.09,0.63,1.09
        ~       Dmnl
        ~       verhouding      kort            lang
                spits           0,62962963      1,094594595
                buitenspits     0,627906977     1,094594595
                Wardman tabel 2.7, pub trans values of time
        |

time value weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B8' )
        ~       Dmnl
        ~               |

waiting time value[traveltype]=
        in train time value[traveltype]*waiting time weight
        ~       euro/Hour
        ~               |

waiting time weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B11' )
        ~       Dmnl
        ~       van dalen - paper reistijdwaardering p2.
        |

walking access eggres time=
        avg dist walking/avg speed walking
        ~       Hour/trip
        ~               |

avg speed bus tram metro=
        22.9
        ~       km/Hour
        ~               |

avg speed car passenger=
        26.6
        ~       km/Hour
        ~               |

bus tram metro access eggres time=
        avg dist bus tram metro/avg speed bus tram metro
        ~       Hour/trip
        ~               |

price weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B7' )
        ~       Dmnl
        ~               |

avg cycling speed=
        13.7
        ~       km/Hour
        ~               |

car access eggres time=
        avg dist acc egr car pass/avg speed car passenger
        ~       Hour/trip
        ~               |

transfer time weight=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B13' )
        ~       Dmnl
        ~       van dalen - paper reistijdwaardering p2.
        |

transfer time value[traveltype]=
        in train time value[traveltype]*transfer time weight
        ~       euro/Hour
        ~               |

car driver access eggres time=
        avg car dist driver acc egr/avg speed car driver
        ~       Hour/trip
        ~               |
```

```
value in car time[traveltype]=
        car to train time value ratios[traveltype]*in train time value[traveltype]
        ~       euro/Hour
        ~               |

norm avg schld transf time noninst=
        avg scheduled transfer time noninstant/value of norm for train
        ~       Dmnl
        ~               |

avg scheduled transfer time noninstant=
        train headway*avg waiting transfer time factor
        ~       Hour
        ~               |

avg transf time noninstant missed connection=
        train headway
        ~       Hour
        ~               |

train per headway=
        1
        ~       train
        ~               |

train headway=
        1/train frequency*train per headway
        ~       Hour
        ~               |

avg transfer time noninstant=
        noninst  connections  made*avg  transf  time  noninstant  made  connection+(1-noninst
connections made\
                )*avg transf time noninstant missed connection
        ~       Hour
        ~               |

avg transf time noninstant made connection=
        train headway*avg waiting transfer time factor
        ~       Hour
        ~               |

avg waiting transfer time factor=
        0.5
        ~       Dmnl
        ~               |

noninst connections made=
        cumulative arrival distribution(norm avg schld transf noninst connections made)
        ~       Dmnl
        ~               |

norm avg schld transf noninst connections made=
        norm avg schld transf time noninst+norm train on time
        ~       Dmnl
        ~               |

"95 norm time train"=
        LOOKUP INVERT(cumulative arrival distribution, 0.95 )
        ~       Dmnl
        ~               |

"95 norm time"=
        LOOKUP INVERT(cumulative arrival distribution, 0.95 )
        ~       Dmnl
        ~               |

time value early arrival train[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B25' )
        ~       euro/Hour
        ~       value of traveltime reliability p.14 in euro/hour
        |

norm car on time=
        LOOKUP INVERT(cumulative arrival distribution, percentage car on time )
        ~       Dmnl
        ~               |
```

```
norm train on time=
        LOOKUP INVERT(cumulative arrival distribution, percentage train on time )
        ~       Dmnl
        ~               |

time value late arrival train[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B26' )
        ~       euro/Hour
        ~       value of traveltime reliability p.14 in euro/hour
        |

waiting time=
        avg train delay+avg waiting time
        ~       Hour/trip
        ~               |

avg waiting time= WITH LOOKUP (
        train headway,
                ([(0,0)-
(1.5,0.2)],(0,0),(0.083,0.042),(0.25,0.083),(0.5,0.125),(1,0.167),(1.5,0.167\
                ) ))
        ~       Hour/trip
        ~       describing the arrival pattern of passengers at the station. With high \
                frequency (small headway), passengers will arrive uniformly. Otherwise \
                they arrive on avg 5-10 min befor departure
        |

in train time[traveltype]=
        avg train trip distance[traveltype]/avg train scheduled speed[traveltype]
        ~       Hour/trip
        ~               |

in train time value[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B10' )
        ~       euro/Hour
        ~       value of traveltime reliability p.14 in euro/hour
        |

value of norm[traveltype]=
        "95 percent delay value car"[traveltype]/("95 norm time"-norm car on time)
        ~       Hour/trip
        ~               |

"95 percent delay value car"[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B20' )
        ~       Hour/trip
        ~               |

arrival distribution(
        [(0,0)-(1,0.4)],(0,0),(0.05,0.00516351),(0.075,0.03861),(0.1,0.107982),(0.125,0.1909\

        ),(0.15,0.262317),(0.175,0.3093),(0.2,0.330465),(0.225,0.3301),(0.25,0.314712),(0.3\

        ,0.260839),(0.35,0.200622),(0.4,0.148002),(0.45,0.106666),(0.5,0.0759213),(0.55,0.0537
249\

        ),(0.6,0.0379564),(0.65,0.0268451),(0.7,0.0190404),(0.75,0.0135584),(0.8,0.00970008\
                ),(0.85,0.00697544),(0.9,0.00504323),(0.95,0.0036664),(1,0))
        ~
        ~               ~       :SUPPLEMENTARY
        |

cumulative arrival distribution(
        [(0,0)-(1,1)],(0,0),(0.05,0),(0.1,0.02),(0.15,0.12),(0.2,0.27),(0.25,0.43),(0.3,0.58\

        ),(0.35,0.69),(0.4,0.78),(0.45,0.84),(0.5,0.89),(0.55,0.92),(0.6,0.94),(0.65,0.96),\
                (0.7,0.97),(0.75,0.98),(0.85,0.99),(1,1))
        ~       Dmnl
        ~               |

percentage car on time=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B19' )
        ~       Dmnl
        ~       Hoe laat denk je thuis te zijn -> in spits
        |
```

```
avg car trip length[traveltype]=
        avg trip distance[traveltype]/avg car speed[traveltype]
        ~       Hour
        ~               |

avg car speed[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B18' )
        ~       km/Hour
        ~               |

yearly parking levies=
        5.66e+008
        ~       euro
        ~       http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=80420NED&D1=9&D2=0&D\
                3=a&VW=T
        |

number of trips by car=
        5.01615e+009
        ~       trips
        ~               |

walking access ratio=
        0.453
        ~       Dmnl
        ~               |

avg train trip distance[traveltype]=
        avg trip distance[traveltype]-avg access and egress distance
        ~       km/trip
        ~               |

avg car passenger access cost=
        avg dist acc egr car pass*cost per km car pass
        ~       euro/trip
        ~               |

avg walking access costs=
        avg dist walking*cost per km walking
        ~       euro/trip
        ~               |

train cost km(
        [(0,0)-(400,40)],(0,2.1),(7,2.1),(23,4.4),(56,9.3),(77,12.4),(120,17.6),(144,19.4),(\
                193,22.4),(298,24),(400,24))
        ~       euro/trip
        ~       graph describing relation between km and ticket price
        |

cost per km cycling=
        0
        ~       euro/km
        ~               |

train trip cost[traveltype]=
        train cost km(avg train trip distance[traveltype])+station access and egress transport
cost
        ~       euro/trip
        ~               |

avg dist walking=
        0.82
        ~       km/trip
        ~               |

car trip cost[traveltype]=
        avg trip distance[traveltype]*cost per km car+parking costs per trip
        ~       euro/trip
        ~               |

avg cycling access costs=
        avg distance cycling*cost per km cycling
        ~       euro/trip
        ~               |

avg dist acc egr car pass=
        7.94
```

```
        ~       km/trip
        ~               |

avg distance cycling=
        2.72
        ~       km/trip
        ~               |

cost per km car pass=
        0
        ~       euro/km
        ~               |

cost per km walking=
        0
        ~       euro/km
        ~               |

fuel cost per km=
        1.8
        ~       euro/liter
        ~               |

base cost bus tram metro=
        0.8
        ~       euro/trip
        ~               |

bike access ratio=
        0.245
        ~       Dmnl
        ~               |

avg bus tram metro access cost=
        base cost bus tram metro+cost per km bus tram metro*avg dist bus tram metro
        ~       euro/trip
        ~               |

avg car dist driver acc egr=
        7.21
        ~       km/trip
        ~               |

avg car driver access cost=
        avg car dist driver acc egr*cost per km car
        ~       euro/trip
        ~               |

avg dist bus tram metro=
        5.8
        ~       km/trip
        ~               |

traveltype:
        peakshort, peaklong, offpeakshort, offpeaklong
        ~
        ~               |

efficiency car=
        1/15
        ~       liter/km
        ~               |

car access driver ratio=
        0.029
        ~       Dmnl
        ~               |

bus tram metro access ratio=
        0.235
        ~       Dmnl
        ~               |

car acc egr passenger ratio=
        0.038
        ~       Dmnl
        ~               |
```

```
cost per km bus tram metro=
        0.12
        ~       euro/km
        ~               |

avg train scheduled speed[traveltype]=
        GET XLS CONSTANTS('?sens', 'Blad1' , 'B33' )
        ~       km/Hour
        ~       OViN2011 kort: 60, lang: 73 km/h
        |
```