



# OPUS

## *Optimising the use of Partial information in Urban and regional Systems*

**Project IST-2001-32471**

IST Programme

**Title :** **Zurich Case study 1 : Combining travel information  
from multiple sources  
APPENDIX : Model description and results**

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**Deliverable No. :** D9.2a  
**Version :** 1.1

**Date:** Initial version: December 2005  
Revised:

**Dissemination Level :** LI — Limited to programme participants  
**Deliverable Nature :** RE — Report  
**Deliverable Type :** PD — Programme Deliverable

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SYSTEMATICA, WHO.  
MINNERVA, SURVEY AND STATISTICAL  
COMPUTING

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## APPENDIX A

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### A.1.1 Socio model description in BUGS language

---

```
model;
{

/* Parameter distribution definition with random effects (MZ 2000) */
mz.hhincome ~ dnorm(income,income_var)
mz.hh_size ~ dnorm(hhsize,hhsize_var)
mz.age ~ dnorm(age,age_var)
mz.working ~ dnorm(working,working_var)
mz.gender ~ dnorm(gender,gender_var)

for( i in 1 : K ) {
  mz.socio_demo[i] <- mz_hhincome[i] * mz.hhincome + mz_hh_size[i] * mz.hh_size +
mz_age[i] * mz.age + mz_working[i] * mz.working + mz_gender[i] * mz.gender
}

/* Factors influencing travel demand (MZ 2000) */
for( i in 1 : K ) {
  mz_trips[i] <- mz.socio_demo[i]
}

/* Parameter distribution and the relationship definitions (SRM 2001) */
srm.hhead_inc ~ dnorm(income,income_var)
srm.hh_size ~ dnorm(hhsize,hhsize_var)
srm.age ~ dnorm(age,age_var)
srm.working ~ dnorm(working,working_var)
srm.gender ~ dnorm(gender,gender_var)

for( j in 1 : L ) {
  srm_socio_demo[j] <- srm_hhead_inc[j] * srm.hhead_inc + srm_hh_size[j] *
srm.hh_size + srm_age[j] * srm.age + srm_working[j] * srm.working + srm_gender[j] *
srm.gender
}

/* Factors influencing travel demand (SRM 2001) */
for( j in 1 : L ) {
  srm_trips[j] <- (srm_socio_demo[j] )
}

/* Parameter distribution and the relationship definitions (EVE 1998) */
eve.age ~ dnorm(age,age_var)
eve.hh_size ~ dnorm(hhsize,hhsize_var)
```

```
eve.hhincome ~ dnorm(income,income_var)
eve.working ~ dnorm(working,working_var)
eve.gender ~ dnorm(gender,gender_var)

for( k in 1 : M ) {
  eve_socio_demo[k] <- eve_hhincome[k] * eve.hhincome + eve_hh_size[k] *
eve.hh_size + eve_age[k] * eve.age + eve_working[k] * eve.working + eve_gender[k] *
eve.gender
}

/* Factors influencing travel demand (EVE 1998) */
for( k in 1 : M ) {
  eve_trips[k] <- (eve_socio_demo[k])
}

/* Random effect parameters distribution specifications */
trip_var ~ dgamma(0.001,0.001)
income ~ dnorm( 0.0,1.0E-6)
income_var ~ dgamma(0.001,0.001)
hhsz ~ dnorm( 0.0,1.0E-6)
hhsz_var ~ dgamma(0.001,0.001)
age ~ dnorm( 0.0,1.0E-6)
age_var ~ dgamma(0.001,0.001)
working ~ dnorm( 0.0,1.0E-6)
working_var ~ dgamma(0.001,0.001)
gender ~ dnorm( 0.0,1.0E-6)
gender_var ~ dgamma(0.001,0.001)

/* Definition of the travel demand distributions with random effects */
for( i in 1 : K ) {
  mz_trip[i] ~ dnorm(mz_trips[i],trip_var)
}
for( j in 1 : L ) {
  srm_trip[j] ~ dnorm(srm_trips[j],trip_var)
}
for( k in 1 : M ) {
  eve_trip[k] ~ dnorm(eve_trips[k],trip_var)
}
}
```

---

### A.1.2 SoMo model description in BUGS language

```

model;
{

/* Parameter distribution and the relationship definitions of Socio-demographics (MZ
2000) */
mz.hhincome ~ dnorm(income,income_var)
mz.hh_size ~ dnorm(hhsize,hhsize_var)
mz.age ~ dnorm(age,age_var)
mz.working ~ dnorm(working,working_var)
mz.gender ~ dnorm(gender,gender_var)
for( i in 1 : K ) {
    mz.socio_demo[i] <- mz_hhincome[i] * mz.hhincome + mz_hh_size[i] * mz.hh_size +
mz_age[i] * mz.age + mz_working[i] * mz.working + mz_gender[i] * mz.gender
}

/* Parameter distribution and the relationship definitions of Mobility tools ownership (MZ
2000) */
mz.car ~ dnorm(car,car_var)
mz.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( i in 1 : K ) {
    mz_mobility_tools[i] <- mz_car[i] * mz.car + mz_PT_tickets[i] * mz.PT_tickets
}

/* Factor influencing travel demand (MZ 2000) */
for( i in 1 : K ) {
    mz_trips[i] <- mz.socio_demo[i] + mz_mobility_tools[i]
}

/* Parameter distribution and the relationship definitions of Socio-demographics (SRM
2001) */
srm.hhead_inc ~ dnorm(income,income_var)
srm.hh_size ~ dnorm(hhsize,hhsize_var)
srm.age ~ dnorm(age,age_var)
srm.working ~ dnorm(working,working_var)
srm.gender ~ dnorm(gender,gender_var)
for( j in 1 : L ) {
    srm_socio_demo[j] <- srm_hhead_inc[j] * srm.hhead_inc + srm_hh_size[j] *
srm.hh_size + srm_age[j] * srm.age + srm_working[j] * srm.working + srm_gender[j] *
srm.gender
}

/* Parameter distribution and the relationship definitions of Mobility tools ownership
(SRM 2001) */
srm.car ~ dnorm(car,car_var)
srm.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( j in 1 : L ) {
    srm_mobility_tools[j] <- srm_car[j] * srm.car + srm_PT_tickets[j] * srm.PT_tickets
}

```

```

}

/* Factor influencing travel demand (SRM 2001) */
for(j in 1 : L) {
  srm_trips[j] <- srm_socio_demo[j] + srm_mobility_tools[j]
}

/* Parameter distribution and the relationship definitions of Socio-demographics (EVE
1998) */
eve.age ~ dnorm(age,age_var)
eve.hh_size ~ dnorm(hhsize,hhsize_var)
eve.hhincome ~ dnorm(income,income_var)
eve.working ~ dnorm(working,working_var)
eve.gender ~ dnorm(gender,gender_var)
for( k in 1 : M ) {
  eve_socio_demo[k] <- eve_hhincome[k] * eve.hhincome + eve_hh_size[k] *
eve.hh_size + eve_age[k] * eve.age + eve_working[k] * eve.working + eve_gender[k] *
eve.gender
}
/* Parameter distribution and the relationship definitions of Mobility tools ownership
(EVE 1998) */
eve.car ~ dnorm(car,car_var)
eve.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( k in 1 : M ) {
  eve_mobility_tools[k] <- eve_car[k] * eve.car + eve_PT_tickets[k] * eve.PT_tickets
}

/* Factor influencing travel demand (EVE 1998) */
for( k in 1 : M ) {
  eve_trips[k] <- eve_socio_demo[k] + eve_mobility_tools[k]
}

/* Random effect parameters distribution specifications */
trip_var ~ dgamma(0.001,0.001)
income ~ dnorm( 0.0,1.0E-6)
income_var ~ dgamma(0.001,0.001)
hhsize ~ dnorm( 0.0,1.0E-6)
hhsize_var ~ dgamma(0.001,0.001)
age ~ dnorm( 0.0,1.0E-6)
age_var ~ dgamma(0.001,0.001)
working ~ dnorm( 0.0,1.0E-6)
working_var ~ dgamma(0.001,0.001)
gender ~ dnorm( 0.0,1.0E-6)
gender_var ~ dgamma(0.001,0.001)
car ~ dnorm( 0.0,1.0E-6)
car_var ~ dgamma(0.001,0.001)
PT_tickets ~ dnorm( 0.0,1.0E-6)
pt_var ~ dgamma(0.001,0.001)

```

*/\* Definition of the travel demand distributions with random effects \*/*

```
for( i in 1 : K ) {  
  mz_trip[i] ~ dnorm(mz_trips[i], trip_var)  
}  
for( j in 1 : L ) {  
  srm_trip[j] ~ dnorm(srm_trips[j], trip_var)  
}  
for( k in 1 : M ) {  
  eve_trip[k] ~ dnorm(eve_trips[k], trip_var)  
}  
}
```

*/\* Comments\*/*

---

---

### A.1.3 *Wotfc* model description in BUGS language

---

```
model;
{

/* Parameter distribution and the relationship definitions of Socio-demographics (MZ
2000) */
mz.hhincome ~ dnorm(income,income_var)
mz.hh_size ~ dnorm(hhsize,hhsize_var)
mz.age ~ dnorm(age,age_var)
mz.working ~ dnorm(working,working_var)
mz.gender ~ dnorm(gender,gender_var)
for( i in 1 : K ) {
  mz.socio_demo[i] <- mz_hhincome[i] * mz.hhincome + mz_hh_size[i] * mz.hh_size +
mz_age[i] * mz.age + mz_working[i] * mz.working + mz_gender[i] * mz.gender
}

/* Parameter distribution and the relationship definitions of Mobility tools ownership (MZ
2000) */
mz.car ~ dnorm(car,car_var)
mz.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( i in 1 : K ) {
  mz_mobility_tools[i] <- mz_car[i] * mz.car + mz_PT_tickets[i] * mz.PT_tickets
}

/* Parameter distribution and the relationship definitions of Survey characteristics (MZ
2000) */
mz.rep_prd ~ dnorm(rep_prd,rep_prd_var)
mz.per_inf ~ dnorm(per_inf,per_inf_var)
for( i in 1 : K ) {
  mz_survey_cha[i] <- mz_rep_prd[i] * mz.rep_prd + mz_per_inf[i] * mz.per_inf
}

/* Factor influencing travel demand (MZ 2000) */
for( i in 1 : K ) {
  mz_trips[i] <- mz.socio_demo[i] + mz_mobility_tools[i] + mz_survey_cha[i]
}

/* Parameter distribution and the relationship definitions of Socio-demographics (SRM
2001) */
srm.hhead_inc ~ dnorm(income,income_var)
srm.hh_size ~ dnorm(hhsize,hhsize_var)
srm.age ~ dnorm(age,age_var)
srm.working ~ dnorm(working,working_var)
srm.gender ~ dnorm(gender,gender_var)
for( j in 1 : L ) {
  srm_socio_demo[j] <- srm_hhead_inc[j] * srm.hhead_inc + srm_hh_size[j] *
srm.hh_size + srm_age[j] * srm.age + srm_working[j] * srm.working + srm_gender[j] *
srm.gender
}
```

}

*/\* Parameter distribution and the relationship definitions of Mobility tools ownership (SRM 2001) \*/*

```
srm.car ~ dnorm(car,car_var)
srm.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( j in 1 : L ) {
  srm_mobility_tools[j] <- srm_car[j] * srm.car + srm_PT_tickets[j] * srm.PT_tickets
}
```

*/\* Parameter distribution and the relationship definitions of Survey characteristics (SRM 2001) \*/*

```
srm.rep_prd ~ dnorm(rep_prd,rep_prd_var)
srm.per_inf ~ dnorm(per_inf,per_inf_var)
for( j in 1 : L ) {
  srm_survey_cha[j] <- srm_rep_prd[j] * srm.rep_prd + srm_per_inf[j] * srm.per_inf
}
```

*/\* Factor influencing travel demand (SRM 2001) \*/*

```
for( j in 1 : L ) {
  srm_trips[j] <- srm_socio_demo[j] + srm_mobility_tools[j] + srm_survey_cha[j]
}
```

*/\* Parameter distribution and the relationship definitions of Socio-demographics (EVE 1998) \*/*

```
eve.age ~ dnorm(age,age_var)
eve.hh_size ~ dnorm(hhsize,hhsize_var)
eve.hhincome ~ dnorm(income,income_var)
eve.working ~ dnorm(working,working_var)
eve.gender ~ dnorm(gender,gender_var)
for( k in 1 : M ) {
  eve_socio_demo[k] <- eve_hhincome[k] * eve.hhincome + eve_hh_size[k] *
eve.hh_size + eve_age[k] * eve.age + eve_working[k] * eve.working + eve_gender[k] *
eve.gender
}
```

*/\* Parameter distribution and the relationship definitions of Mobility tools ownership (EVE 1998) \*/*

```
eve.car ~ dnorm(car,car_var)
eve.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( k in 1 : M ) {
  eve_mobility_tools[k] <- eve_car[k] * eve.car + eve_PT_tickets[k] * eve.PT_tickets
}
```

*/\* Parameter distribution and the relationship definitions of Survey characteristics (EVE 1998) \*/*

```
eve.rep_prd ~ dnorm(rep_prd,rep_prd_var)
eve.per_inf ~ dnorm(per_inf,per_inf_var)
for( k in 1 : M ) {
```

```
eve_survey_cha[k] <- eve_rep_prd[k] * eve.rep_prd + eve_per_inf[k] * eve.per_inf
}

/* Factor influencing travel demand (EVE 1998) */
for( k in 1 : M ) {
  eve_trips[k] <- eve_socio_demo[k] + eve_mobility_tools[k] + eve_survey_cha[k]
}

/* Random effect parameters distribution specifications */
trip_var ~ dgamma(0.001,0.001)
income ~ dnorm( 0.0,1.0E-6)
income_var ~ dgamma(0.001,0.001)
hhszsize ~ dnorm( 0.0,1.0E-6)
hhszsize_var ~ dgamma(0.001,0.001)
age ~ dnorm( 0.0,1.0E-6)
age_var ~ dgamma(0.001,0.001)
working ~ dnorm( 0.0,1.0E-6)
working_var ~ dgamma(0.001,0.001)
gender ~ dnorm( 0.0,1.0E-6)
gender_var ~ dgamma(0.001,0.001)
car ~ dnorm( 0.0,1.0E-6)
car_var ~ dgamma(0.001,0.001)
PT_tickets ~ dnorm( 0.0,1.0E-6)
pt_var ~ dgamma(0.001,0.001)
rep_prd ~ dnorm( 0.0,1.0E-6)
per_inf ~ dnorm( 0.0,1.0E-6)
rep_prd_var ~ dgamma(0.001,0.001)
per_inf_var ~ dgamma(0.001,0.001)

/* Definition of the travel demand distributions with random effects */
for( i in 1 : K ) {
  mz_trip[i] ~ dnorm(mz_trips[i], trip_var)
}
for( j in 1 : L ) {
  srm_trip[j] ~ dnorm(srm_trips[j], trip_var)
}
for( k in 1 : M ) {
  eve_trip[k] ~ dnorm(eve_trips[k], trip_var)
}
}
```

---

---

#### A.1.4 Complete model description in BUGS language

---

```
model;
{

/* Parameter distribution and the relationship definitions of Socio-demographics (MZ
2000) */
mz.hhincome ~ dnorm(income,income_var)
mz.hh_size ~ dnorm(hhsize,hhsize_var)
mz.age ~ dnorm(age,age_var)
mz.working ~ dnorm(working,working_var)
mz.gender ~ dnorm(gender,gender_var)
for( i in 1 : K ) {
  mz.socio_demo[i] <- mz_hhincome[i] * mz.hhincome + mz_hh_size[i] * mz.hh_size +
mz_age[i] * mz.age + mz_working[i] * mz.working + mz_gender[i] * mz.gender
}

/* Parameter distribution and the relationship definitions of Mobility tools ownership (MZ
2000) */
mz.car ~ dnorm(car,car_var)
mz.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( i in 1 : K ) {
  mz_mobility_tools[i] <- mz_car[i] * mz.car + mz_PT_tickets[i] * mz.PT_tickets
}

/* Parameter distribution and the relationship definitions of Survey characteristics (MZ
2000) */
mz.rep_prd ~ dnorm(rep_prd,rep_prd_var)
mz.per_inf ~ dnorm(per_inf,per_inf_var)
for( i in 1 : K ) {
  mz_survey_cha[i] <- mz_rep_prd[i] * mz.rep_prd + mz_per_inf[i] * mz.per_inf
}

/*Parameter distribution definition of Land-use (MZ 2000) */
mz.tfc ~ dnorm(tfc, tfc_var)

/* Factor influencing travel demand (MZ 2000) */
for( i in 1 : K ) {
  mz_trips[i] <- mz.socio_demo[i] + mz_mobility_tools[i] + mz_survey_cha[i] +
mz_tfc[i] * mz.tfc
}

/* Parameter distribution and the relationship definitions of Socio-demographics (SRM
2001) */
srm.hhead_inc ~ dnorm(income,income_var)
srm.hh_size ~ dnorm(hhsize,hhsize_var)
srm.age ~ dnorm(age,age_var)
srm.working ~ dnorm(working,working_var)
srm.gender ~ dnorm(gender,gender_var)
```

```

for(j in 1 : L ) {
  srm_socio_demo[j] <- srm_hhead_inc[j] * srm.hhead_inc + srm_hh_size[j] *
srm.hh_size + srm_age[j] * srm.age + srm_working[j] * srm.working + srm_gender[j] *
srm.gender
}

```

*/\* Parameter distribution and the relationship definitions of Mobility tools ownership (SRM 2001) \*/*

```

srm.car ~ dnorm(car,car_var)
srm.PT_tickets ~ dnorm(PT_tickets,pt_var)
for(j in 1 : L ) {
  srm_mobility_tools[j] <- srm_car[j] * srm.car + srm_PT_tickets[j] * srm.PT_tickets
}

```

*/\* Parameter distribution and the relationship definitions of Survey characteristics (SRM 2001) \*/*

```

srm.rep_prd ~ dnorm(rep_prd,rep_prd_var)
srm.per_inf ~ dnorm(per_inf,per_inf_var)
for(j in 1 : L ) {
  srm_survey_cha[j] <- srm_rep_prd[j] * srm.rep_prd + srm_per_inf[j] * srm.per_inf
}

```

*/\*Parameter distribution definition of Land-use (SRM 2001) \*/*

```

srm.tfc ~ dnorm(tfc, tfc_var)

```

*/\* Factor influencing travel demand (SRM 2001) \*/*

```

for(j in 1 : L ) {
  srm_trips[j] <- srm_socio_demo[j] + srm_mobility_tools[j] + srm_survey_cha[j] +
srm_tfc[j] * srm.tfc
}

```

*/\* Parameter distribution and the relationship definitions of Socio-demographics (EVE 1998) \*/*

```

eve.age ~ dnorm(age,age_var)
eve.hh_size ~ dnorm(hhsize,hhsize_var)
eve.hhincome ~ dnorm(income,income_var)
eve.working ~ dnorm(working,working_var)
eve.gender ~ dnorm(gender,gender_var)
for( k in 1 : M ) {
  eve_socio_demo[k] <- eve_hhincome[k] * eve.hhincome + eve_hh_size[k] *
eve.hh_size + eve_age[k] * eve.age + eve_working[k] * eve.working + eve_gender[k] *
eve.gender
}

```

*/\* Parameter distribution and the relationship definitions of Mobility tools ownership (EVE 1998) \*/*

```

eve.car ~ dnorm(car,car_var)
eve.PT_tickets ~ dnorm(PT_tickets,pt_var)
for( k in 1 : M ) {

```

```

eve_mobility_tools[k] <- eve_car[k] * eve.car + eve_PT_tickets[k] * eve.PT_tickets
}

/* Parameter distribution and the relationship definitions of Survey characteristics (EVE
1998) */
eve.rep_prd ~ dnorm(rep_prd,rep_prd_var)
eve.per_inf ~ dnorm(per_inf,per_inf_var)
for( k in 1 : M ) {
  eve_survey_cha[k] <- eve_rep_prd[k] * eve.rep_prd + eve_per_inf[k] * eve.per_inf
}

/*Parameter distribution definition of Land-use (EVE 1998) */
eve.tfc ~ dnorm(tfc, tfc_var)

/* Factor influencing travel demand (EVE 1998) */
for( k in 1 : M ) {
  eve_trips[k] <- eve_socio_demo[k] + eve_mobility_tools[k] + eve_survey_cha[k] +
eve_tfc[k] * eve.tfc
}

/* Random effect parameters distribution specifications */
trip_var ~ dgamma(0.001,0.001)
income ~ dnorm( 0.0,1.0E-6)
income_var ~ dgamma(0.001,0.001)
hhsz ~ dnorm( 0.0,1.0E-6)
hhsz_var ~ dgamma(0.001,0.001)
age ~ dnorm( 0.0,1.0E-6)
age_var ~ dgamma(0.001,0.001)
working ~ dnorm( 0.0,1.0E-6)
working_var ~ dgamma(0.001,0.001)
gender ~ dnorm( 0.0,1.0E-6)
gender_var ~ dgamma(0.001,0.001)
car ~ dnorm( 0.0,1.0E-6)
car_var ~ dgamma(0.001,0.001)
PT_tickets ~ dnorm( 0.0,1.0E-6)
pt_var ~ dgamma(0.001,0.001)
rep_prd ~ dnorm( 0.0,1.0E-6)
per_inf ~ dnorm( 0.0,1.0E-6)
rep_prd_var ~ dgamma(0.001,0.001)
per_inf_var ~ dgamma(0.001,0.001)
tfc ~ dnorm(0.0, 1.0E-6)
tfc_var ~ dgamma(0.001,0.001)

/* Definition of the travel demand distributions with random effects */
for( i in 1 : K ) {
  mz_trip[i] ~ dnorm(mz_trips[i], trip_var)
}
for( j in 1 : L ) {
  srm_trip[j] ~ dnorm(srm_trips[j], trip_var)
}

```

```
for( k in 1 : M ) {  
  eve_trip[k] ~ dnorm(eve_trips[k], trip_var)  
}  
}
```

---

A.3.1 Summary statistics of *Stage II* model (*So-Mo*) posterior distribution sample

Parameter	Mean	Std. Dev	MC error	Start	Sample
<b>MZ 2000</b>					
mz.age	0.001474	0.004925	1.19E-05	1000	999001
mz.gender	0.007209	0.01717	2.65E-05	1000	999001
mz.hh_size	0.005508	0.005525	1.44E-05	1000	999001
mz.hhincome	0.001864	0.005261	1.56E-05	1000	999001
mz.working	-0.00623	0.02136	4.24E-05	1000	999001
mz.PT_tickets	0.008637	0.02995	4.26E-05	1000	999001
mz.car	0.01665	0.02329	5.71E-05	1000	999001
<b>SRM 2001</b>					
srm.age	0.639	0.01479	4.33E-05	1000	999001
srm.gender	-0.01083	0.03837	6.39E-05	1000	999001
srm.hh_size	0.1104	0.01308	3.81E-05	1000	999001
srm.hhead_inc	0.09541	0.007792	2.40E-05	1000	999001
srm.working	-0.6444	0.04642	8.06E-05	1000	999001
srm.PT_tickets	0.9644	0.07242	1.16E-04	1000	999001
srm.car	-0.3932	0.06035	1.76E-04	1000	999001
<b>EVE 1998</b>					
eve.age	0.0311	0.01402	3.89E-05	1000	999001
eve.gender	0.08586	0.04556	8.90E-05	1000	999001
eve.hh_size	0.02903	0.01623	4.30E-05	1000	999001
eve.hhincome	0.01876	0.01239	4.19E-05	1000	999001
eve.working	-0.09468	0.05097	1.05E-04	1000	999001
eve.PT_tickets	1.046	0.08348	1.04E-04	1000	999001
eve.car	0.06503	0.06036	1.35E-04	1000	999001
<b>Joint</b>					
age	0.224	0.7495	7.88E-04	1000	999001
gender	0.02754	0.174	2.16E-04	1000	999001
hhszise	0.04841	0.1546	1.56E-04	1000	999001
income	0.03851	0.1348	1.67E-04	1000	999001
working	-0.2477	0.6868	6.94E-04	1000	999001
PT_tickets	0.6715	1.607	0.001134	1000	999001
car	-0.1041	0.6666	6.34E-04	1000	999001



A.3.2 Summary statistics of *Stage III* model (*Wotfc*) posterior distribution sample

Parameter	Mean	Std. Dev	MC error	Start	Sample
<b>MZ 2000</b>					
mz.age	0.001809	0.008058	1.03E-04	1000	999001
mz.gender	0.006272	0.01765	6.62E-05	1000	999001
mz.hh_size	0.005247	0.0071	7.45E-05	1000	999001
mz.hhincome	0.002252	0.005409	3.72E-05	1000	999001
mz.working	-0.00569	0.0215	1.10E-04	1000	999001
mz.PT_tickets	0.008585	0.03	1.02E-04	1000	999001
mz.car	0.01605	0.02377	1.46E-04	1000	999001
mz.per_inf	-7.636	18.18	0.8488	1000	999001
mz.rep_prd	0.1513	0.3677	0.01713	1000	999001
<b>SRM 2001</b>					
srm.age	0.4212	0.3063	4.59E-04	1000	999001
srm.gender	-0.05748	0.2184	3.72E-04	1000	999001
srm.hh_size	-0.08563	0.2364	2.98E-04	1000	999001
srm.hhead_inc	0.04483	0.06142	2.80E-04	1000	999001
srm.working	-0.6378	0.2614	0.002265	1000	999001
srm.PT_tickets	0.9353	0.2492	0.002504	1000	999001
srm.car	-0.2714	0.08341	4.85E-04	1000	999001
srm.per_inf	-2.624	2.114	0.04125	1000	999001
srm.rep_prd	0.008965	0.005331	5.93E-05	1000	999001
<b>EVE 1998</b>					
eve.age	0.03287	0.0359	5.20E-04	1000	999001
eve.gender	0.09074	0.04729	2.33E-04	1000	999001
eve.hh_size	0.02616	0.02016	2.10E-04	1000	999001
eve.hhincome	0.01954	0.01456	1.39E-04	1000	999001
eve.working	-0.09439	0.05493	4.54E-04	1000	999001
eve.PT_tickets	1.045	0.08319	2.48E-04	1000	999001
eve.car	0.06361	0.06155	3.99E-04	1000	999001
eve.per_inf	-16.44	24.32	1.15	1000	999001
eve.rep_prd	0.1958	0.2904	0.01373	1000	999001

Joint

age	0.1504	0.4532	8.91E-04	1000	999001
gender	0.01225	0.3129	4.59E-04	1000	999001
hhsz	-0.01789	0.1743	3.03E-04	1000	999001
income	0.02224	0.08221	2.22E-04	1000	999001
working	-0.2473	0.5935	0.001486	1000	999001
PT_tickets	0.6621	0.9489	0.002169	1000	999001
car	-0.06392	0.3469	8.48E-04	1000	999001
per_inf	-8.91	28.08	0.6103	1000	999001
rep_prd	0.1179	0.4227	0.009313	1000	999001

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A.3.3 Summary statistics of *Stage IV* model (*Full*) posterior distribution sample

Parameter	Mean	Std. Dev	MC error	Start	Sample
<b>MZ 2000</b>					
mz.age	0.0017	0.00788	4.69E-05	1000	999001
mz.gender	0.006219	0.01697	2.69E-05	1000	999001
mz.hh_size	0.003765	0.00714	3.20E-05	1000	999001
mz.hhincome	0.00252	0.0053	1.72E-05	1000	999001
mz.working	-0.00521	0.02125	5.00E-05	1000	999001
mz.PT_tickets	0.01252	0.0299	5.07E-05	1000	999001
mz.car	0.01367	0.02312	6.43E-05	1000	999001
mz.per_inf	-12.23	26.41	0.8266	1000	999001
mz.rep_prd	0.229	0.5311	0.01661	1000	999001
mz.tfc	0.00538	0.005704	1.98E-05	1000	999001
<b>SRM 2001</b>					
srm.age	0.428	0.02222	1.60E-04	1000	999001
srm.gender	-0.05566	0.04052	7.54E-05	1000	999001
srm.hh_size	-0.09416	0.02	1.28E-04	1000	999001
srm.hhead_inc	0.04795	0.0083	3.67E-05	1000	999001
srm.working	-0.6409	0.04562	8.42E-05	1000	999001
srm.PT_tickets	0.9546	0.07148	1.24E-04	1000	999001
srm.car	-0.293	0.06075	2.06E-04	1000	999001
srm.per_inf	-3.113	0.3643	0.003712	1000	999001
srm.rep_prd	0.009056	2.41E-04	1.53E-06	1000	999001
srm.tfc	0.04941	0.01482	7.77E-05	1000	999001
<b>EVE 1998</b>					
eve.age	0.03077	0.02633	1.83E-04	1000	999001
eve.gender	0.0917	0.04601	9.26E-05	1000	999001
eve.hh_size	0.02176	0.01872	7.96E-05	1000	999001
eve.hhincome	0.0204	0.01225	3.89E-05	1000	999001
eve.working	-0.09477	0.05427	1.93E-04	1000	999001
eve.PT_tickets	1.05	0.08239	1.07E-04	1000	999001
eve.car	0.04868	0.06223	1.63E-04	1000	999001
eve.per_inf	-24.42	40.25	1.272	1000	999001

eve.rep_prd	0.2883	0.4802	0.01518	1000	999001
eve.tfc	0.01706	0.01456	4.61E-05	1000	999001
Joint					
age	0.1536	0.4534	4.87E-04	1000	999001
gender	0.01403	0.1713	1.75E-04	1000	999001
hhsz	-0.02324	0.1467	1.59E-04	1000	999001
income	0.02356	0.1017	1.26E-04	1000	999001
working	-0.2473	0.6387	6.47E-04	1000	999001
PT_tickets	0.6733	1.607	0.001439	1000	999001
car	-0.07651	0.4301	4.22E-04	1000	999001
per_inf	-13.18	40.49	0.6401	1000	999001
rep_prd	0.1751	0.9796	0.009648	1000	999001
tfc	0.02388	0.09648	1.13E-04	1000	999001

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A.4.1 Correlation matrix of the *Stage II* model

	age	gender	hhsz	income	working	PT_tickets	cars
<b>EVE 1998</b>							
age	1	-0.1761	-0.1471	-0.3808	0.0190	-0.2253	-0.2913
gender	-0.1761	1	-0.1041	0.0251	-0.3608	0.0220	0.0122
hhsz	-0.1471	-0.1041	1	-0.5281	0.0962	0.0328	-0.0609
income	-0.3808	0.0251	-0.5281	1	-0.2847	-0.0551	-0.2290
working	0.0190	-0.3608	0.0962	-0.2847	1	0.0041	-0.2424
PT_tickets	-0.2253	0.0220	0.0328	-0.0551	0.0041	1	0.1629
cars	-0.2913	0.0122	-0.0609	-0.2290	-0.2424	0.1629	1
<b>MZ 2000</b>							
age	1	-0.0840	-0.0600	-0.2671	0.0965	-0.2546	-0.5114
gender	-0.0840	1	-0.1768	-0.0407	-0.2448	-0.0023	-0.0436
hhsz	-0.0600	-0.1768	1	-0.6248	0.1186	-0.0351	0.0070
income	-0.2671	-0.0407	-0.6248	1	-0.2511	-0.1081	-0.1582
working	0.0965	-0.2448	0.1186	-0.2511	1	-0.0948	-0.3908
PT_tickets	-0.2546	-0.0023	-0.0351	-0.1081	-0.0948	1	0.2753
cars	-0.5114	-0.0436	0.0070	-0.1582	-0.3908	0.2753	1
<b>SRM 2001</b>							
age	1	-0.0701	-0.0731	-0.2138	0.0415	-0.3174	-0.6401
gender	-0.0701	1	-0.2140	-0.0519	-0.1818	0.0108	-0.0079
hhsz	-0.0731	-0.2140	1	-0.6613	0.0753	-0.0003	0.0477
income	-0.2138	-0.0519	-0.6613	1	-0.1607	-0.1343	-0.1376
working	0.0415	-0.1818	0.0753	-0.1607	1	-0.0514	-0.3310
PT_tickets	-0.3174	0.0108	-0.0003	-0.1343	-0.0514	1	0.2279
cars	-0.6401	-0.0079	0.0477	-0.1376	-0.3310	0.2279	1.0000
<b>Joint</b>							
age	1	-0.0006	0.0002	0.0002	0.0002	0.0014	-0.0005
gender	-0.0006	1	-0.0011	0.0003	-0.0013	0.0004	0.0007
hhsz	0.0002	-0.0011	1	-0.0013	0.0005	-0.0002	0.0000
income	0.0002	0.0003	-0.0013	1	-0.0016	0.0013	-0.0006
working	0.0002	-0.0013	0.0005	-0.0016	1	-0.0001	-0.0016

PT_tickets	0.0014	0.0004	-0.0002	0.0013	-0.0001	1	0.0001
car	-0.0005	0.0007	0.0000	-0.0006	-0.0016	0.0001	1

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A.4.2 Correlation matrix of the posterior distributions of *Stage III* model

	Age	Gender	Hhsize	Income	Working	PTT*	Car	Per_inf	Rep_prd
EVE 1998									
Age	1	0.2071	0.5097	0.4973	-0.6427	0.8849	-0.0998	0.1532	-0.1673
Gender	0.2071	1	0.0793	0.0820	-0.3192	0.2669	-0.0820	0.0718	-0.0784
Hhsize	0.5097	0.0793	1	0.1746	-0.3876	0.6309	-0.0983	0.0972	-0.1062
Income	0.4973	0.0820	0.1746	1	-0.4464	0.6604	-0.1115	0.0989	-0.1080
Working	-0.6427	-0.3192	-0.3876	-0.4464	1	-0.6278	-0.1097	-0.1522	0.1662
PTT*	0.8849	0.2669	0.6309	0.6604	-0.6278	1	0.0476	0.1534	-0.1675
Car	-0.0998	-0.0820	-0.0983	-0.1115	-0.1097	0.0476	1	0.0049	-0.0054
Per_inf	0.1532	0.0718	0.0972	0.0989	-0.1522	0.1534	0.0049	1	-0.9934
Rep_prd	-0.1673	-0.0784	-0.1062	-0.1080	0.1662	-0.1675	-0.0054	-0.9934	1
MZ 2000									
Age	1	0.0865	0.2041	0.1715	-0.3124	0.0915	-0.0489	0.1364	-0.1459
Gender	0.0865	1	-0.0042	0.0003	-0.1061	0.0262	-0.0364	0.0420	-0.0449
Hhsize	0.2041	-0.0042	1	0.0250	-0.1227	0.0458	-0.0500	0.0570	-0.0611
Income	0.1715	0.0003	0.0250	1	-0.1139	0.0353	-0.0423	0.0482	-0.0516
Working	-0.3124	-0.1061	-0.1227	-0.1139	1	-0.0515	-0.0578	-0.1018	0.1090
PTT*	0.0915	0.0262	0.0458	0.0353	-0.0515	1	0.0814	0.0252	-0.0269
Car	-0.0489	-0.0364	-0.0500	-0.0423	-0.0578	0.0814	1	0.0060	-0.0064

Per_inf	0.1364	0.0420	0.0570	0.0482	-0.1018	0.0252	0.0060	1	-0.9953
Rep_prd	-0.1459	-0.0449	-0.0611	-0.0516	0.1090	-0.0269	-0.0064	-0.9953	1
SRM 2001									
Age	1	-0.2057	0.9801	0.9875	-0.9918	0.9851	-0.9675	0.1496	-0.1857
Gender	-0.2057	1	-0.2418	-0.2104	0.1788	-0.1982	0.1895	-0.0366	0.0455
Hhsize	0.9801	-0.2418	1	0.9532	-0.9725	0.9694	-0.9401	0.1466	-0.1820
Income	0.9875	-0.2104	0.9532	1	-0.9853	0.9749	-0.9562	0.1489	-0.1849
Working	-0.9918	0.1788	-0.9725	-0.9853	1	-0.9818	0.9438	-0.1495	0.1857
PTT*	0.9851	-0.1982	0.9694	0.9749	-0.9818	1	-0.9399	0.1476	-0.1834
Car	-0.9675	0.1895	-0.9401	-0.9562	0.9438	-0.9399	1	-0.1440	0.1788
Per_inf	0.1496	-0.0366	0.1466	0.1489	-0.1495	0.1476	-0.1440	1	-0.8503
Rep_prd	-0.1857	0.0455	-0.1820	-0.1849	0.1857	-0.1834	0.1788	-0.8503	1
Joint									
Age	1	0.0574	0.3660	0.3722	-0.5909	-0.0642	-0.2704	0.1307	-0.0811
Gender	0.0574	1	0.0090	0.0120	-0.1078	0.0012	-0.0484	0.0363	-0.0229
Hhsize	0.3660	0.0090	1	0.1611	-0.3111	-0.0402	-0.1595	0.0746	-0.0464
Income	0.3722	0.0120	0.1611	1	-0.3373	-0.0384	-0.1723	0.0738	-0.0454
Working	-0.5909	-0.1078	-0.3111	-0.3373	1	0.0425	0.0137	-0.1268	0.0782
PTT*	-0.0642	0.0012	-0.0402	-0.0384	0.0425	1	0.0254	0.0252	-0.0157
Car	-0.2704	-0.0484	-0.1595	-0.1723	0.0137	0.0254	1	-0.0322	0.0189
Per_inf	0.1307	0.0363	0.0746	0.0738	-0.1268	0.0252	-0.0322	1	-0.3614

Rep\_prd     -0.0811    -0.0229    -0.0464    -0.0454    0.0782    -0.0157    0.0189    -0.3614    1

PTT\*: PT\_tickets

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A.4.3 Correlation matrix of the posterior distributions of *Stage IV* model

	Age	Gender	Hhsize	Income	Working	PTT*	Car	per_inf	repprd	Rep_prd
EVE 1998										
Age	1	-0.1387	0.3525	-0.0485	0.3359	-0.0450	0.0882	0.0039	-0.0201	-0.1018
Gender	-0.1387	1	-0.1206	0.0172	-0.3596	0.0165	-0.0057	0.0022	-0.0012	0.0205
Hhsize	0.3525	-0.1206	1	-0.3690	0.2607	0.0625	0.1137	0.0035	-0.0120	-0.2132
Income	-0.0485	0.0172	-0.3690	1	-0.1905	-0.0362	-0.1726	-0.0013	-0.0022	0.0309
Working	0.3359	-0.3596	0.2607	-0.1905	1	0.0401	-0.1139	-0.0002	-0.0073	-0.0124
PTT*	-0.0450	0.0165	0.0625	-0.0362	0.0401	1	0.1637	0.0022	-0.0041	0.0452
Car	0.0882	-0.0057	0.1137	-0.1726	-0.1139	0.1637	1	0.0061	-0.0100	-0.2219
Per_inf	0.0039	0.0022	0.0035	-0.0013	-0.0002	0.0022	0.0061	1	-0.9988	0.0034
Rep_prd	-0.0201	-0.0012	-0.0120	-0.0022	-0.0073	-0.0041	-0.0100	-0.9988	1	-0.0072
Tfc	-0.1018	0.0205	-0.2132	0.0309	-0.0124	0.0452	-0.2219	0.0034	-0.0072	1
MZ 2000										
Age	1	0.0205	0.4658	0.0261	0.1771	-0.0562	-0.3707	0.0227	-0.0808	-0.0434
Gender	0.0205	1	-0.0771	-0.0164	-0.2258	0.0075	-0.0514	0.0027	-0.0092	-0.0119
Hhsize	0.4658	-0.0771	1	-0.3163	0.1735	0.0222	-0.0217	0.0157	-0.0558	-0.2309
Income	0.0261	-0.0164	-0.3163	1	-0.2051	-0.0637	-0.1715	0.0067	-0.0258	0.0394
Working	0.1771	-0.2258	0.1735	-0.2051	1	-0.0699	-0.3998	0.0033	-0.0153	0.0285
PTT*	-0.0562	0.0075	0.0222	-0.0637	-0.0699	1	0.2450	0.0074	-0.0208	0.1342

Car	-0.3707	-0.0514	-0.0217	-0.1715	-0.3998	0.2450	1	-0.0007	0.0095	-0.1066
Per_inf	0.0227	0.0027	0.0157	0.0067	0.0033	0.0074	-0.0007	1	-0.9968	0.0080
Rep_prd	-0.0808	-0.0092	-0.0558	-0.0258	-0.0153	-0.0208	0.0095	-0.9968	1	-0.0340
Tfc	-0.0434	-0.0119	-0.2309	0.0394	0.0285	0.1342	-0.1066	0.0080	-0.0340	1
SRM 2001										
Age	1	0.0132	0.5242	0.1844	0.0412	-0.1695	-0.5170	-0.6197	0.0220	0.0930
Gender	0.0132	1	-0.0861	-0.0185	-0.1923	0.0178	-0.0213	-0.0670	0.0005	0.0131
Hhsize	0.5242	-0.0861	1	-0.0939	0.0609	0.0197	-0.0446	-0.5280	-0.0271	-0.1215
Income	0.1844	-0.0185	-0.0939	1	-0.1370	-0.0964	-0.1838	-0.3477	0.0132	0.1009
Working	0.0412	-0.1923	0.0609	-0.1370	1	-0.0527	-0.3277	-0.0099	0.0005	-0.0045
PTT*	-0.1695	0.0178	0.0197	-0.0964	-0.0527	1	0.2116	-0.0750	0.0195	0.0939
Car	-0.5170	-0.0213	-0.0446	-0.1838	-0.3277	0.2116	1	0.1329	-0.0084	-0.1089
Per_inf	-0.6197	-0.0670	-0.5280	-0.3477	-0.0099	-0.0750	0.1329	1	-0.5348	-0.4432
Rep_prd	0.0220	0.0005	-0.0271	0.0132	0.0005	0.0195	-0.0084	-0.5348	1	0.1905
Tfc	0.0930	0.0131	-0.1215	0.1009	-0.0045	0.0939	-0.1089	-0.4432	0.1905	1
Joint										
Age	1	0.0001	0.0015	0.0000	0.0015	0.0011	0.0009	-0.0005	0.0008	0.0012
Gender	0.0001	1	0.0003	0.0010	-0.0017	-0.0001	0.0001	0.0004	-0.0001	-0.0005
Hhsize	0.0015	0.0003	1	-0.0009	0.0008	0.0006	-0.0013	0.0009	-0.0014	0.0000
Income	0.0000	0.0010	-0.0009	1	-0.0015	0.0000	-0.0032	-0.0012	0.0034	-0.0002
Working	0.0015	-0.0017	0.0008	-0.0015	1	0.0004	-0.0003	0.0008	-0.0016	0.0010

PTT*	0.0011	-0.0001	0.0006	0.0000	0.0004	1	0.0001	0.0038	-0.0009	-0.0013
Car	0.0009	0.0001	-0.0013	-0.0032	-0.0003	0.0001	1	0.0003	-0.0006	-0.0006
Per_inf	-0.0005	0.0004	0.0009	-0.0012	0.0008	0.0038	0.0003	1	-0.1579	0.0005
Rep_prd	0.0008	-0.0001	-0.0014	0.0034	-0.0016	-0.0009	-0.0006	-0.1579	1	0.0001
Tfc	0.0012	-0.0005	0.0000	-0.0002	0.0010	-0.0013	-0.0006	0.0005	0.0001	1

PTT\* : PT\_tickets