APPENDIX B

R CODE FOR ANALYSES

This appendix contains the R code for running the analyses presented in the book. I strongly recommend running these analyses in R Studio. In R Studio, it is particularly useful to create an R project in a convenient folder. Data and R codes should be copied to this folder. This makes it easier to keep track of files and their location.

Chapter 8

Item analysis for TIMSS Booklet 1:

```
## load packages
library(psych)
library(readxl)
## TIMSS 2003 Math Book 1 (US data, dichotomous example)
## Response Data
bk1 <- read_excel("TIMMS 2003 Math data.xlsx",sheet = "book 1")
names(bk1)
str(bk1)

## Extract Test Items
resp_bk1 <- bk1[-1:-3]
dim(resp_bk1)

##use score.multiple.choice function from psych package
bk1key <- c(1,3,4,4,2,3,2,3,3,2,4,5,1,3,1,4,1,2,2,3)
bk1scored <- score.multiple.choice(bk1key,resp_bk1,score=FALSE)

#sink function directs output to a text file.
sink("book1 item analysis.txt", append=TRUE)

## descriptive statistics (using psych package)
describe(bk1scored)
```

```
## item analysis & reliability analysis (using psych package)
psych::alpha(bk1scored)

sink() # return output to console
```

Item analysis of political viewpoint data:

```
## load packages
library(psych)
library(readxl)
## CIRP poliview data 1999
## Response Data
poliview <- read_excel(path = "political viewpoint data.xlsx", sheet = "poliview")
poliview <- as.data.frame(poliview)

## Extract Test Items
resp_pol <- poliview[,2:19]
dim(resp_pol)

##use reverse.code function from psych package
polikey <- c(1,-1,-1,-1,-1,1,1,-1,-1,1,1,1,-1,-1,1,1,1,-1)
poliscored <- reverse.code(polikey,resp_pol,mini=rep(1,18),maxi=rep(4,18))
str(poliscored)
head(poliscored)

#sink function directs output to a text file.
sink("poliview item analysis.txt", append=TRUE)

## descriptive statistics (using psych package)
describe(poliscored)
## item analysis & reliability analysis (using psych package)
psych::alpha(poliscored)
sink() # return output to console
```

Chapter 10

DIF/SIBTEST analysis for TIMSS Booklet 1:

```
## load packages
library(psych)
library(readxl)
library(mirt)
bk1 <- read_excel("TIMMS 2003 Math data.xlsx",sheet = "book 1")
names(bk1)
str(bk1)
```

```
## Extract Test Items
resp_bk1 <- bk1[-1:-3]
dim(resp_bk1)

##use score.multiple.choice function from psych package
bk1key <- c(1,3,4,4,2,3,2,3,3,2,4,5,1,3,1,4,1,2,2,3)
bk1scored <- score.multiple.choice(bk1key,resp_bk1,score=FALSE)

## combine sex and scored item responses
bk1combo <- data.frame(bk1$ITSEX,bk1scored)
dim(bk1combo)

## descriptive statistics (using psych package)
describe(bk1combo)

#sink function directs output to a text file.
sink("dif of timss booklet 1 w difr & mirt.txt", append=TRUE)

## Mantel-Haenszel
results_bk1_MH <- difMH(bk1combo[,2:21],group=bk1$ITSEX,focal.name=1)
results_bk1_MH

## MH with purification
results_bk1_MH_pure <- difMH(bk1combo[,2:21],group=bk1$ITSEX,focal.name=1,
purify=TRUE)
results_bk1_MH_pure

## running SIBTEST from mirt package

#DIF (all other items as anchors)
SIBTEST(bk1scored, bk1$ITSEX, suspect_set = 1, focal_name='1')
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',2)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',3)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',4)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',5)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',6)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',7)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',8)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',9)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',10)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',11)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',12)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',13)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',14)
```

```
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',15)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',16)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',17)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',18)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',19)
SIBTEST(bk1scored, bk1$ITSEX, focal_name='1',20)

##purified
#DIF purification: matched is a vector of non-DIF items
matched <- c(2,3,5,7:10,13:16,18)

SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',1)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',4)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',6)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',11)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',12)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',17)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',19)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',20)

#DBF: differential bundle functioning: example for algebra
suspect_alg <- c(2, 10, 19, 20)

SIBTEST(bk1scored, bk1$ITSEX, suspect_set=suspect_alg, focal_name='1')

#example for reasoning
suspect_reas <- c(7, 17, 19)

SIBTEST(bk1scored, bk1$ITSEX, suspect_set=suspect_reas, focal_name='1')

#purify dbf
matched_alg <- c(3,5,8:9,13:16,18)

SIBTEST(bk1scored, bk1$ITSEX, match_set = matched_alg, suspect_set=suspect_
alg, focal_name='1')

#example for reasoning
matched_reas <- c(2,3,5,8:10,13:16,18)

SIBTEST(bk1scored, bk1$ITSEX, match_set = matched_reas, suspect_set=suspect_
reas, focal_name='1',)

#DIF purification of crossing SIBTEST: matched is a vector of non-DIF items
crossmatch <- c(2,3,5,7:10,13:16,18)

SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',1)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',4)
```

```
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',6)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',11)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',12)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',17)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',19)
SIBTEST(bk1scored, bk1$ITSEX, match_set = matched, focal_name='1',20)

sink() # return output to console
```

DIF/SIBTEST analysis for political viewpoint data:

```
## load packages
library(psych)
library(readxl)
library(mirt)

## CIRP poliview data 1999
poliview <- read_excel(path = "political viewpoint data.xlsx", sheet = "poliview")
poliview <- as.data.frame(poliview)

## listwise deletion of missing data needed for sibtest
poliviewr <- na.omit(poliview)
dim(poliviewr)

## Extract Test Items
resp_pol <- poliviewr[,2:19]
dim(resp_pol)

##use reverse.code function from psych package
polikey <- c(1,-1,-1,-1,-1,1,1,-1,-1,1,1,1,-1,-1,1,1,1,-1)
poliscored <- reverse.code(polikey,resp_pol,mini=rep(1,18),maxi=rep(4,18))
str(poliscored)
head(poliscored)

## descriptive statistics (using psych package)
describe(poliscored)

## combine sex and scored item responses
polivwcombo <- data.frame(poliviewr$sex,poliscored)
dim(polivwcombo)

## descriptive statistics (using psych package)
describe(polivwcombo)
```

```
#sink function directs output to a text file.
sink("sibtest of poliview w mirt.txt", append=TRUE)
## running SIBTEST from mirt package

#DIF (all other items as anchors)
SIBTEST(poliscored, poliviewr$sex, suspect_set = 1, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 2, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 3, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 4, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 5, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 6, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 7, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 8, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 9, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 10, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 11, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 12, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 13, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 14, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 15, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 16, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 17, focal_name='2')
SIBTEST(poliscored, poliviewr$sex, suspect_set = 18, focal_name='2')

#DBF: differential bundle functioning: example for regulation
suspect_reg <- c(7, 13, 15, 17)

SIBTEST(poliscored, poliviewr$sex, suspect_set=suspect_reg, focal_name='2')
sink() # return output to console
```

Chapter 11

EFA of political viewpoint data:

```
## load packages
library(psych)
library(readxl)

## CIRP poliview data 1999
poliview <- read_excel(path = "political viewpoint data.xlsx", sheet = "poliview")
poliview <- as.data.frame(poliview)
```

```
## listwise deletion of missing data needed for sibtest
poliviewr <- na.omit(poliview)
dim(poliviewr)

## Extract Test Items
resp_pol <- poliviewr[,2:19]
dim(resp_pol)

##use reverse.code function from psych package
polikey <- c(1,-1,-1,-1,-1,1,1,-1,-1,1,1,1,-1,-1,1,1,1,-1)
poliscored <- reverse.code(polikey,resp_pol,mini=rep(1,18),maxi=rep(4,18))
str(poliscored)
head(poliscored)

sink("poliview efa 5 factors.txt", append=TRUE)

##parallel analysis to estimate number of factors
fa.parallel(poliscored,fm="minres")

## EFA on poliview data
fa(r=poliscored,nfactors=5,rotate= "oblimin")

sink() # return output to console
```

EFA of TIMSS Booklet 1:

```
## load packages
library(psych)
library(readxl)

bk1 <- read_excel("TIMMS 2003 Math data.xlsx",sheet = "book 1")
names(bk1)
str(bk1)

## Extract Test Items
resp_bk1 <- bk1[-1:-3]
dim(resp_bk1)

##use score.multiple.choice function from psych package
bk1key <- c(1,3,4,4,2,3,2,3,3,2,4,5,1,3,1,4,1,2,2,3)
bk1scored <- score.multiple.choice(bk1key,resp_bk1,score=FALSE)

sink("efa timss booklet 1.txt", append=TRUE)

##parallel analysis to estimate number of factors
fa.parallel(bk1scored, cor="tet",fm="ml")
```

```
## EFA on timss data
fa(r=bk1scored,nfactors=8,fm="ml", cor="tet",rotate= "quartimax")
fa(r=bk1scored,nfactors=8,fm="ml", cor="tet",rotate= "oblimin")
fa(r=bk1scored,nfactors=6,fm="ml", cor="tet",rotate= "bifactor")

sink() # return output to console
```

CFA of TIMSS Booklet 1:

```
## load packages
library(lavaan)
library(psych)
library(readxl)

bk1 <- read_excel("TIMMS 2003 Math data.xlsx",sheet = "book 1")
names(bk1)
str(bk1)

## Extract Test Items
resp_bk1 <- bk1[-1:-3]
dim(resp_bk1)

##use score.multiple.choice function from psych package
bk1key <- c(1,3,4,4,2,3,2,3,3,2,4,5,1,3,1,4,1,2,2,3)
bk1scored <- score.multiple.choice(bk1key,resp_bk1,score=FALSE)

#sink function directs output to a text file.
sink("cfa of timss book1 w lavaan.txt", append=TRUE)


## lavaan code starts here. First, the model is specified.
timss.mod5 <- 'number =~ M012001 + M012004 + M012041 + M032570 + M032643 + M012016
               measurement =~ M012003 + M012038 + M012013
               geometry =~ M012005 + M012039 + M012015
               data =~ M012006 + M012037 + M012014
               algebra =~ M012002 + M012040 + M012042 + M022251
               '
## Then, lavaan runs the CFA.
fit5 <- cfa(timss.mod5, data=bk1scored)

##The next three lines extracts various outputs.
##Inspect lets the user verify that the model is setup correctly.
```

```
##Summary provides the basic results.
##lavInspect provides the correlation matrix between the five domains.

inspect (fit5)
summary(fit5, standardized=TRUE, fit.measures=TRUE)
lavInspect(fit5, "cor.lv")

timss.mod1 <- 'math =~ M012001 + M012004 + M012041 + M032570 + M032643 + M012016
               + M012003 + M012038 + M012013
               + M012005 + M012039 + M012015
               + M012006 + M012037 + M012014
               + M012002 + M012040 + M012042 + M022251
               '
fit1 <- cfa(timss.mod1, data=bk1scored)
inspect (fit1)
summary(fit1, standardized=TRUE, fit.measures=TRUE)

##This code provides a comparison of fit indices between the 5- and 1-score models.
fit5d <- fitmeasures(fit5,fit.measures = c("rmsea","tli","cfi",'rmsr',"AIC","BIC"))
fit1d <- fitmeasures(fit1,fit.measures = c("rmsea","tli","cfi",'rmsr',"AIC","BIC"))
rbind(fit5d,fit1d)

sink() # return output to console
```