#Section 1 - Kenny & Judd Method

#This analysis will be conducted on the intdata excel file.

#This file contains the raw and centered versions of two indicators each for two latent predictors.

#It also contains the four cross products of those centered predictors and a single dependent variable.

#################

#Step 0. Load relevant packages and data.

#First, we install and library lavaan.

install.packages("lavaan")

library(lavaan)

#Next we read in the data file

library(readxl)

intdata <- read\_excel("intdata.xlsx") #This assumes that the data file is in the working directory.

View(intdata)

################

#Step 1. Define the full model

#This code creates the R object that reflects the various equations in Kenny and Judd 1984 and Jaccard and Wan 1996

model.inter <- '

#Meas model with reference indicators (aff1t1c, ti1t1c,and a1t1) and labels for loadings.

#Labels are needed because these values will be used to compute other values below.

Afft1 =~ 1\*aff1t1c+b\*aff2t1c

Trnt1 =~ 1\*ti1t1c+d\*ti2t1c

Inter =~ 1\*a1t1+f\*a1t2+g\*a2t1+h\*a2t2

#constrain loadings as per eqs 12-15 in Kenny and Judd. The loading for a1t1 is already fixed to 1.

#Because f and g are loadings attached to products that involve one of the reference indicators, they are simple equality constraints,

#but technically, they are 1\*d and 1\*b respectively.

f==d

g==b

h==b\*d

Afft1~~i\*Afft1 #labeling latent variances

Trnt1~~j\*Trnt1

Afft1~~k\*Trnt1 #labeling latent covariance

aff1t1c~~o\*aff1t1c #error variance labels

aff2t1c~~p\*aff2t1c

ti1t1c~~q\*ti1t1c

ti2t1c~~s\*ti2t1c

a1t1~~t\*a1t1

a1t2~~u\*a1t2

a2t1~~v\*a2t1

a2t2~~w\*a2t2

Inter~~m\*Inter #labeling variance of latent product

m==(i\*j)+k^2 #constraining variance of latent product per eq10 in Jaccard & Wan

t==(i\*q)+(j\*o)+(q\*o) #constraining error variances per eq 7-13 in jaccard & wan

u==(i\*s)+((d^2)\*j\*o)+(o\*s)

v==((b^2)\*i\*q)+(j\*p)+(q\*p)

w==((b^2)\*i\*s)+((d^2)\*j\*p)+(s\*p)

aff1t1c~~a1t1 #freeing error covariances for terms that share components as implied by kenny and judd

aff1t1c~~a1t2

aff2t1c~~a2t1

aff2t1c~~a2t2

ti1t1c~~a1t1

ti1t1c~~a2t1

ti2t1c~~a1t2

ti2t1c~~a2t2

a1t1~~a1t2

a1t1~~a2t1

a2t1~~a2t2

a1t2~~a2t2

NPVHC ~ Afft1 + Trnt1 + Inter'

################

#Step 2. Fit the full model

model.inter.fit <- sem(model.inter, data=intdata)

summary(model.inter.fit, fit.measures=TRUE, standardized=TRUE)

#Because sets of variables that contain products are not multivariate normal,

#distribution free estimators can be useful. The simplest is probably the

#Diagonally Weighted Least Squares (DWLS) estimator, which is based on a fit function in

#which values are weighted by their sampling variances, i.e., the diagonal of the sampling variance/covariance matrix.

#Instead of the previous two lines, these would be used.

model.inter.fit <- sem(model.inter, data=intdata,estimator="WLSMV")

summary(model.inter.fit, fit.measures=TRUE, standardized=TRUE)