SUPPLEMENTAL MATERIAL (R-CODES) ACCOMPANYING

Gross, S., Meier, L. L., & Semmer, N. K. (2012). Latent growth modeling applied to diary data: The course of vigor across a work week as an illustrative example. In A. Bakker & K. Daniels (Eds.), A day in the life of a happy worker (pp. 114-131).

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1. MEASUREMENT MODEL WITHOUT CONSTRAINTS (CFA1)

R-Code (# are comments to the syntax)

```
# Model:

cfa1 <- "

    # Measurement Model for vigor (lv = latent vigor, vig1_M = first item measurement
    point t)

    lv0 =~ vig1_M0 + vig2_M0 + vig3_M0

    lv1 =~ vig1_M1 + vig2_M1 + vig3_M1

    lv2 =~ vig1_M2 + vig2_M2 + vig3_M2

    lv3 =~ vig1_M3 + vig2_M3 + vig3_M3

    lv4 =~ vig1_M4 + vig2_M4 + vig3_M4

    lv5 =~ vig1_M5 + vig2_M5 + vig3_M5

    lv6 =~ vig1_M6 + vig2_M6 + vig3_M6

    #Covariances of Uniqueness

    vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

    vig1_M4 ~~ vig1_M5 + vig1_M6

    vig1_M5 ~~ vig1_M6

    vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

    vig2_M4 ~~ vig2_M5 + vig2_M6

    vig2_M5 ~~ vig2_M6
```

```
        vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

        vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

        vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

        vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

        vig3_M4 ~~ vig3_M5 + vig3_M6

        vig3_M5 ~~ vig3_M6"
# The  model is estimated

cfa1.fit<-sem(model=cfa1, data=dataset)

# The output is printed

summary(cfa1.fit, rsquare=TRUE, standardized=TRUE)
```

2. MEASUREMENT MODEL WITH EQUAL FACTOR LOADINGS (CFA2)

R-Code

```
cfa2 <- "

    # Measurement Model for vigor (lv = latent vigor, vig1_M = first item measurement point t, iv2 and iv3 are used to define, which factor loading should be equal across time)

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0

    lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1

    lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

    lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

    lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

    lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

    lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

    # Covariances of Uniqueness

    vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

    vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

    vig1_M4 ~~ vig1_M5 + vig1_M6

    vig1_M5 ~~ vig1_M6

    vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

    vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

    vig2_M4 ~~ vig2_M5 + vig2_M6

    vig2_M5 ~~ vig2_M6

    vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6
```

```
        vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

        vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

        vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

        vig3_M4 ~~ vig3_M5 + vig3_M6

        vig3_M5 ~~ vig3_M6"

cfa2.fit<-sem(model=cfa2, data=dataset)

summary(cfa2.fit, rsquare=TRUE, standardized=TRUE)
```

3. State model or measurement model with equal factor loadings and equal intercepts (CFA3)

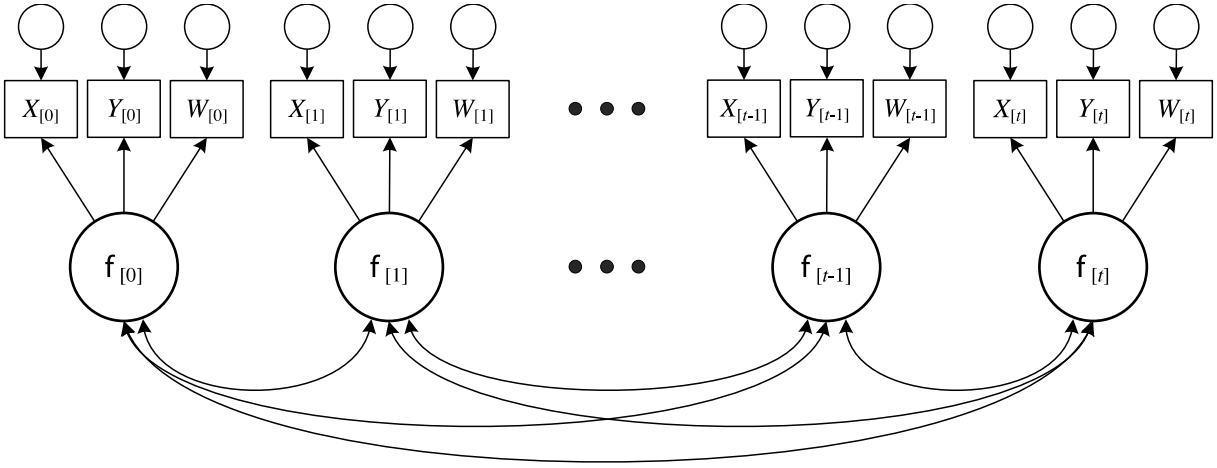

Figure 3.1. Simplified State-Model.

Latent variables are represented by circles and manifest variables by squares. Not depicted in this figure are the intercepts of the manifest and latent variables, the covariances of uniqueness and the variances of the latent variables.

R-Code

```
cfa3 <- "

    # Measurement Model

    # First two code parts (definition of factors and covariances of uniqueness) are the same as in CFA2

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0

    lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1

    lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

    lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

    lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

    lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

    lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

    # Covariances of Uniqueness

    vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6
```

```
vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

vig1_M4 ~~ vig1_M5 + vig1_M6

vig1_M5 ~~ vig1_M6

vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

vig2_M4 ~~ vig2_M5 + vig2_M6

vig2_M5 ~~ vig2_M6

vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

vig3_M4 ~~ vig3_M5 + vig3_M6

vig3_M5 ~~ vig3_M6

#Intercepts

# Estimating intercepts at the latent level

lv0 ~1

lv1 ~1

lv2 ~1

lv3 ~1

lv4 ~1

lv5 ~1

lv6 ~1

#Setting intercepts of the first indicator to zero
```

```
vig1_M0~0*1

vig1_M1~0*1

vig1_M2~0*1

vig1_M3~0*1

vig1_M4~ 0*1

vig1_M5~ 0*1

vig1_M6~ 0*1

#Setting intercepts of the second indicator to be equal across time

vig2_M0~ ii 2*1

vig2_M1~ ii 2*1

vig2_M2~ ii 2*1

vig2_M3~ ii 2*1

vig2_M4~ ii 2*1

vig2_M5~ ii 2*1

vig2_M6~ ii 2*1

#Setting intercepts of the third indicator to be equal across time

vig3_M0~ ii 3*1

vig3_M1~ ii 3*1

vig3_M2~ ii 3*1

vig3_M3~ ii 3*1

vig3_M4~ ii 3*1

vig3_M5~ ii 3*1

vig3_M6~ ii 3*1"

cfa3.fit<-sem(model=cfa3, data=dataset)

summary(cfa3.fit, rsquare=TRUE, standardized=TRUE)

#Comparing model caf1, cfa2 and caf3
```

```
inspect(cfa1.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower", "rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]

inspect(cfa2.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower", "rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]

inspect(cfa3.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower", "rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]

anova(cfa1.fit, cfa2.fit)

anova(cfa2.fit, cfa3.fit)
```

4. State – Trait Model

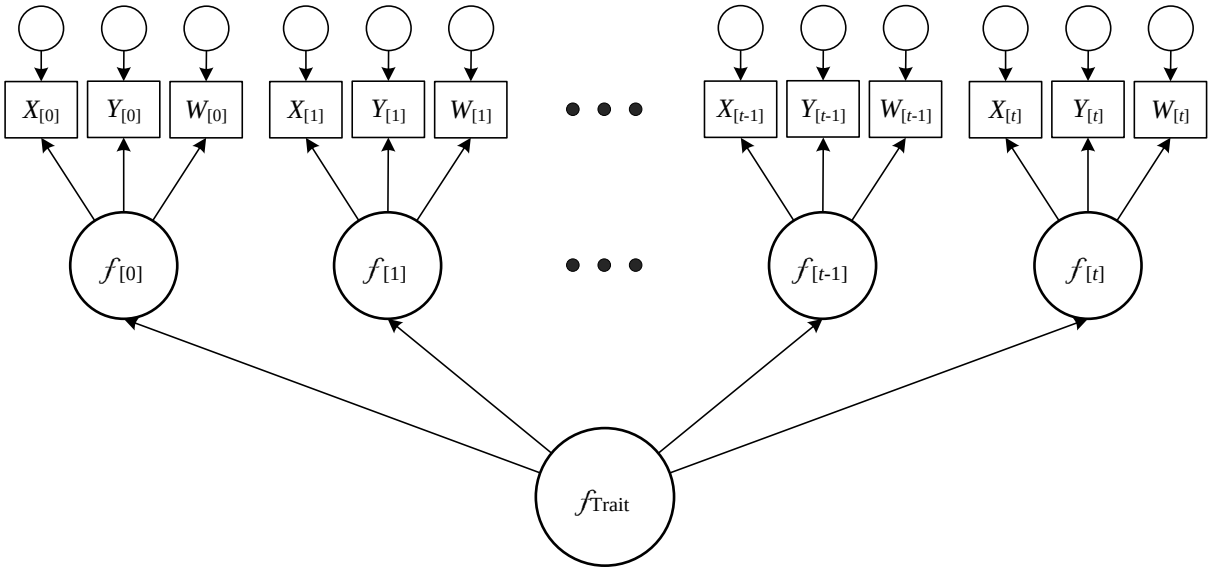

Figure 4.1. Simplified State-Trait Model.

Latent variables are represented by circles and manifest variables by squares. Not depicted in this figure are the intercepts of the manifest and latent variables, the covariances of uniqueness and the variances of the latent variables.

R-Code

```
statetrait <- "

    # Measurement Model

    # First three code parts (definition of factors, covariances of uniqueness, intercepts) are the same as in the state-model

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0

    lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1

    lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

    lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

    lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

    lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

    lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

    # Covariances of Uniqueness

    vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6
```

```
vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

vig1_M4 ~~ vig1_M5 + vig1_M6

vig1_M5 ~~ vig1_M6

vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

vig2_M4 ~~ vig2_M5 + vig2_M6

vig2_M5 ~~ vig2_M6

vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

vig3_M4 ~~ vig3_M5 + vig3_M6

vig3_M5 ~~ vig3_M6

#Intercepts

# Estimating intercepts at the latent level

lv0 ~1

lv1 ~1

lv2 ~1

lv3 ~1

lv4 ~1

lv5 ~1

lv6 ~1

#Setting intercepts of the first indicator to zero
```

```
vig1_M0~0*1

vig1_M1~0*1

vig1_M2~0*1

vig1_M3~0*1

vig1_M4~ 0*1

vig1_M5~ 0*1

vig1_M6~ 0*1

#Setting intercepts of the second indicator to be equal across time

vig2_M0~ ii 2*1

vig2_M1~ ii 2*1

vig2_M2~ ii 2*1

vig2_M3~ ii 2*1

vig2_M4~ ii 2*1

vig2_M5~ ii 2*1

vig2_M6~ ii 2*1

#Setting intercepts of the third indicator to be equal across time

vig3_M0~ ii 3*1

vig3_M1~ ii 3*1

vig3_M2~ ii 3*1

vig3_M3~ ii 3*1

vig3_M4~ ii 3*1

vig3_M5~ ii 3*1

vig3_M6~ ii 3*1

# Structural Part

# Trait (ltVig = latent Trait Vigor)

ltVig =~lv0 + lv1 + lv2 + lv3 + lv4 + lv5 + lv6

"
```

```
statetrait.fit<-sem(model=statetrait.fit, data=dataset)

summary(statetrait.fit, fit.measure=TRUE, rsquare=TRUE, standardized=TRUE)

inspect(statetrait.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower",
“rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]
```

5. LINEAR LGM

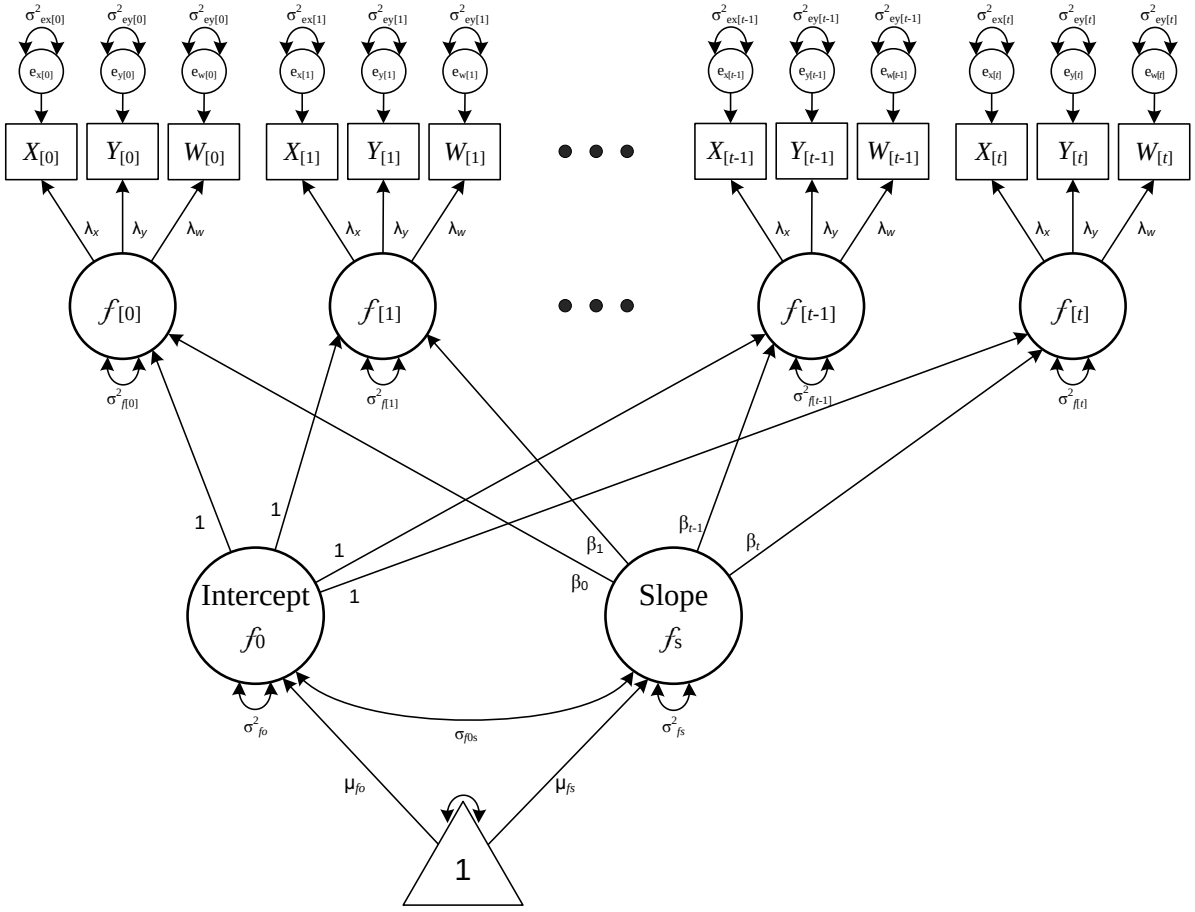

Figure 5.1. Linear LGM.

Latent variables are represented by circles and manifest variables by squares. Depicted in the figure are most of the parameters that are estimated. The triangle represents a constant to estimate the means and intercepts. Parameters that are estimated but not depicted in this figure are the covariances of uniqueness and the intercepts of the manifest variables.

σ^2 = Variance; σ = Covariance; μ = Mean; λ = Factor loading

R-Code

```
linearlgm <-"

    # Measurement Model

    # First two code parts (definition of factors and covariances of uniqueness) are the same as in the state-model

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0

    lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1
```

```
lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

# Covariances of Uniqueness

vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

vig1_M4 ~~ vig1_M5 + vig1_M6

vig1_M5 ~~ vig1_M6

vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

vig2_M4 ~~ vig2_M5 + vig2_M6

vig2_M5 ~~ vig2_M6

vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

vig3_M4 ~~ vig3_M5 + vig3_M6

vig3_M5 ~~ vig3_M6

#Intercepts

#Estimating the growth parameter

i~1
```

```
s~1
# The intercepts of the latent vigor factors are set to zero by default
#Setting intercepts of the first indicator to zero
vig1_M0~0*1
vig1_M1~0*1
vig1_M2~0*1
vig1_M3~0*1
vig1_M4~ 0*1
vig1_M5~ 0*1
vig1_M6~ 0*1
#Setting intercepts of the second indicator to be equal across time
vig2_M0~ ii 2*1
vig2_M1~ ii 2*1
vig2_M2~ ii 2*1
vig2_M3~ ii 2*1
vig2_M4~ ii 2*1
vig2_M5~ ii 2*1
vig2_M6~ ii 2*1
#Setting intercepts of the third indicator to be equal across time
vig3_M0~ ii 3*1
vig3_M1~ ii 3*1
vig3_M2~ ii 3*1
vig3_M3~ ii 3*1
vig3_M4~ ii 3*1
vig3_M5~ ii 3*1
vig3_M6~ ii 3*1
# Structural Part
```

```
        # linear LGM (i = intercept factor, s = linear slope factor)
        i =~ 1* lv0 + 1 * lv1 + 1 * lv2 + 1 * lv3 + 1 * lv4 + 1 * lv5 + 1 * lv6
        s =~ 0* lv0 + 1 * lv1 + 2 * lv2 + 3 * lv3 + 4 * lv4 + 5 * lv5 + 6 * lv6
        ”
linearlgm.fit<-sem(model=linearlgm, data=dataset)
summary(linearlgm.fit, fit.measure=TRUE, rsquare=TRUE, standardized=TRUE)
inspect(linearlgm.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower",
“rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]
```

6. QUADRATIC LGM WITHOUT TICS

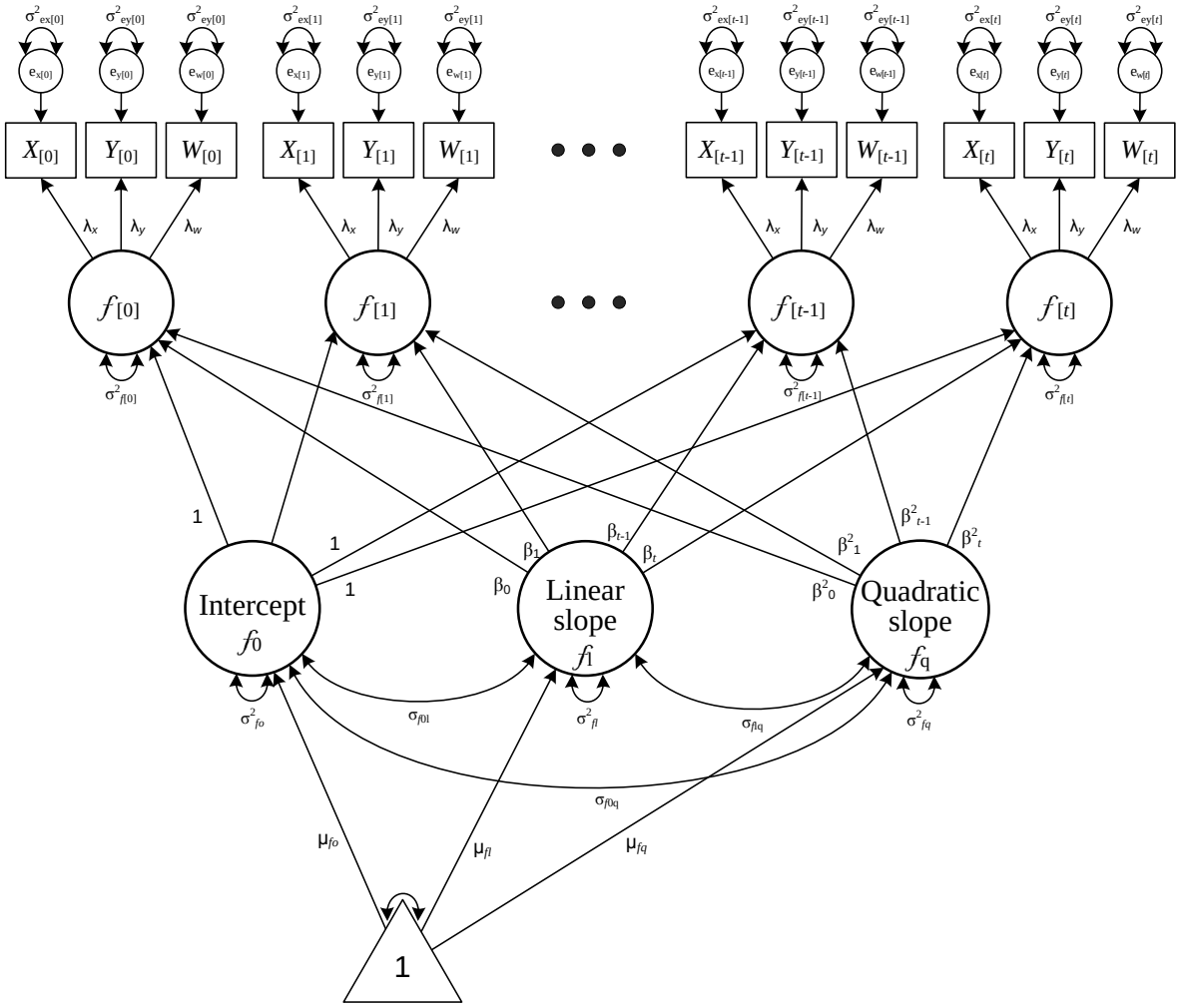

Figure 6.1. Quadratic LGM.

Latent variables are represented by circles and manifest variables by squares. Depicted in the figure are most of the parameters that are estimated. The triangle represents a constant to estimate the means and intercepts. Parameters that are estimated but not depicted in this figure are the covariances of uniqueness and the intercepts of the manifest variables.

σ^2 = Variance; σ = Covariance; μ = Mean; λ = Factor loading

R-Code

```
quadlgm <-“

    # Measurement Model

    # First two code parts (definition of factors and covariances of uniqueness) are the
    same as in the state-model

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0
```

```
lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1

lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

# Covariances of Uniqueness

vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

vig1_M4 ~~ vig1_M5 + vig1_M6

vig1_M5 ~~ vig1_M6

vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

vig2_M4 ~~ vig2_M5 + vig2_M6

vig2_M5 ~~ vig2_M6

vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

vig3_M4 ~~ vig3_M5 + vig3_M6

vig3_M5 ~~ vig3_M6

#Intercepts

#Estimating the growth parameter
```

```
i~1

s~1

q~1

# The intercepts of the latent vigor factors are set to zero by default

#Setting intercepts of the first indicator to zero

vig1_M0~0*1

vig1_M1~0*1

vig1_M2~0*1

vig1_M3~0*1

vig1_M4~ 0*1

vig1_M5~ 0*1

vig1_M6~ 0*1

#Setting intercepts of the second indicator to be equal across time

vig2_M0~ ii 2*1

vig2_M1~ ii 2*1

vig2_M2~ ii 2*1

vig2_M3~ ii 2*1

vig2_M4~ ii 2*1

vig2_M5~ ii 2*1

vig2_M6~ ii 2*1

#Setting intercepts of the third indicator to be equal across time

vig3_M0~ ii 3*1

vig3_M1~ ii 3*1

vig3_M2~ ii 3*1

vig3_M3~ ii 3*1

vig3_M4~ ii 3*1

vig3_M5~ ii 3*1
```

```
vig3_M6~ ii 3*1

# Structural Part

# quadratic LGM (i = intercept factor, s = linear slope factor, q = quadratic slope factor)

i =~ 1* lv0 + 1 * lv1 + 1 * lv2 + 1 * lv3 + 1 * lv4 + 1 * lv5 + 1 * lv6

s =~ 0* lv0 + 1 * lv1 + 2 * lv2 + 3 * lv3 + 4 * lv4 + 5 * lv5 + 6 * lv6

q =~  0* lv0 + 1 * lv1 + 4 * lv2 + 9 * lv3 + 16 * lv4 + 25 * lv5 + 36 * lv6

”

quadlgm.fit<-sem(model=quadlgm, data=dataset)

summary(quadlgm.fit, fit.measure=TRUE, rsquare=TRUE, standardized=TRUE)

inspect(quadlgm.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower",
“rmsea.ci.upper",  "rmsea.pvalue", "cfi", "tli")]
```

7. Quadratic LGM including TICs

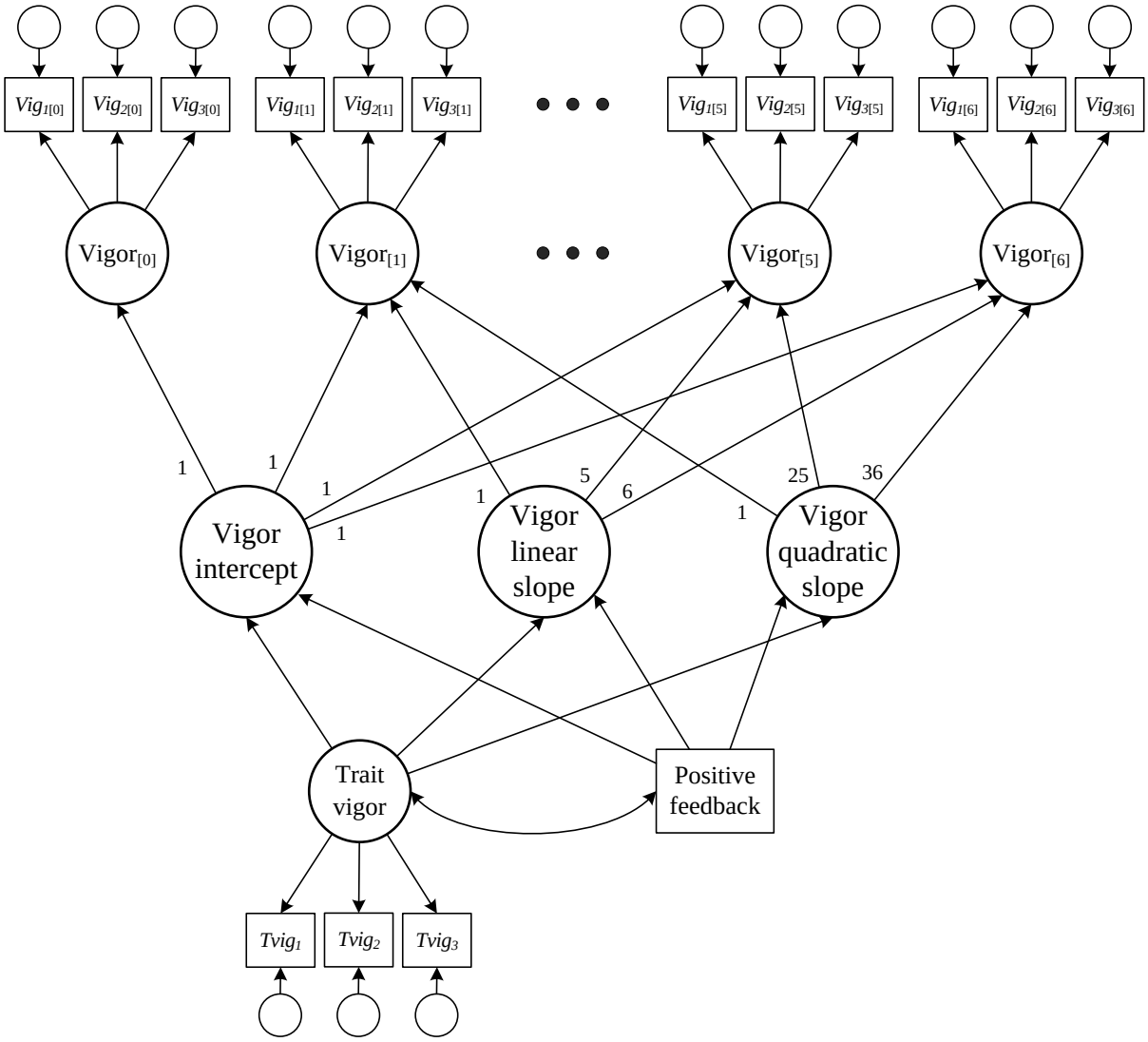

Figure 7.1. Simplified quadratic LGM with covariates.

Latent variables are represented by circles and manifest variables by squares. Not depicted in this figure are the intercepts of the manifest and latent variables, the covariances of uniqueness and the variances of the latent variables.

R-Code

```
tic <-“

    # Measurement Model

    # Code for the measurement model of vigor is the same as in the quadratic LGM without TICs

    lv0 =~ vig1_M0 + iv2 * vig2_M0 + iv3 * vig3_M0
```

```
lv1 =~ vig1_M1 + iv2 * vig2_M1 + iv3 * vig3_M1

lv2 =~ vig1_M2 + iv2 * vig2_M2 + iv3 * vig3_M2

lv3 =~ vig1_M3 + iv2 *vig2_M3 + iv3 * vig3_M3

lv4 =~ vig1_M4 + iv2 * vig2_M4 + iv3 * vig3_M4

lv5 =~ vig1_M5 + iv2 * vig2_M5 + iv3 * vig3_M5

lv6 =~ vig1_M6 + iv2 *vig2_M6 + iv3 * vig3_M6

# Covariances of Uniqueness

vig1_M0 ~~ vig1_M1 + vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M1 ~~ vig1_M2 + vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M2 ~~ vig1_M3 + vig1_M4 + vig1_M5 + vig1_M6

vig1_M3 ~~ vig1_M4 + vig1_M5 + vig1_M6

vig1_M4 ~~ vig1_M5 + vig1_M6

vig1_M5 ~~ vig1_M6

vig2_M0 ~~ vig2_M1 + vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M1 ~~ vig2_M2 + vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M2 ~~ vig2_M3 + vig2_M4 + vig2_M5 + vig2_M6

vig2_M3 ~~ vig2_M4 + vig2_M5 + vig2_M6

vig2_M4 ~~ vig2_M5 + vig2_M6

vig2_M5 ~~ vig2_M6

vig3_M0 ~~ vig3_M1 + vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M1 ~~ vig3_M2 + vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M2 ~~ vig3_M3 + vig3_M4 + vig3_M5 + vig3_M6

vig3_M3 ~~ vig3_M4 + vig3_M5 + vig3_M6

vig3_M4 ~~ vig3_M5 + vig3_M6

vig3_M5 ~~ vig3_M6

#Intercepts

#Estimating the growth parameter
```

```
i~1

s~1

q~1

# The intercepts of the latent vigor factors are set to zero by default

#Setting intercepts of the first indicator to zero

vig1_M0~0*1

vig1_M1~0*1

vig1_M2~0*1

vig1_M3~0*1

vig1_M4~ 0*1

vig1_M5~ 0*1

vig1_M6~ 0*1

#Setting intercepts of the second indicator to be equal across time

vig2_M0~ ii 2*1

vig2_M1~ ii 2*1

vig2_M2~ ii 2*1

vig2_M3~ ii 2*1

vig2_M4~ ii 2*1

vig2_M5~ ii 2*1

vig2_M6~ ii 2*1

#Setting intercepts of the third indicator to be equal across time

vig3_M0~ ii 3*1

vig3_M1~ ii 3*1

vig3_M2~ ii 3*1

vig3_M3~ ii 3*1

vig3_M4~ ii 3*1

vig3_M5~ ii 3*1
```

```
vig3_M6~ ii 3*1

#Measurement Model for latent Trait vigor (LTV = latent trait vigor)

LTV =~ ltv1 + ltv2 + ltv3

# Structural Part

# quadratic LGM

i =~ 1* lv0 + 1 * lv1 + 1 * lv2 + 1 * lv3 + 1 * lv4 + 1 * lv5 + 1 * lv6

s =~ 0* lv0 + 1 * lv1 + 2 * lv2 + 3 * lv3 + 4 * lv4 + 5 * lv5 + 6 * lv6

q =~  0* lv0 + 1 * lv1 + 4 * lv2 + 9 * lv3 + 16 * lv4 + 25 * lv5 + 36 * lv6

#TICs as predictors of the quadratic LGM (PF = positive feedback (manifest variable: was centered around the grand mean)

i ~ LTV + PF

s ~ LTV + PF

q ~ LTV + PF

#Allowing covariances among growth factors and among TICs

i~~s + q

s~~q

LTV ~~ PF

"

tic.fit<-sem(model=tic, data=dataset)

summary(tic.fit, fit.measure=TRUE, rsquare=TRUE, standardized=TRUE)

inspect(tic.fit, "fit")[c("chisq", "df", "pvalue", "rmsea", "rmsea.ci.lower", "rmsea.ci.upper", "rmsea.pvalue", "cfi", "tli")]
```