PSY 9556B (Jan 29) Longitudinal Measurement/Factorial Invariance

1. Configural invariance (identical factorial structures)
2. Weak invariance (identical indicator loadings)
3. Strong invariance (identical indicator intercepts)
4. Strict invariance (identical indicator residuals)

Means of the latent variables

Variances of the latent variables

Covariances (or correlations) of the latent variables

Why Measurement Invariance is Needed

Consider the relation between a latent variable and one of its indicator variable

This relation could be expressed as a regression equation in which we predict the indicator variable score from the latent variable score.

$$y_{ij} = \tau_j + \lambda_{j1}\eta_{1i} + r_{ij}$$

$$y_{ij} = \tau_j + \lambda_{j1}\eta_{1i} + s_{ij} + e_{ij}$$

$y_{ij} =$ Person (i)'s value on indicator (j)

$\tau_j =$ Intercept (Person (i)'s value on indicator (j) when latent mean = 0

$\lambda_{j1} =$ Loading (regression coefficient/slope)

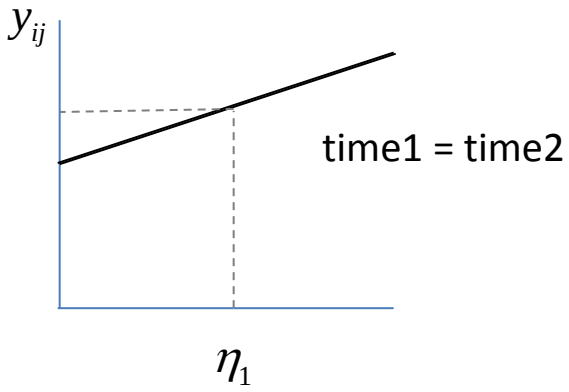
$\eta_{1i} =$ Person (i)'s value on Latent variable 1

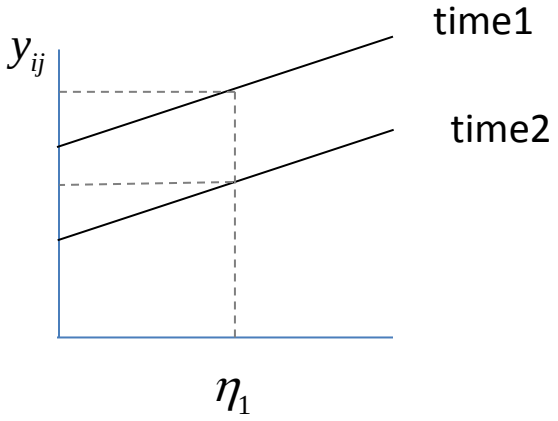
$r_{ij} =$ Residual

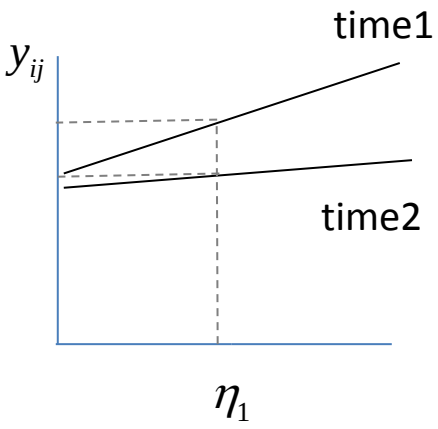
$s_{ij} =$ Residual part consisting of systematic variance

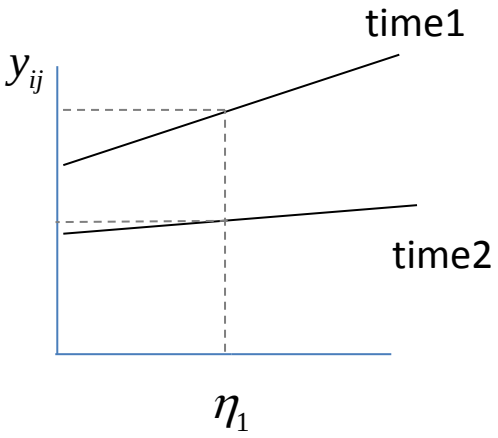
$e_{ij} =$ Residual part consisting of random fluctuations/unreliability

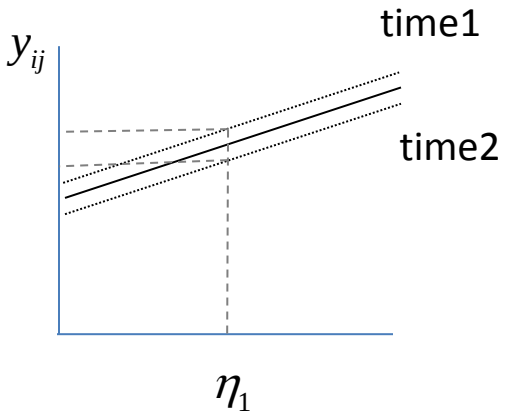
Why Measurement Invariance is Needed





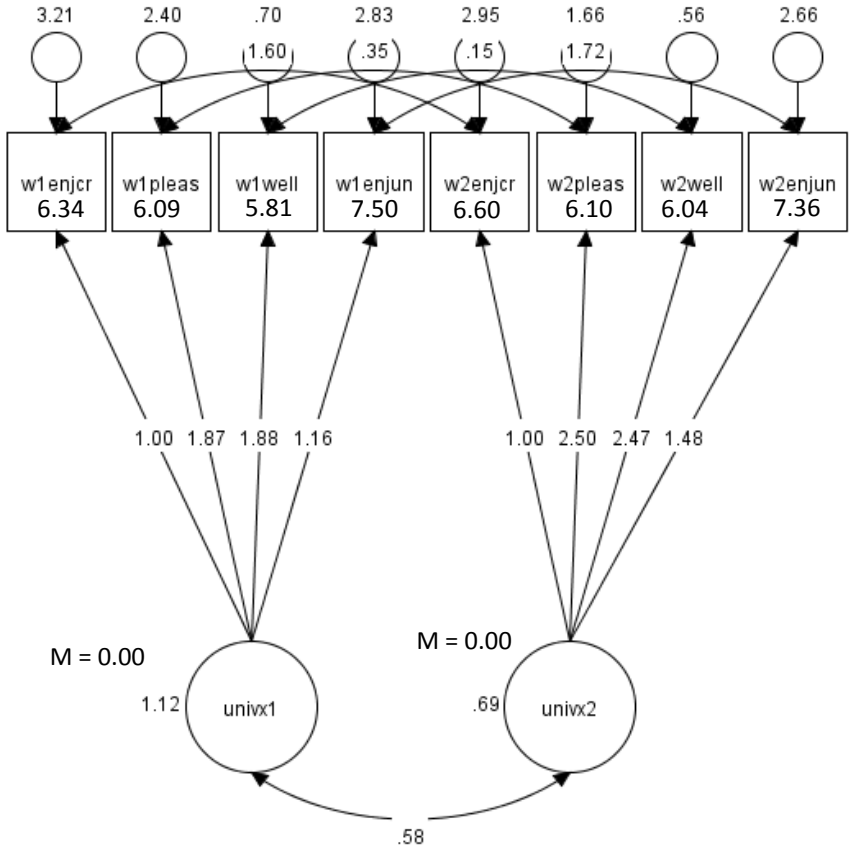






Configural Invariance

```
MODEL:
univx1 by w1enjcr w1pleas w1well w1enjun;
univx2 by w2enjcr w2pleas w2well w2enjun;
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
output: sampstat residual stdyx tech4 modindices;
```



$\chi^2_{(15)} = 55.002$, $p < .001$

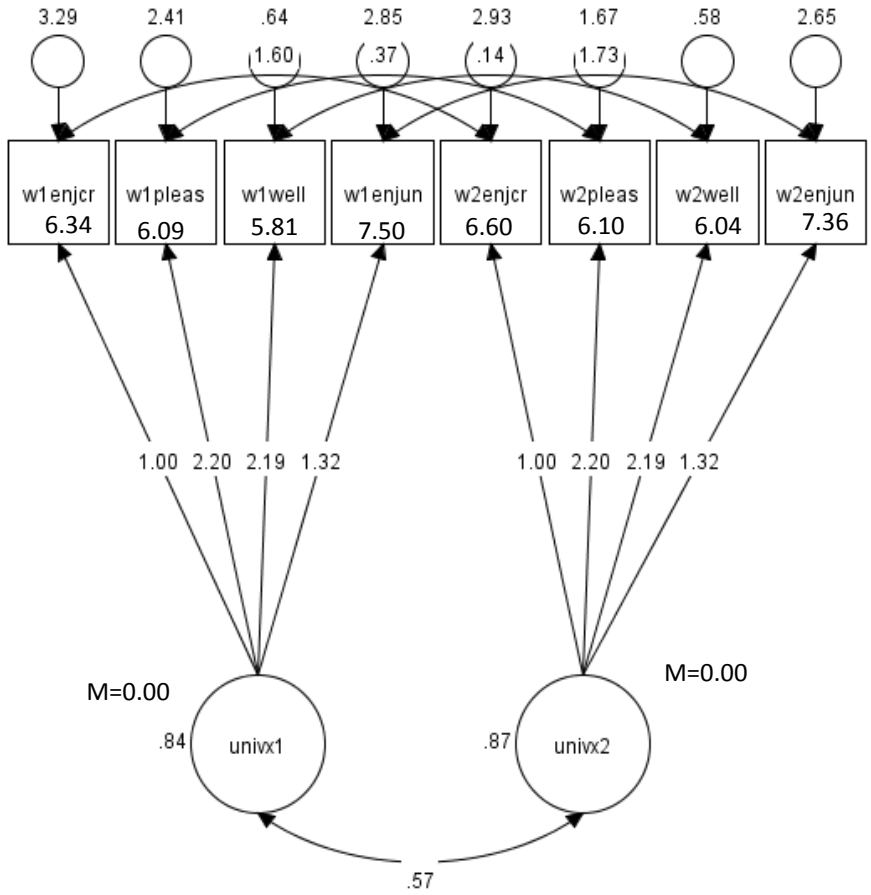
CFI = .976

TLI = .955

RMSEA = .080 (CI=.058 .104)

Weak (Loadings) Invariance

```
MODEL:
univx1 by w1enjcr
w1pleas (2)
w1well (3)
w1enjun (4);
univx2 by w2enjcr
w2pleas (2)
w2well (3)
w2enjun (4);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
output: sampstat residual stdyx tech4 modindices;
```



$\chi^2_{(18)} = 61.290$, $p < .001$

$\Delta\chi^2_{(3)} = 6.288$, n.s.

CFI = .974

ΔCFI = .002 pass

TLI = .959

RMSEA = .076 (CI=.056 .098)

Strong (Intercepts) Invariance

```
MODEL:
univx1 by w1enjcr
w1pleas (2)
w1well (3)
w1enjun (4);
[w1enjcr] (5)
[w1pleas] (6)
[w1well] (7)
[w1enjun] (8);
[univx1] ; !the other mean left fixed at 0;
univx2 by w2enjcr
w2pleas (2)
w2well (3)
w2enjun (4);
[w2enjcr] (5)
[w2pleas] (6)
[w2well] (7)
[w2enjun] (8);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
output: sampstat residual stdyx tech4 modindices (5);
```

$\chi^2_{(21)} = 79.104, p < .001$

$\Delta\chi^2_{(3)} = 17.814, p < .001$

CFI = .965

ΔCFI = .009 pass

TLI = .953

RMSEA = .082 (CI=.063 .102)

Although the test passes based on CFI <= .010, I am going to fail it given that it is close to the cutoff and I want an example to show you how to deal with partial invariance. So let's assume that the test failed.

Strong (Intercepts) Invariance

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	1.000	0.000	999.000	999.000
W1PLEAS	2.175	0.181	12.050	0.000
W1WELL	2.174	0.186	11.655	0.000
W1ENJUN	1.296	0.121	10.700	0.000
UNIVX2 BY				
W2ENJCR	1.000	0.000	999.000	999.000
W2PLEAS	2.175	0.181	12.050	0.000
W2WELL	2.174	0.186	11.655	0.000
W2ENJUN	1.296	0.121	10.700	0.000
UNIVX2 WITH				
UNIVX1	0.577	0.110	5.244	0.000
W1ENJCR WITH				
W2ENJCR	1.592	0.184	8.651	0.000
W1PLEAS WITH				
W2PLEAS	0.369	0.153	2.405	0.016
W1WELL WITH				
W2WELL	0.126	0.115	1.099	0.272
W1ENJUN WITH				
W2ENJUN	1.723	0.173	9.938	0.000
Means				
UNIVX1	-0.070	0.045	-1.558	0.119
Intercepts				
W1ENJCR	6.514	0.091	71.552	0.000
W1PLEAS	6.157	0.118	52.086	0.000
W1WELL	6.001	0.109	54.821	0.000
W1ENJUN	7.466	0.098	76.013	0.000
W2ENJCR	6.514	0.091	71.552	0.000
W2PLEAS	6.157	0.118	52.086	0.000
W2WELL	6.001	0.109	54.821	0.000
W2ENJUN	7.466	0.098	76.013	0.000
Variances				
UNIVX1	0.856	0.152	5.644	0.000
UNIVX2	0.886	0.156	5.687	0.000
Residual Variances				
W1ENJCR	3.300	0.248	13.288	0.000
W1PLEAS	2.421	0.235	10.287	0.000
W1WELL	0.631	0.169	3.744	0.000
W1ENJUN	2.873	0.220	13.073	0.000
W2ENJCR	2.937	0.219	13.397	0.000
W2PLEAS	1.679	0.190	8.814	0.000
W2WELL	0.568	0.151	3.755	0.000
W2ENJUN	2.676	0.204	13.086	0.000

Discuss the implication on latent means

Strong (Intercepts) Invariance

Given that the model failed the invariance of the intercepts test, we need to identify which intercept(s) are causing the test to fail

I will look at the modification indices and see if I should relax one constraint

Minimum M.I. value for printing the modification index 5.000

		M.I.	E.P.C.	Std E.P.C.	StdYX E.P.C.
BY Statements					
UNIVX1	BY W1ENJCR	5.851	0.269	0.249	0.122
UNIVX2	BY W1ENJCR	6.669	0.243	0.229	0.112
UNIVX2	BY W2ENJCR	5.851	-0.269	-0.253	-0.129
WITH Statements					
W1WELL	WITH W1ENJCR	5.754	-0.287	-0.287	-0.199
W1ENJUN	WITH W1ENJCR	10.622	0.380	0.380	0.124
W1ENJUN	WITH W1PLEAS	12.514	-0.493	-0.493	-0.187
W2ENJCR	WITH W1ENJUN	8.883	-0.331	-0.331	-0.114
W2WELL	WITH W2ENJCR	10.759	-0.350	-0.350	-0.271
W2WELL	WITH W2PLEAS	12.709	0.784	0.784	0.803
W2ENJUN	WITH W2ENJCR	13.183	0.386	0.386	0.138
Means/Intercepts/Thresholds					
[W1WELL]		6.558	-0.188	-0.188	-0.087
[W1ENJUN]		9.909	0.149	0.149	0.072
[W2WELL]		6.557	0.035	0.035	0.016
[W2ENJUN]		9.910	-0.104	-0.104	-0.051

Strong (Intercepts) Partial Invariance

I will run the model constraining the intercepts with the exception of w1enjun and w2enjun and repeat the nested chi-square and CFI difference tests

```
MODEL:
univx1 by w1enjcr
w1pleas (2)
w1well (3)
w1enjun (4);
[w1enjcr] (5)
[w1pleas] (6)
[w1well] (7)
[w1enjun]; !remove constraint partial invariance
[univx1] ; !the other mean left fixed at 0;
univx2 by w2enjcr
w2pleas (2)
w2well (3)
w2enjun (4);
[w2enjcr] (5)
[w2pleas] (6)
[w2well] (7)
[w2enjun];!remove constraint partial invariance;
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
output: sampstat residual stdyx tech4 modindices (5);
```

(earlier test)

$\chi^2_{(21)} = 79.104$, $p < .001$

$\Delta\chi^2_{(3)} = 17.814$, $p < .001$

CFI = .965

ΔCFI = .009 pass (but I failed it)

TLI = .953

RMSEA = .082 (CI=.063 .102)

$\chi^2_{(20)} = 69.035$, $p < .001$

$\Delta\chi^2_{(2)} = 7.745$, $p < .05$

CFI = .970

ΔCFI = .004 pass – partial inv

TLI = .958

RMSEA = .077 (CI=.058 .097)

Strong (Intercepts) Partial Invariance

I accept the model with partial invariance in the intercepts

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	1.000	0.000	999.000	999.000
W1PLEAS	2.167	0.180	12.067	0.000
W1WELL	2.170	0.186	11.685	0.000
W1ENJUN	1.311	0.121	10.800	0.000
UNIVX2 BY				
W2ENJCR	1.000	0.000	999.000	999.000
W2PLEAS	2.167	0.180	12.067	0.000
W2WELL	2.170	0.186	11.685	0.000
W2ENJUN	1.311	0.121	10.800	0.000
UNIVX2 WITH				
UNIVX1	0.578	0.110	5.250	0.000
W1ENJCR WITH				
W2ENJCR	1.594	0.184	8.666	0.000
W1PLEAS WITH				
W2PLEAS	0.362	0.153	2.362	0.018
W1WELL WITH				
W2WELL	0.130	0.114	1.138	0.255
W1ENJUN WITH				
W2ENJUN	1.732	0.173	10.035	0.000
Means				
UNIVX1	-0.091	0.046	-2.003	0.045
Intercepts				
W1ENJCR	6.523	0.091	71.655	0.000
W1PLEAS	6.175	0.118	52.254	0.000
W1WELL	6.023	0.109	55.049	0.000
W1ENJUN	7.616	0.109	70.089	0.000
W2ENJCR	6.523	0.091	71.655	0.000
W2PLEAS	6.175	0.118	52.254	0.000
W2WELL	6.023	0.109	55.049	0.000
W2ENJUN	7.362	0.103	71.494	0.000
Variances				
UNIVX1	0.859	0.152	5.656	0.000
UNIVX2	0.889	0.156	5.698	0.000
Residual Variances				
W1ENJCR	3.297	0.248	13.292	0.000
W1PLEAS	2.438	0.235	10.384	0.000
W1WELL	0.626	0.167	3.755	0.000
W1ENJUN	2.854	0.218	13.107	0.000
W2ENJCR	2.935	0.219	13.399	0.000
W2PLEAS	1.686	0.189	8.921	0.000
W2WELL	0.565	0.149	3.788	0.000
W2ENJUN	2.651	0.202	13.128	0.000

Test of Latent Means

```
MODEL:
univx1 by w1enjcr
w1pleas (2)
w1well (3)
w1enjun (4);
[w1enjcr] (5)
[w1pleas] (6)
[w1well] (7)
[w1enjun] ; !remove constraint partial invariance;
![univx1] now both means are fixed at zero and therefore constrained;
univx2 by w2enjcr
w2pleas (2)
w2well (3)
w2enjun (4);
[w2enjcr] (5)
[w2pleas] (6)
[w2well] (7)
[w2enjun] ; !remove constraint partial invariance;
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
output: sampstat residual stdyx tech4 modindices;
```

$\chi^2_{(21)} = 73.121$, $p < .001$

$\Delta\chi^2_{(1)} = 4.086$, $p < .05$

CFI = .968

ΔCFI = .002

TLI = .958

RMSEA = .078 (CI=.059 .097)

What would you conclude about the latent means?

Strict (Residuals) Invariance

Let's go back to the partial invariance model before constraining the latent means and add equality constraints to the indicator residuals across time

```
MODEL:
univx1 by w1enjcr
w1pleas (2)
w1well (3)
w1enjun (4);
[w1enjcr] (5)
[w1pleas] (6)
[w1well] (7)
[w1enjun]; !remove constraint partial invariance
[univx1] ; !the other mean left fixed at 0;
univx2 by w2enjcr
w2pleas (2)
w2well (3)
w2enjun (4);
[w2enjcr] (5)
[w2pleas] (6)
[w2well] (7)
[w2enjun];!remove constraint partial invariance;
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
w1enjcr (9) !residual constraints
w1pleas (10)
w1well (11)
w1enjun (12);
w2enjcr (9)
w2pleas (10)
w2well (11)
w2enjun (12);
output: sampstat residual stdyx tech4 modindices (5)
```

$\chi^2_{(24)} = 81.250$, $p < .001$
$\Delta\chi^2_{(4)} = 12.215$, $p < .05$
CFI = .965
ΔCFI = .005 pass
TLI = .960
RMSEA = .076 (CI=.058 .095)

Strict (Residuals) Invariance

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	1.000	0.000	999.000	999.000
W1PLEAS	2.125	0.174	12.189	0.000
W1WELL	2.144	0.182	11.753	0.000
W1ENJUN	1.290	0.119	10.888	0.000
UNIVX2 BY				
W2ENJCR	1.000	0.000	999.000	999.000
W2PLEAS	2.125	0.174	12.189	0.000
W2WELL	2.144	0.182	11.753	0.000
W2ENJUN	1.290	0.119	10.888	0.000
UNIVX2 WITH				
UNIVX1	0.596	0.113	5.299	0.000
W1ENJCR WITH				
W2ENJCR	1.594	0.184	8.643	0.000
W1PLEAS WITH				
W2PLEAS	0.376	0.155	2.427	0.015
W1WELL WITH				
W2WELL	0.110	0.115	0.958	0.338
W1ENJUN WITH				
W2ENJUN	1.735	0.173	10.041	0.000
Means				
UNIVX1	-0.092	0.046	-2.004	0.045
Intercepts				
W1ENJCR	6.515	0.091	71.382	0.000
W1PLEAS	6.195	0.118	52.312	0.000
W1WELL	6.022	0.109	55.141	0.000
W1ENJUN	7.615	0.107	70.948	0.000
W2ENJCR	6.515	0.091	71.382	0.000
W2PLEAS	6.195	0.118	52.312	0.000
W2WELL	6.022	0.109	55.141	0.000
W2ENJUN	7.363	0.104	70.751	0.000
Variances				
UNIVX1	0.890	0.156	5.715	0.000
UNIVX2	0.905	0.157	5.768	0.000
Residual Variances				
W1ENJCR	3.113	0.185	16.857	0.000
W1PLEAS	2.083	0.166	12.536	0.000
W1WELL	0.581	0.137	4.250	0.000
W1ENJUN	2.759	0.173	15.908	0.000
W2ENJCR	3.113	0.185	16.857	0.000
W2PLEAS	2.083	0.166	12.536	0.000
W2WELL	0.581	0.137	4.250	0.000
W2ENJUN	2.759	0.173	15.908	0.000

Are the Latent Variances Different?

univx1 (13)
univx2 (13);

$\chi^2_{(25)} = 81.286$, $p < .001$
$\Delta\chi^2_{(1)} = 0.036$, n.s.
CFI = .966
ΔCFI = +.001 pass
TLI = .962
RMSEA = .074 (CI=.058 .095)

Null Model According to Little

```
!appropriate null model
ANALYSIS: Model = NOCOVARIANCES;
MODEL:
    w1enjcr w2enjcr (p1);
    w1pleas w2pleas (p2);
    w1well w2well (p3);
    w1enjun w2enjun (p4);
    [w1enjcr w2enjcr] (a1);
    [w1pleas w2pleas] (a2);
    [w1well w2well] (a3);
   [w1enjun w2enjun] (a4);
OUTPUT:
TECH1
STANDARDIZED;
```

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Means				
W1ENJCR	6.467	0.073	88.596	0.000
W1PLEAS	6.109	0.090	68.133	0.000
W1WELL	5.931	0.078	75.703	0.000
W1ENJUN	7.428	0.075	99.189	0.000
W2ENJCR	6.467	0.073	88.596	0.000
W2PLEAS	6.109	0.090	68.133	0.000
W2WELL	5.931	0.078	75.703	0.000
W2ENJUN	7.428	0.075	99.189	0.000
Variances				
W1ENJCR	4.093	0.209	19.596	0.000
W1PLEAS	6.141	0.314	19.545	0.000
W1WELL	4.701	0.240	19.571	0.000
W1ENJUN	4.312	0.220	19.608	0.000
W2ENJCR	4.093	0.209	19.596	0.000
W2PLEAS	6.141	0.314	19.545	0.000
W2WELL	4.701	0.240	19.571	0.000
W2ENJUN	4.312	0.220	19.608	0.000

Chi-Square Test of Model Fit

Value	1687.439
Degrees of Freedom	36
P-Value	0.0000

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.334	
90 Percent C.I.	0.320	0.347
Probability RMSEA <= .05	0.000	

CFI/TLI

CFI	0.000
TLI	0.222

Chi-Square Test of Model Fit for the Baseline Model

Value	1678.803
Degrees of Freedom	28
P-Value	0.0000

Null Model According to Little

Earlier tests based on conventional CFI

$\chi^2_{(21)} = 79.104$, $p < .001$
$\Delta\chi^2_{(3)} = 17.814$, $p < .001$
CFI = .965
ΔCFI = .009 pass (but I failed it)
TLI = .953
RMSEA = .082 (CI=.063 .102)

Calculating new CFI
Null $\chi^2_{(36)}$ =1687.439

$$CFI = 1 - \frac{\max\left[\left(x_t^2 - df_t\right), 0\right]}{\max\left[\left(x_t^2 - df_t\right), \left(x_0^2 - df_0\right), 0\right]}$$

CFI = 1 – (58.104/1651.439) = .965

(note that the remaining slides repeat the earlier analyses with Little's method of scaling)

Configural Invariance with Effect Coded Scaling

```
MODEL:
univx1 by w1enjcr* (L1)
w1pleas (L2)
w1well (L3)
w1enjun (L4);
univx2 by w2enjcr* (L5)
w2pleas (L6)
w2well (L7)
w2enjun (L8);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
[univx1 univx2];
[w1enjcr] (T1)
[w1pleas] (T2)
[w1well] (T3)
[w1enjun] (T4);
[w2enjcr] (T5)
[w2pleas] (T6)
[w2well] (T7)
[w2enjun] (T8);
MODEL CONSTRAINT: L1 = 4 - L2 - L3 - L4;
                  T1 = 0 - T2 - T3 - T4;
                  L5 = 4 - L6 - L7 - L8;
                  T5 = 0 - T6 - T7 - T8;
output: sampstat residual stdyx tech4 modindices;
```

$\chi^2_{(15)} = 55.002$, $p < .001$

CFI = .976

TLI = .955

RMSEA = .080 (CI=.058 .104)

Configural Invariance with Effect Coded Scaling

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	0.677	0.051	13.231	0.000
W1PLEAS	1.266	0.048	26.511	0.000
W1WELL	1.270	0.045	28.086	0.000
W1ENJUN	0.787	0.045	17.460	0.000
UNIVX2 BY				
W2ENJCR	0.537	0.049	10.956	0.000
W2PLEAS	1.344	0.043	31.382	0.000
W2WELL	1.326	0.043	30.992	0.000
W2ENJUN	0.793	0.043	18.488	0.000
UNIVX2 WITH				
UNIVX1	1.605	0.172	9.332	0.000
W1ENJCR WITH				
W2ENJCR	1.603	0.183	8.770	0.000
W1PLEAS WITH				
W2PLEAS	0.353	0.151	2.340	0.019
W1WELL WITH				
W2WELL	0.151	0.113	1.338	0.181
W1ENJUN WITH				
W2ENJUN	1.725	0.172	10.005	0.000
Means				
UNIVX1	6.434	0.087	73.785	0.000
UNIVX2	6.524	0.086	76.187	0.000
Intercepts				
W1ENJCR	1.984	0.339	5.853	0.000
W1PLEAS	-2.055	0.316	-6.511	0.000
W1WELL	-2.362	0.297	-7.964	0.000
W1ENJUN	2.432	0.299	8.120	0.000
W2ENJCR	3.094	0.329	9.408	0.000
W2PLEAS	-2.666	0.286	-9.331	0.000
W2WELL	-2.616	0.284	-9.216	0.000
W2ENJUN	2.188	0.289	7.581	0.000
Variances				
UNIVX1	2.440	0.213	11.446	0.000
UNIVX2	2.398	0.205	11.688	0.000
Residual Variances				
W1ENJCR	3.213	0.245	13.131	0.000
W1PLEAS	2.398	0.233	10.299	0.000
W1WELL	0.703	0.172	4.088	0.000
W1ENJUN	2.830	0.218	12.982	0.000
W2ENJCR	2.946	0.219	13.473	0.000
W2PLEAS	1.656	0.197	8.396	0.000
W2WELL	0.556	0.159	3.501	0.000
W2ENJUN	2.658	0.203	13.123	0.000

Weak (Loadings) Invariance with Effect Coded Scaling

```
MODEL:
univx1 by w1enjcr* (L1)
w1pleas (L2)
w1well (L3)
w1enjun (L4);
univx2 by w2enjcr* (L1)
w2pleas (L2)
w2well (L3)
w2enjun (L4);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
[univx1 univx2];
[w1enjcr] (T1)
[w1pleas] (T2)
[w1well] (T3)
[w1enjun] (T4);
[w2enjcr] (T5)
[w2pleas] (T6)
[w2well] (T7)
[w2enjun] (T8);
MODEL CONSTRAINT: L1 = 4 - L2 - L3 - L4;
                  T1 = 0 - T2 - T3 - T4;
            !      L5 = 4 - L6 - L7 - L8;
                  T5 = 0 - T6 - T7 - T8;
output: sampstat residual stdyx tech4 modindices;
```

$\chi^2_{(18)} = 61.290$, $p < .001$

$\Delta\chi^2_{(3)} = 6.288$, n.s.

CFI = .974

ΔCFI = .002 pass

TLI = .959

RMSEA = .076 (CI=.056 .098)

Weak (Loadings) Invariance with Effect Coded Scaling

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	0.596	0.041	14.432	0.000
W1PLEAS	1.310	0.036	36.858	0.000
W1WELL	1.304	0.036	35.768	0.000
W1ENJUN	0.789	0.037	21.456	0.000
UNIVX2 BY				
W2ENJCR	0.596	0.041	14.432	0.000
W2PLEAS	1.310	0.036	36.858	0.000
W2WELL	1.304	0.036	35.768	0.000
W2ENJUN	0.789	0.037	21.456	0.000
UNIVX2 WITH				
UNIVX1	1.594	0.171	9.319	0.000
W1ENJCR WITH				
W2ENJCR	1.602	0.184	8.716	0.000
W1PLEAS WITH				
W2PLEAS	0.366	0.153	2.399	0.016
W1WELL WITH				
W2WELL	0.137	0.114	1.202	0.229
W1ENJUN WITH				
W2ENJUN	1.731	0.173	10.032	0.000
Means				
UNIVX1	6.435	0.086	74.652	0.000
UNIVX2	6.524	0.086	75.465	0.000
Intercepts				
W1ENJCR	2.504	0.278	9.010	0.000
W1PLEAS	-2.340	0.239	-9.789	0.000
W1WELL	-2.585	0.241	-10.718	0.000
W1ENJUN	2.421	0.247	9.783	0.000
W2ENJCR	2.706	0.280	9.662	0.000
W2PLEAS	-2.449	0.240	-10.221	0.000
W2WELL	-2.474	0.243	-10.166	0.000
W2ENJUN	2.217	0.250	8.873	0.000
Variances				
UNIVX1	2.368	0.204	11.596	0.000
UNIVX2	2.452	0.206	11.883	0.000
Residual Variances				
W1ENJCR	3.289	0.247	13.326	0.000
W1PLEAS	2.409	0.234	10.304	0.000
W1WELL	0.635	0.166	3.820	0.000
W1ENJUN	2.854	0.218	13.108	0.000
W2ENJCR	2.930	0.218	13.425	0.000
W2PLEAS	1.666	0.189	8.822	0.000
W2WELL	0.575	0.149	3.857	0.000
W2ENJUN	2.650	0.202	13.134	0.000

Strong (Intercepts) Invariance with Effect Coded Scaling

```
MODEL:
univx1 by w1enjcr* (L1)
w1pleas (L2)
w1well (L3)
w1enjun (L4);
univx2 by w2enjcr* (L1)
w2pleas (L2)
w2well (L3)
w2enjun (L4);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
[univx1 univx2];
[w1enjcr] (T1)
[w1pleas] (T2)
[w1well] (T3)
[w1enjun] (T4);
[w2enjcr] (T1)
[w2pleas] (T2)
[w2well] (T3)
[w2enjun] (T4);
MODEL CONSTRAINT: L1 = 4 - L2 - L3 - L4;
                  T1 = 0 - T2 - T3 - T4;
 !                L5 = 4 - L6 - L7 - L8;
 !                T5 = 0 - T6 - T7 - T8;
output: sampstat residual stdyx tech4 modindices (5);
```

$\chi^2_{(21)} = 79.104$, $p < .001$

$\Delta\chi^2_{(3)} = 17.814$, $p < .001$

CFI = .965

ΔCFI = .021 fail

TLI = .953

RMSEA = .082 (CI=.063 .102)

Strong (Intercepts) Invariance with Effect Coded Scaling

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	0.602	0.041	14.562	0.000
W1PLEAS	1.309	0.036	36.768	0.000
W1WELL	1.308	0.037	35.501	0.000
W1ENJUN	0.780	0.037	21.061	0.000
UNIVX2 BY				
W2ENJCR	0.602	0.041	14.562	0.000
W2PLEAS	1.309	0.036	36.768	0.000
W2WELL	1.308	0.037	35.501	0.000
W2ENJUN	0.780	0.037	21.061	0.000
UNIVX2 WITH				
UNIVX1	1.591	0.171	9.321	0.000
W1ENJCR WITH				
W2ENJCR	1.592	0.184	8.651	0.000
W1PLEAS WITH				
W2PLEAS	0.369	0.153	2.405	0.016
W1WELL WITH				
W2WELL	0.126	0.115	1.099	0.272
W1ENJUN WITH				
W2ENJUN	1.723	0.173	9.937	0.000
Means				
UNIVX1	6.418	0.085	75.320	0.000
UNIVX2	6.534	0.086	76.049	0.000
Intercepts				
W1ENJCR	2.580	0.277	9.307	0.000
W1PLEAS	-2.399	0.237	-10.120	0.000
W1WELL	-2.549	0.243	-10.476	0.000
W1ENJUN	2.368	0.249	9.518	0.000
W2ENJCR	2.580	0.277	9.307	0.000
W2PLEAS	-2.399	0.237	-10.120	0.000
W2WELL	-2.549	0.243	-10.476	0.000
W2ENJUN	2.368	0.249	9.518	0.000
Variances				
UNIVX1	2.362	0.204	11.583	0.000
UNIVX2	2.444	0.206	11.865	0.000
Residual Variances				
W1ENJCR	3.300	0.248	13.288	0.000
W1PLEAS	2.421	0.235	10.287	0.000
W1WELL	0.631	0.169	3.743	0.000
W1ENJUN	2.873	0.220	13.072	0.000
W2ENJCR	2.937	0.219	13.397	0.000
W2PLEAS	1.679	0.190	8.814	0.000
W2WELL	0.568	0.151	3.754	0.000
W2ENJUN	2.676	0.204	13.086	0.000

Strong (Intercepts) Partial Invariance with Effect Coded Scaling

```
MODEL:
univx1 by w1enjcr* (L1)
w1pleas (L2)
w1well (L3)
w1enjun (L4);
univx2 by w2enjcr* (L1)
w2pleas (L2)
w2well (L3)
w2enjun (L4);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
[univx1 univx2];
[w1enjcr] (T1)
[w1pleas] (T2)
[w1well] (T3)
[w1enjun] (T4);
[w2enjcr] (T1)
[w2pleas] (T2)
[w2well] (T3)
[w2enjun]; !(T4)
MODEL CONSTRAINT: L1 = 4 - L2 - L3 - L4;
                  T1 = 0 - T2 - T3 - T4;
 !                L5 = 4 - L6 - L7 - L8;
 !                T5 = 0 - T6 - T7 - T8;
output: sampstat residual stdyx tech4 modindices (5);
```

$\chi^2_{(20)} = 69.035$, $p < .001$

$\Delta\chi^2_{(2)} = 7.745$, $p < .05$

CFI = .970

ΔCFI = .004 pass – partial inv

TLI = .958

RMSEA = .077 (CI=.058 .097)

Strong (Intercepts) Partial Invariance with Effect Coded Scaling

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
UNIVX1 BY				
W1ENJCR	0.602	0.041	14.601	0.000
W1PLEAS	1.304	0.035	36.792	0.000
W1WELL	1.306	0.037	35.759	0.000
W1ENJUN	0.789	0.037	21.442	0.000
UNIVX2 BY				
W2ENJCR	0.602	0.041	14.601	0.000
W2PLEAS	1.304	0.035	36.792	0.000
W2WELL	1.306	0.037	35.759	0.000
W2ENJUN	0.789	0.037	21.442	0.000
UNIVX2 WITH				
UNIVX1	1.598	0.171	9.322	0.000
W1ENJCR WITH				
W2ENJCR	1.594	0.184	8.666	0.000
W1PLEAS WITH				
W2PLEAS	0.362	0.153	2.362	0.018
W1WELL WITH				
W2WELL	0.130	0.114	1.137	0.255
W1ENJUN WITH				
W2ENJUN	1.732	0.173	10.035	0.000
Means				
UNIVX1	6.433	0.085	75.423	0.000
UNIVX2	6.584	0.087	75.372	0.000
Intercepts				
W1ENJCR	2.561	0.278	9.224	0.000
W1PLEAS	-2.409	0.237	-10.163	0.000
W1WELL	-2.576	0.242	-10.632	0.000
W1ENJUN	2.424	0.248	9.790	0.000
W2ENJCR	2.561	0.278	9.224	0.000
W2PLEAS	-2.409	0.237	-10.163	0.000
W2WELL	-2.576	0.242	-10.632	0.000
W2ENJUN	2.170	0.255	8.499	0.000
Variances				
UNIVX1	2.371	0.204	11.599	0.000
UNIVX2	2.455	0.207	11.878	0.000
Residual Variances				
W1ENJCR	3.297	0.248	13.292	0.000
W1PLEAS	2.438	0.235	10.384	0.000
W1WELL	0.626	0.167	3.754	0.000
W1ENJUN	2.854	0.218	13.107	0.000
W2ENJCR	2.935	0.219	13.399	0.000
W2PLEAS	1.686	0.189	8.921	0.000
W2WELL	0.565	0.149	3.787	0.000
W2ENJUN	2.651	0.202	13.128	0.000

Test of Latent Means

```
MODEL:
univx1 by w1enjcr* (L1)
w1pleas (L2)
w1well (L3)
w1enjun (L4);
univx2 by w2enjcr* (L1)
w2pleas (L2)
w2well (L3)
w2enjun (L4);
w1enjcr with w2enjcr;
w1pleas with w2pleas;
w1well with w2well;
w1enjun with w2enjun;
[univx1 univx2] (1); !constraining the two means to equality
[w1enjcr] (T1)
[w1pleas] (T2)
[w1well] (T3)
[w1enjun] (T4);
[w2enjcr] (T1)
[w2pleas] (T2)
[w2well] (T3)
[w2enjun]; !(T4)
MODEL CONSTRAINT: L1 = 4 - L2 - L3 - L4;
                  T1 = 0 - T2 - T3 - T4;
 !                L5 = 4 - L6 - L7 - L8;
 !                T5 = 0 - T6 - T7 - T8;
output: sampstat residual stdyx tech4 modindices (5);
```

$\chi^2_{(21)} = 73.121$, $p < .001$

$\Delta\chi^2_{(1)} = 4.086$, $p < .05$

CFI = .968

ΔCFI = .002

TLI = .958

RMSEA = .078 (CI=.059 .097)