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23RD - 25TH JULY 2025

Spain Tenerife Canary Islands

European Association of Methodology

Mixture Multigroup SEM: an empirical application revealing cross-national patterns in how human values predict climate policy support

Meijun Yao, Jeroen K. Vermunt, and Kim De Roover

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Cabildo de Tenerife

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Agencia Canaria de Investigación, Innovación y Sociedad de la Información

ICI Instituto Canario de Igualdad

tea

hogrefe

Overview

01 What is Mixture Multigroup SEM (MMG-SEM)?

02 How to conduct MMG-SEM with empirical data?

03 Mediation model with MMG-SEM

04 Discussion and conclusions

01

What is Mixture Multigroup SEM (MMG-SEM)

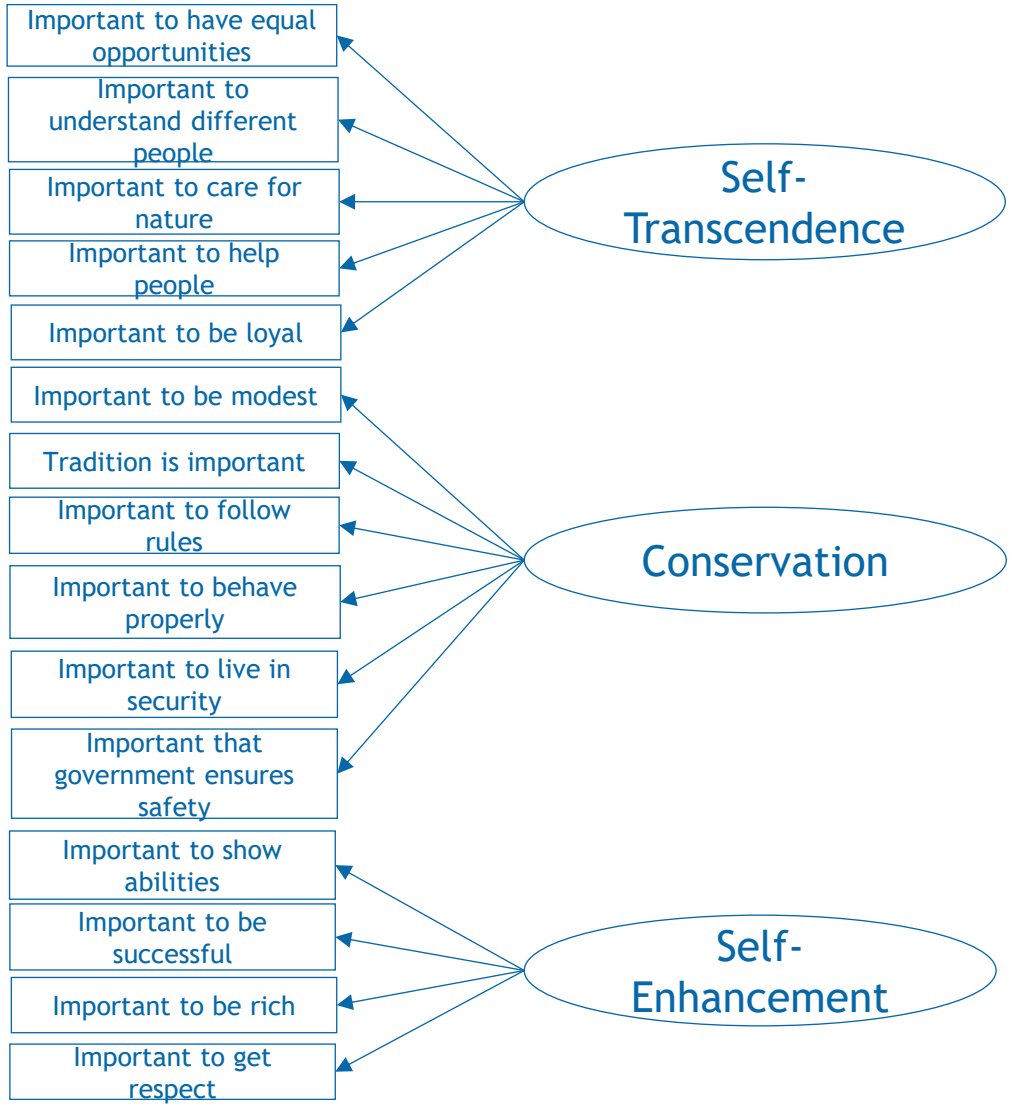
Mixture Multigroup Structural Equation Modeling

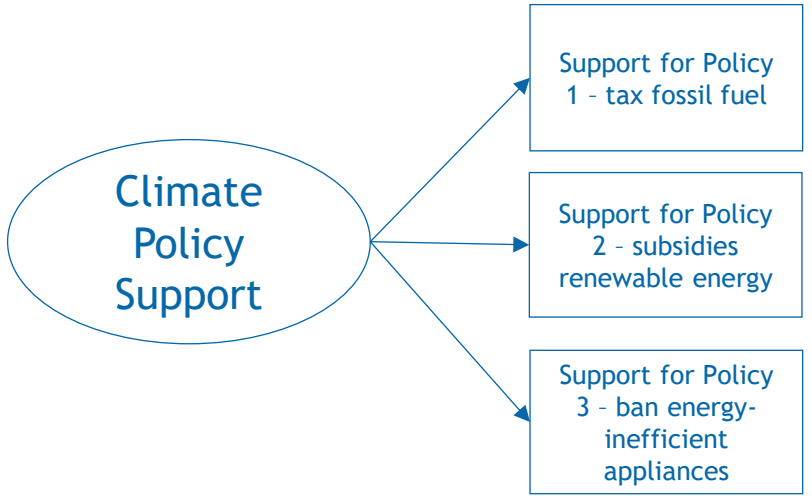

Self-
Transcendence

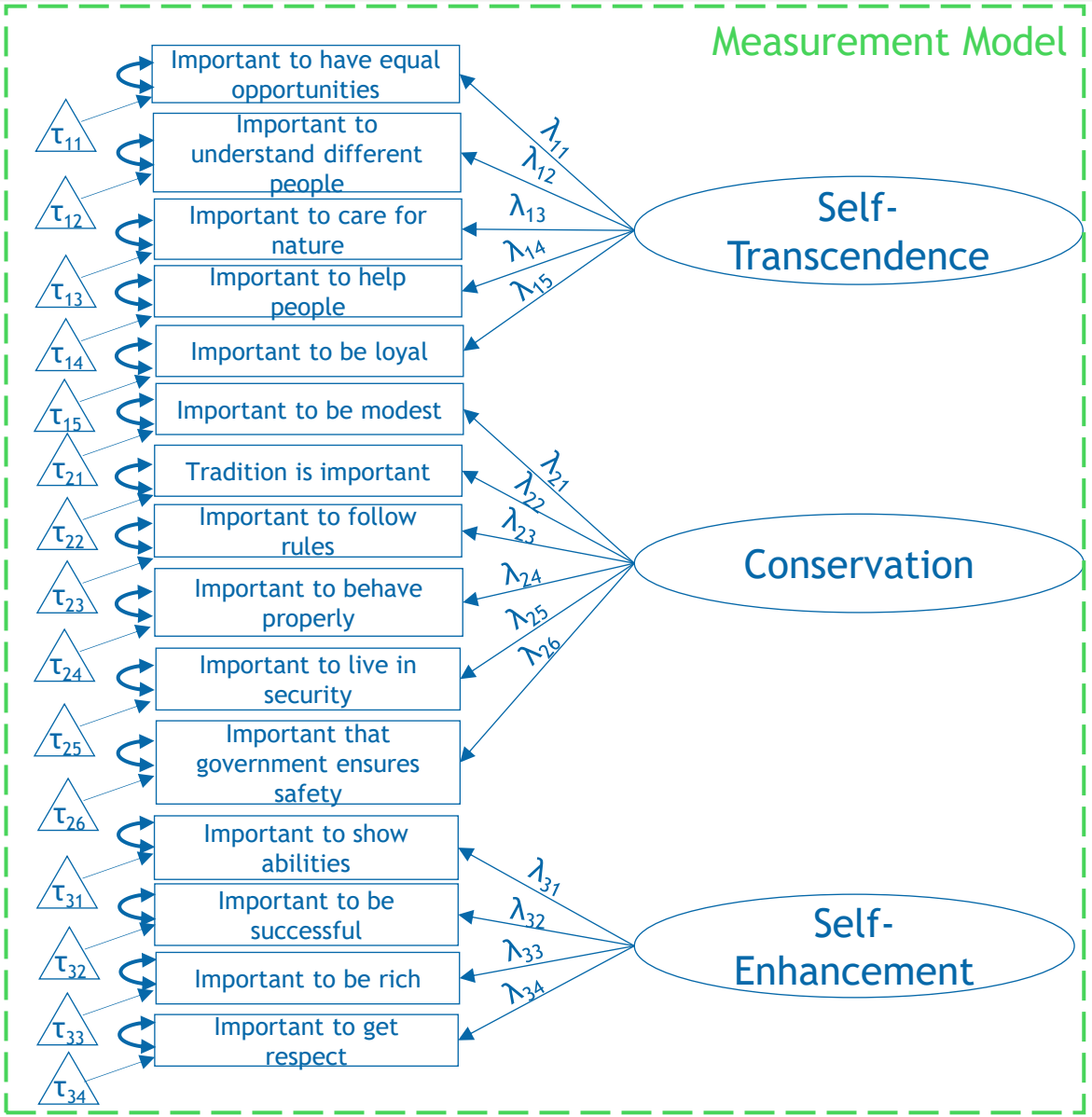

Conservation


Climate
Policy
Support


Self-
Enhancement


Important to have equal opportunities
Important to understand different people
Important to care for nature
Important to help people
Important to be loyal
Important to be modest
Tradition is important
Important to follow rules
Important to behave properly
Important to live in security
Important that government ensures safety
Important to show abilities
Important to be successful
Important to be rich
Important to get respect
Self-Transcendence
Conservation
Self-Enhancement


Climate Policy Support
Support for Policy 1 - tax fossil fuel
Support for Policy 2 - subsidies renewable energy
Support for Policy 3 - ban energy-inefficient appliances


Measurement Model
Important to have equal opportunities
Important to understand different people
Important to care for nature
Important to help people
Important to be loyal
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Tradition is important
Important to follow rules
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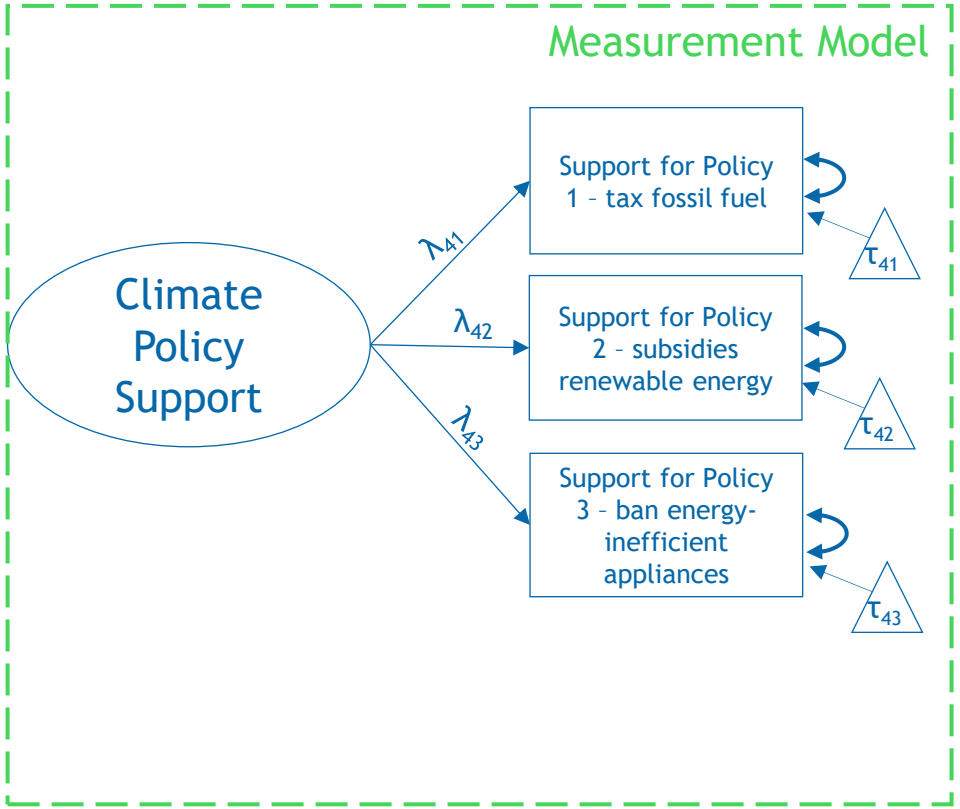
Self-Enhancement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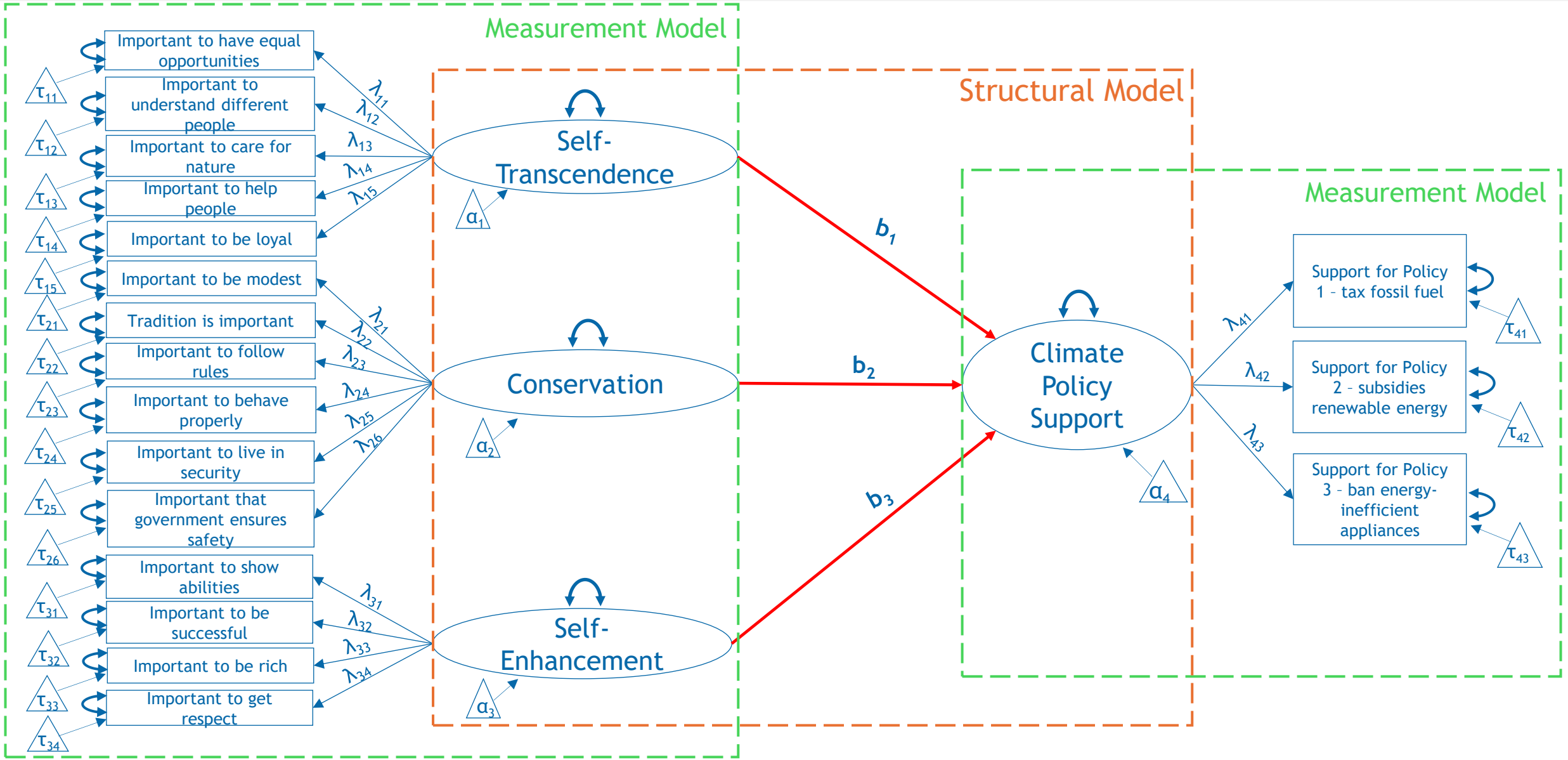
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Tradition is important
Important to follow rules
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Important to live in security
Important that government ensures safety
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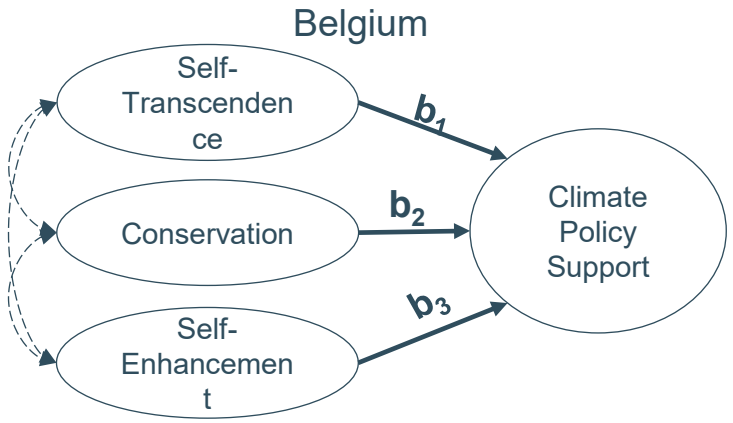
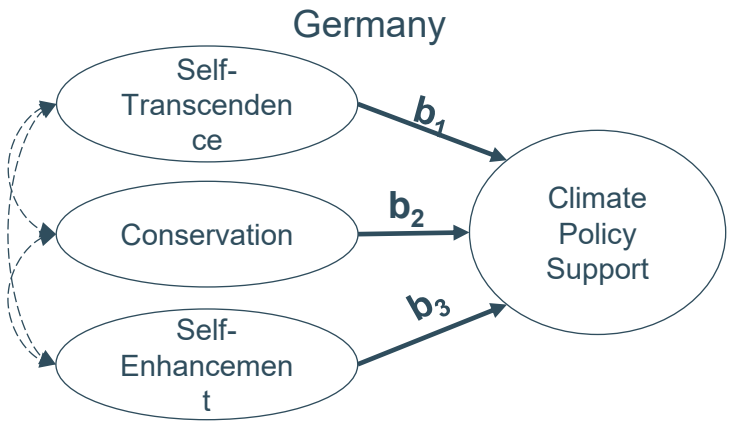
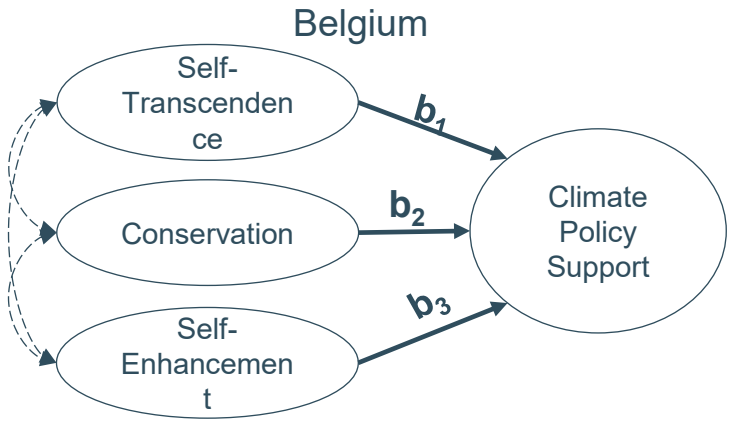
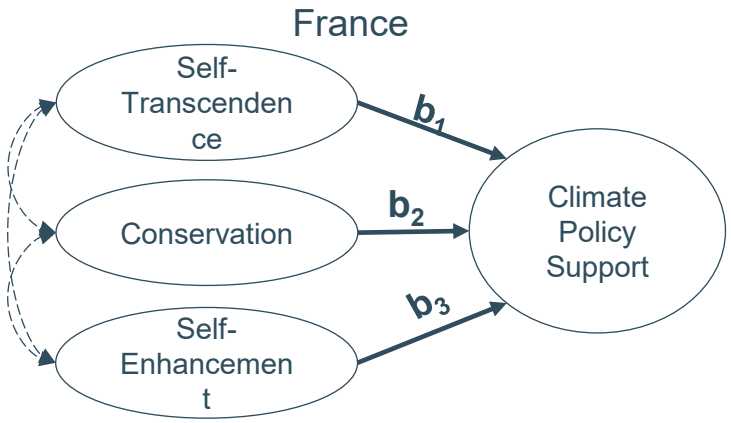
Important to be rich
Important to get respect
Self-Transcendence
Conservation
Self-Enhancement
Structural Model
Climate Policy Support
Measurement Model
Support for Policy 1 - tax fossil fuel
Support for Policy 2 - subsidies renewable energy
Support for Policy 3 - ban energy-inefficient appliances

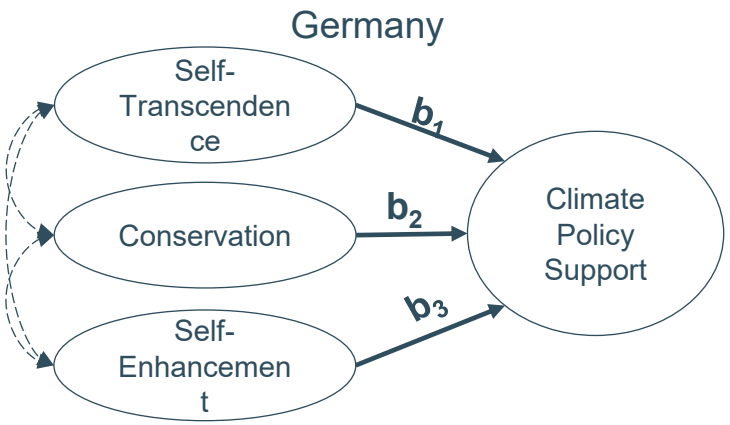
Mixture Multigroup Structural Equation Modeling

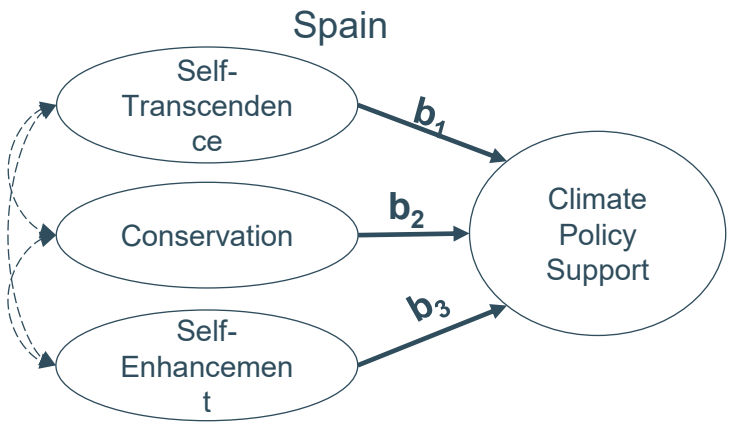

Belgium
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support

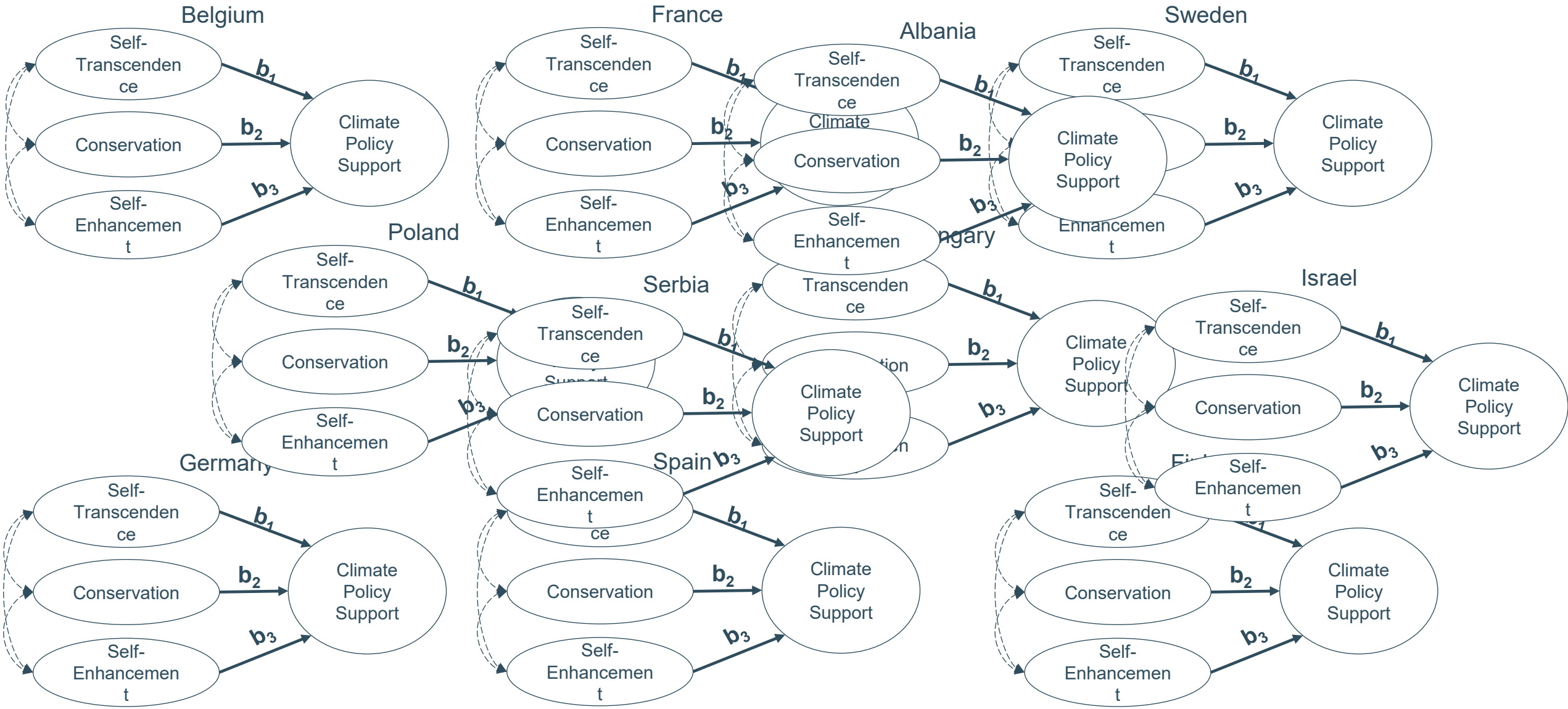

Germany
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support

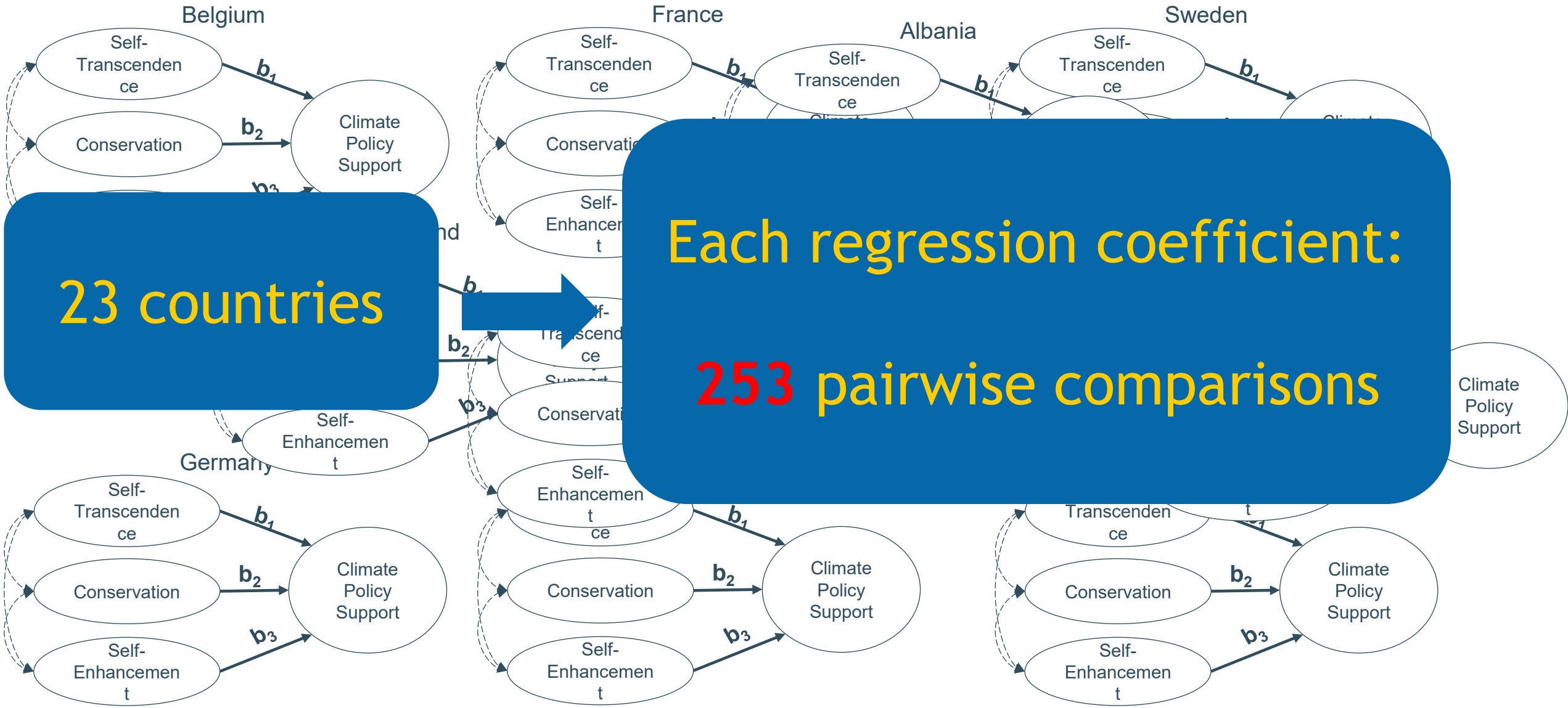

Belgium
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support


France
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support


Germany
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support

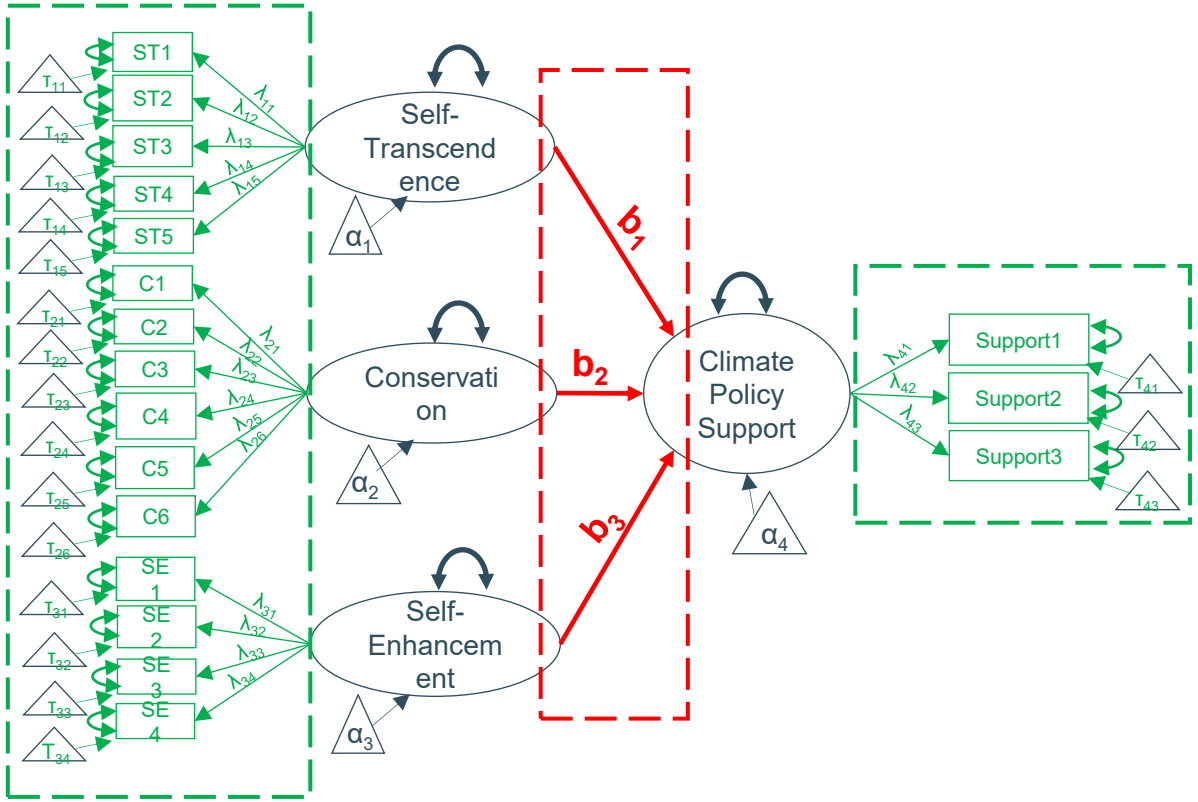

Spain
Self-Transcendence
Conservation
Self-Enhancement
b1
b2
b3
Climate Policy Support


Belgium
Self-Transcendence
Conservation
Self-Enhancement
Climate Policy Support
b1
b2
b3
France
Albania
Sweden
Poland
Serbia
Israel
Germany
Spain
Hungary

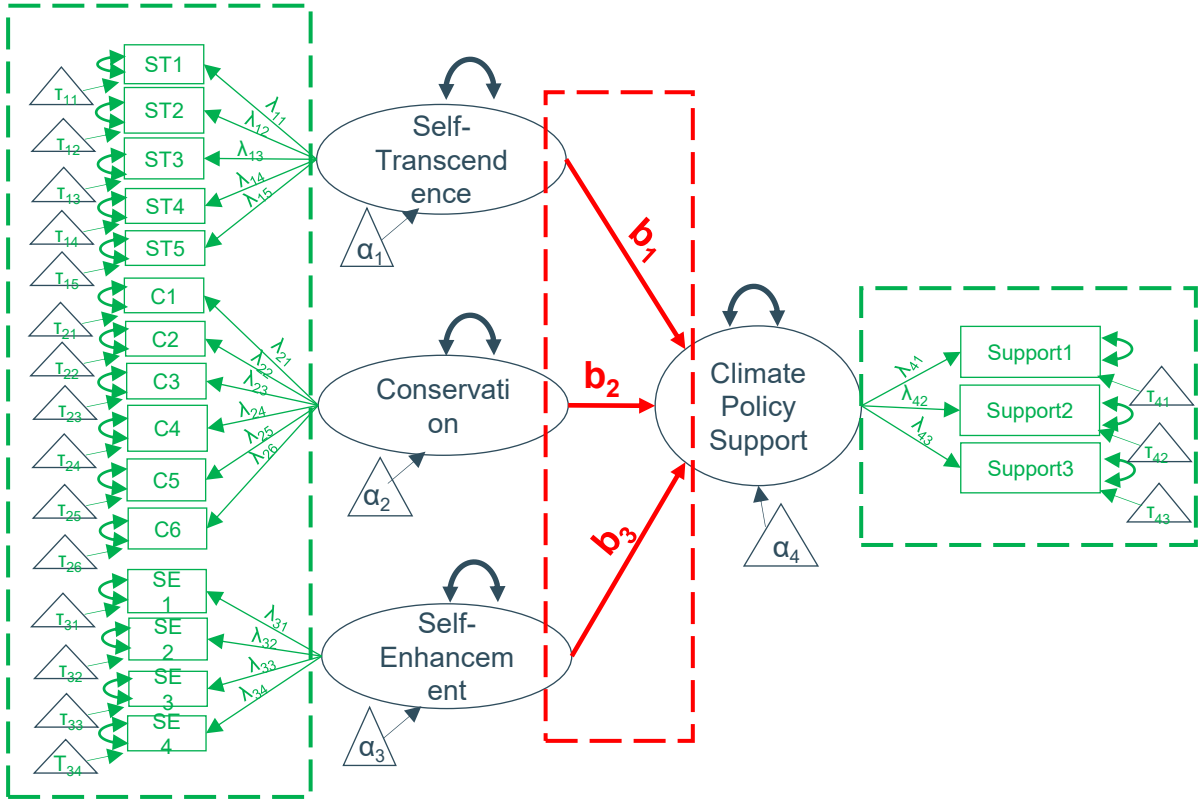

Belgium
Self-Transcendence
Conservation
Self-Enhancement
Climate Policy Support
b1
b2
b3
France
Albania
Sweden
Germany
23 countries
Each regression coefficient:
253 pairwise comparisons

- Group differences can also come from the **measurement model**

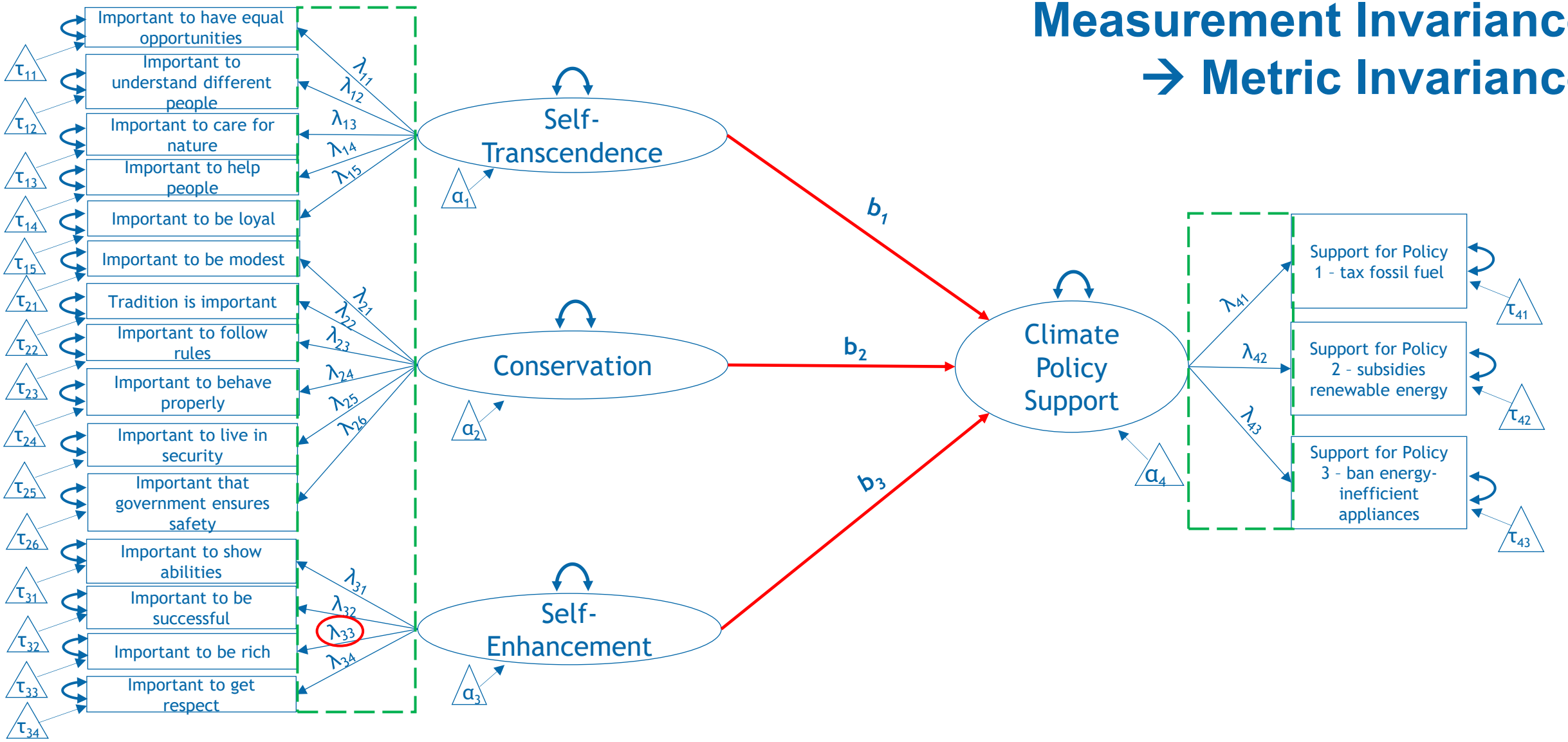
Belgium



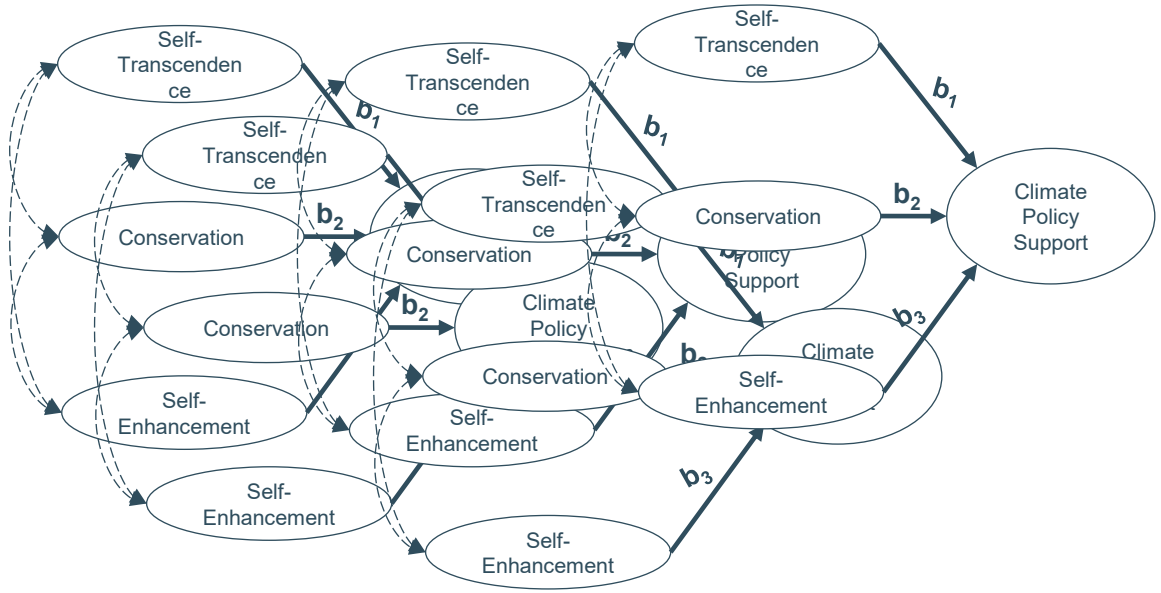
Germany



Measurement Invariance → Metric Invariance

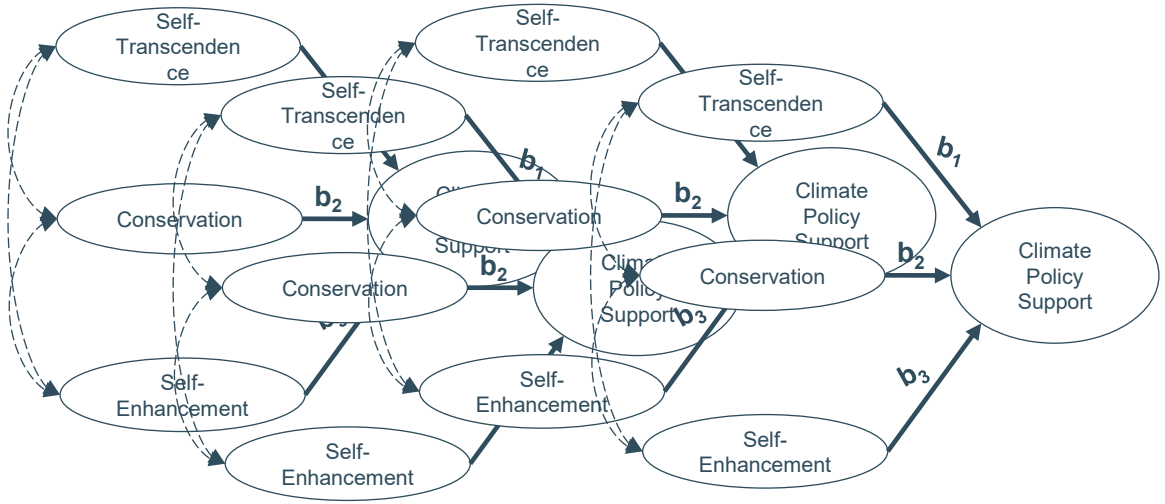


Mixture Multigroup Structural Equation Modeling



Belgium
France
Germany
Sweden
Finland
Spain

Cluster 1



Poland
Hungary
Albania
Serbia

Cluster 2

Mixture Multigroup Structural Equation Modeling

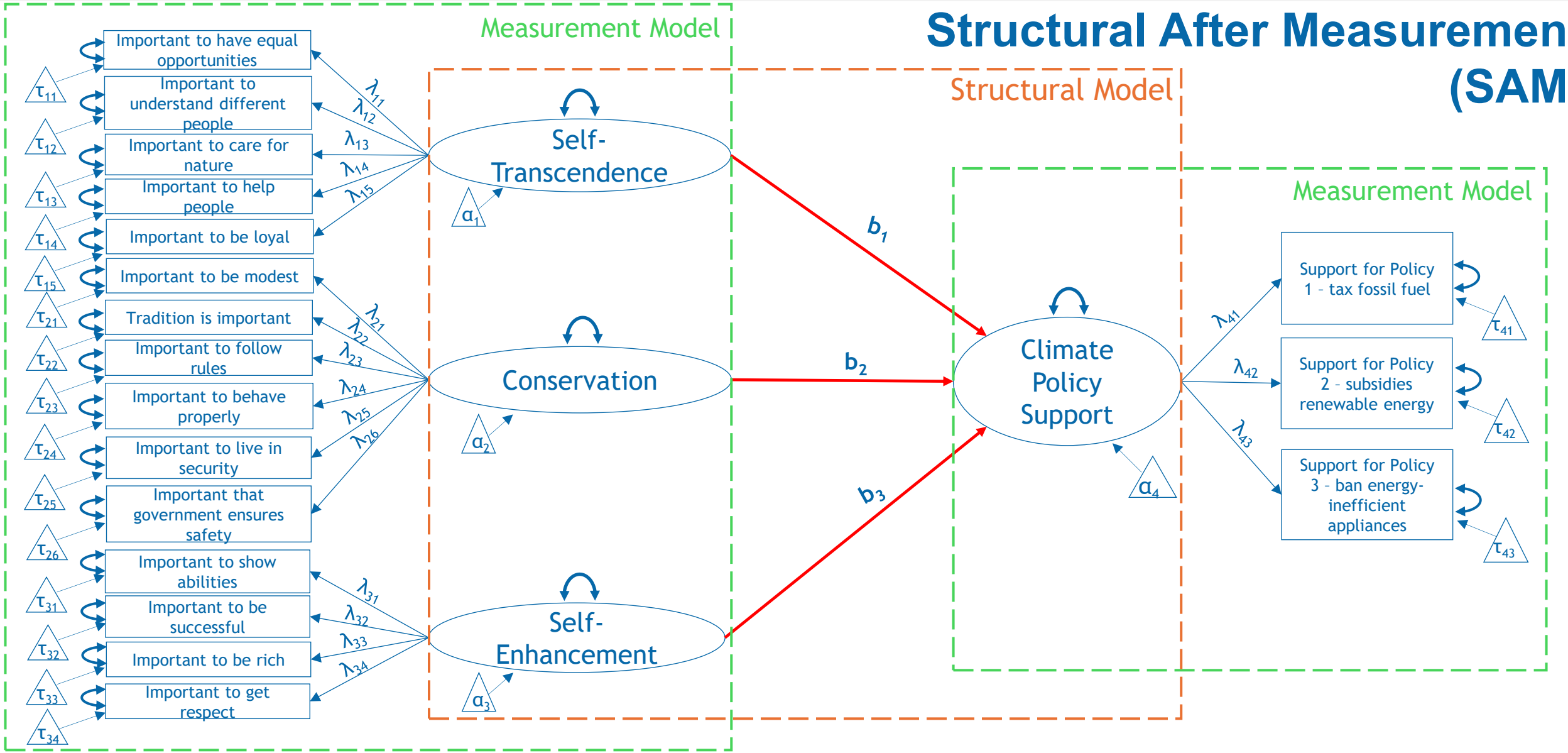
MMG-SEM

Efficient comparisons

Across many groups

Regression coefficients of latent variables

Structural After Measurement (SAM)



02

How to conduct MMG-SEM with empirical data?

Step 0: Data Preparation

- Data: European Social Survey Round 8 (ESS8) with 23 countries
- Variables:

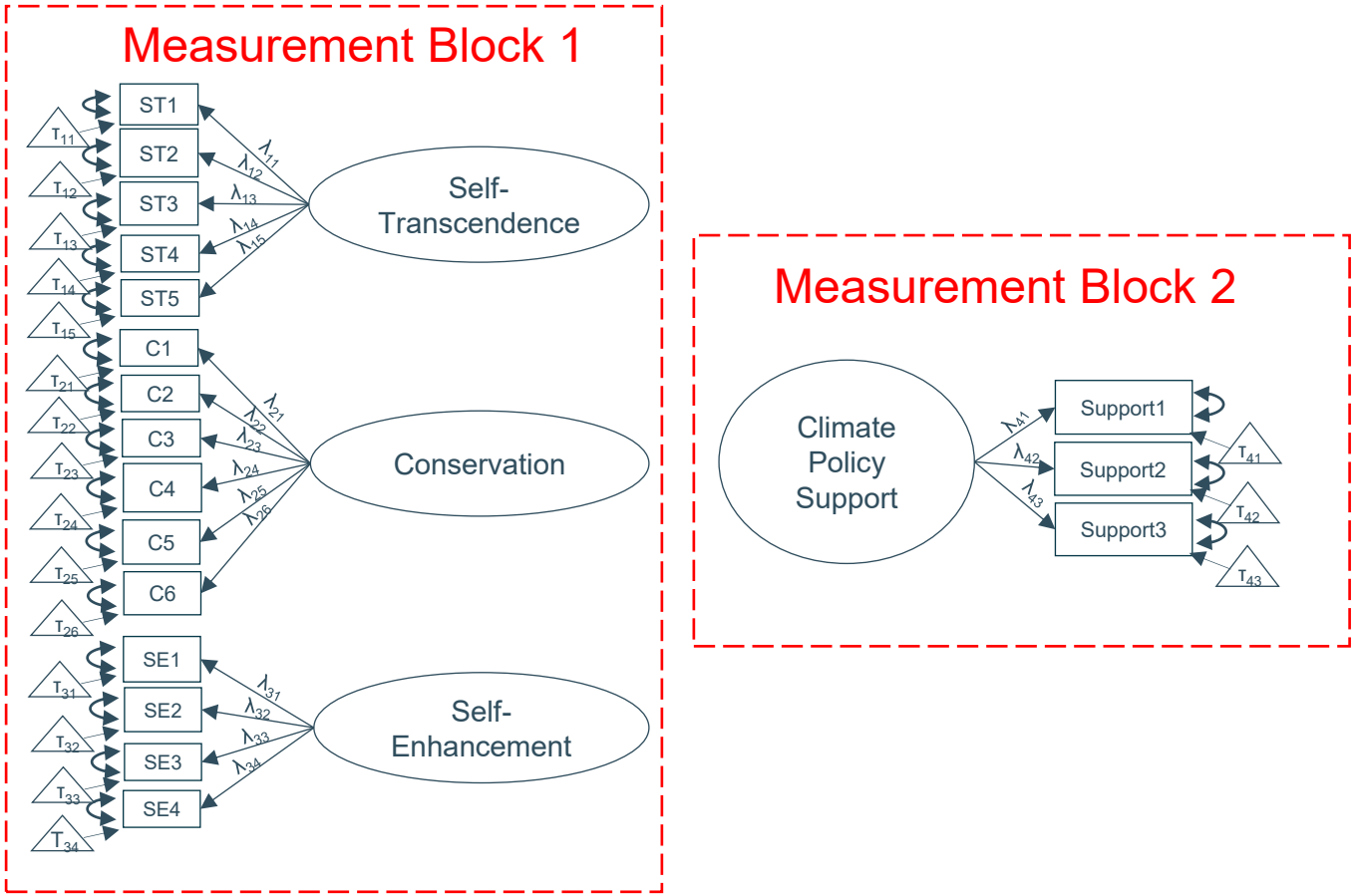
  Survey Items measuring the latent variables of interest

  (5 items for self-transcendence values, 6 items for conservation values, 4 items for self-enhancement values, and 3 items for climate policy support)

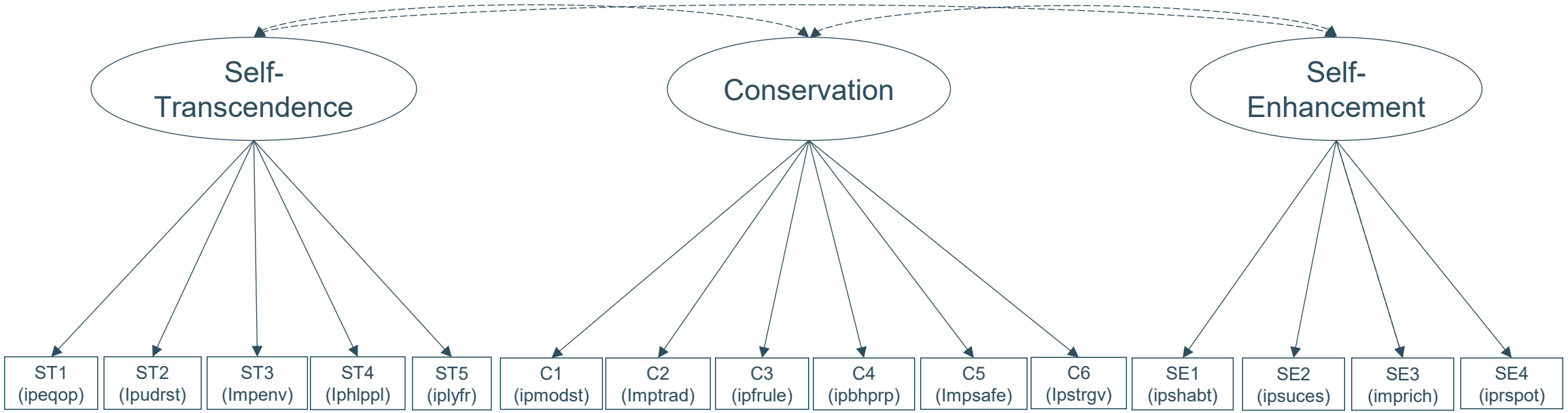
  +

  grouping variable (country)

Step 1: Measurement Model with Measurement Invariance Testing

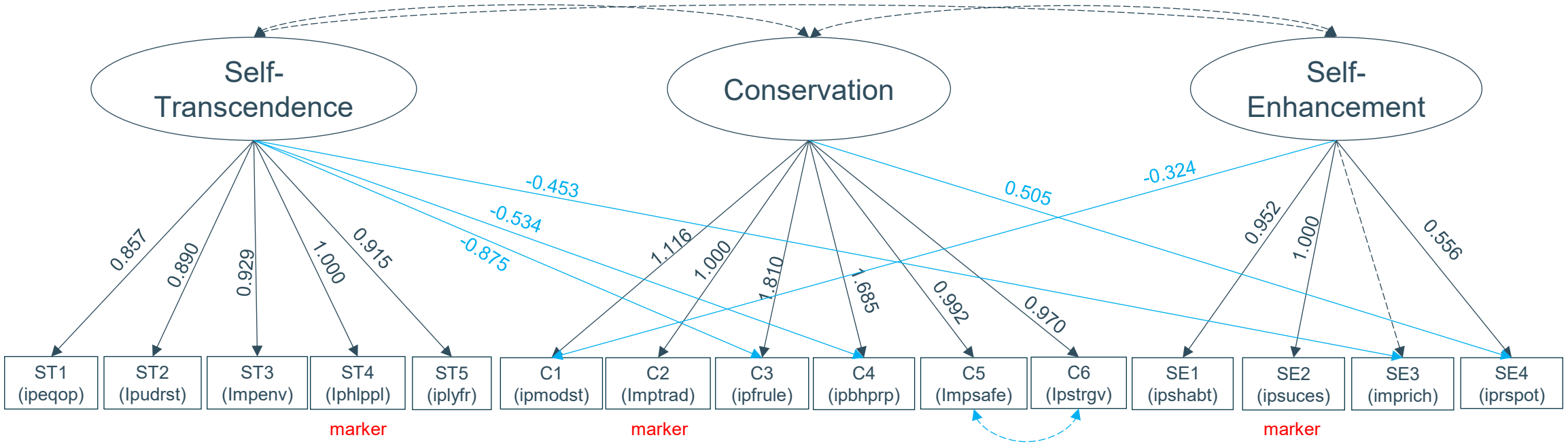


Measurement Block 1



Initial Configural Invariance: χ^2=20032,931, df=2001, CFI=0.854, RMSEA=0.076

Measurement Block 1



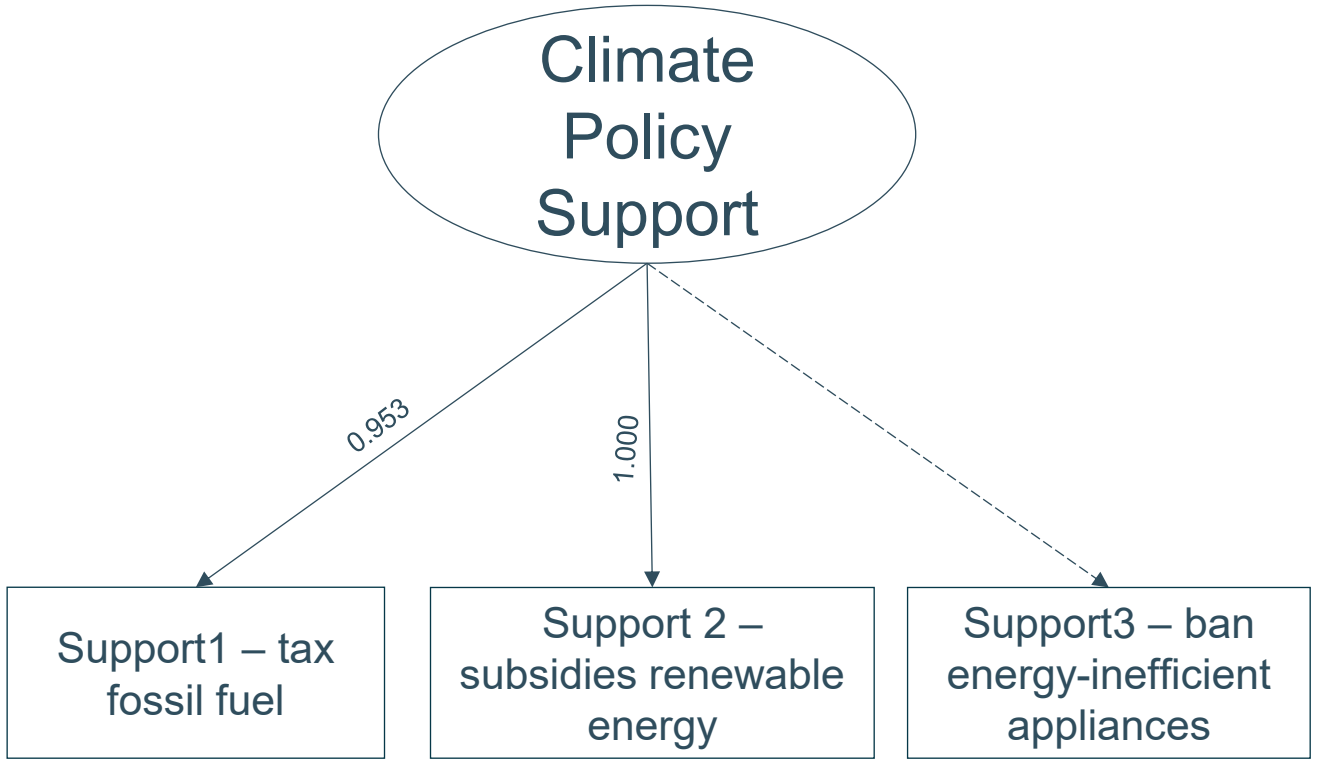
Initial Configural Invariance: χ^2=20032,931, df=2001, CFI=0.854, RMSEA=0.076

Final Configural Invariance: χ^2=11782.775, df=1863, CFI=0.920, RMSEA=0.059

Full Metric Invariance: χ^2=14413.249, df=2237, CFI=0.902, RMSEA=0.059

Partial Metric Invariance: χ^2=13779.825, df=2215, CFI=0.907, RMSEA=0.058

Measurement Block 2



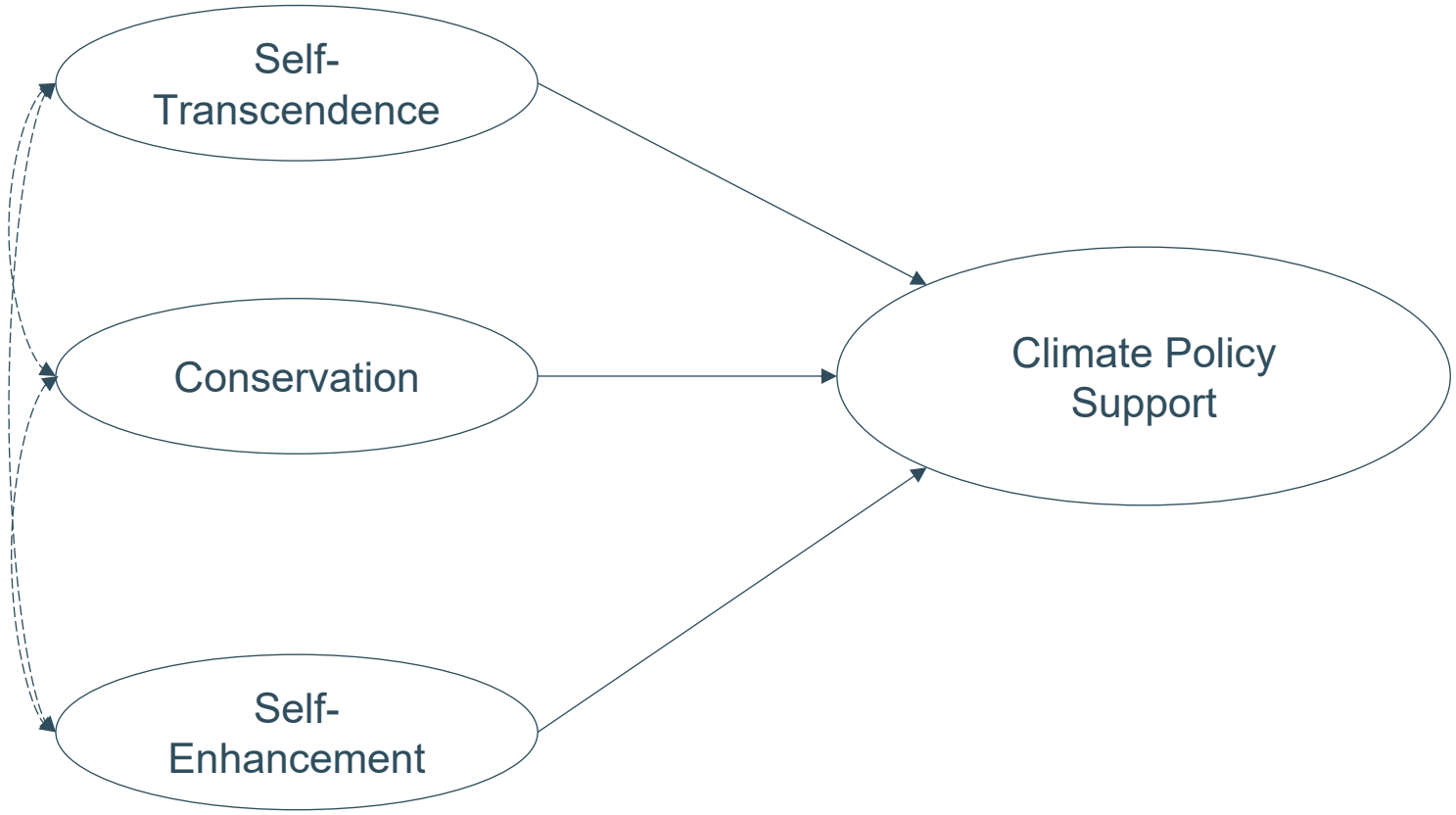
Initial Configural Invariance: just identified – perfect fit

Full Metric Invariance: χ^2=403.688, df=44, CFI=0.949, RMSEA=0.072

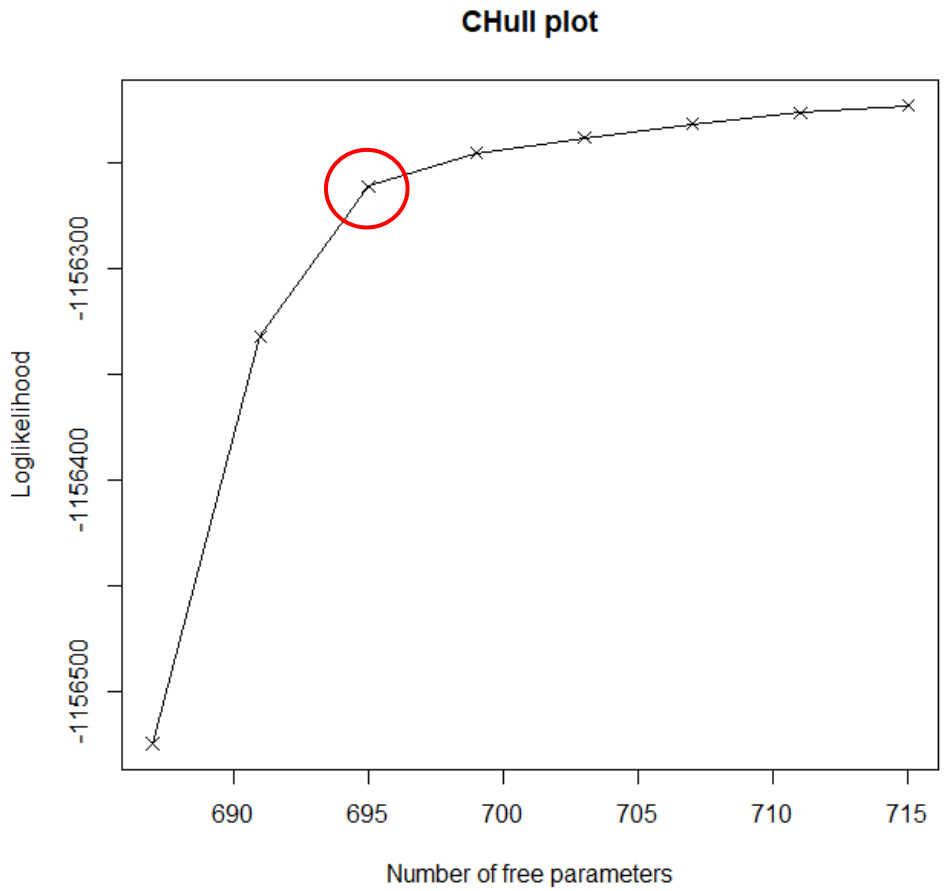
Partial Metric Invariance: χ^2=170.123, df=22, CFI=0.978, RMSEA=0.066

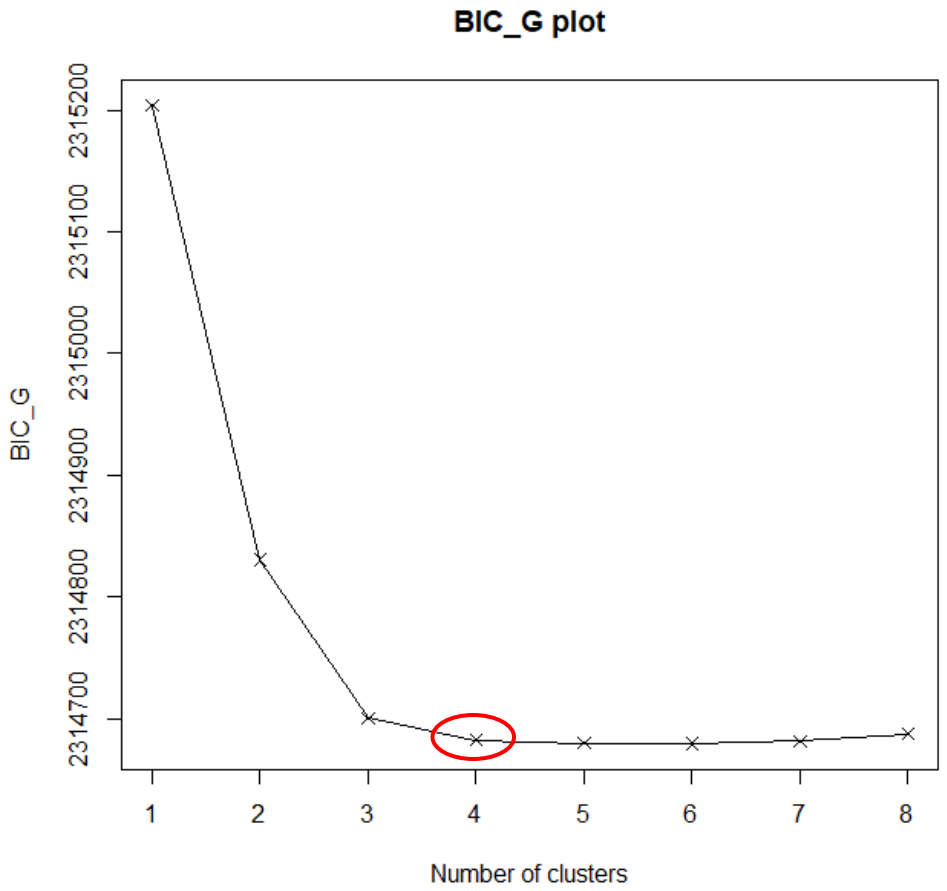
```
NoOpen.HV.Metric.M2.Marker<-'
SelfTran=~ST4+ST1+ST2+ST3+ST5+SE3+C3+C4
Conser=~C2+C1+C3+C4+C5+C6+SE4
SelfEnhan=~SE2+SE1+SE3+SE4+C1

##Add Error Term Correlation
C5~~C6
'

NoOpen.HV.Metric.Fit2.Marker<-cfa(model = NoOpen.HV.Metric.M2.Marker,
                                  data = ESS8,
                                  group = "country",
                                  estimator="MLR",
                                  missing="FIML",
                                  group.equal="loadings",
                                  group.partial=c("SelfEnhan=~SE3"))

CCPolSupport.PMetric.M1.MarkerSup2<-'
CCPolicySupport=~support2+support1+support3
'

CCPolSupport.PMetric.Fit1.MarkerSup2<-cfa(model = CCPolSupport.PMetric.M1.MarkerSup2,
                                          data = ESS8,
                                          group = "country",
                                          estimator="MLR",
                                          missing="FIML",
                                          group.equal="loadings",
                                          group.partial=c("CCPolicySupport=~support3"),
                                          bounds="wide")
```

Step 2: Mixture Clustering on Structural Model



Model Selection – CHull, BIC_G, AIC





```
Str_model<-'
CCPolicySupport~SelfTran+Conser+SelfEnhan
'


BasicModel.Selection<-ModelSelection(dat=ESS8,
                                     S1 = list(NoOpen.HV.Metric.M2.Marker,
                                               CCPolSupport.PMetric.M1.MarkerSup2), ##objects with lavaan syntax for the measurement model
                                     S2 = Str_model,
                                     group = "country",
                                     clusters=c(1,8), ##run from 1-8 clusters
                                     seed = 100,
                                     s1_fit = list(NoOpen.HV.Metric.Fit2.Marker,
                                                   CCPolSupport.PMetric.Fit1.MarkerSup2), #the lavaan cfa objects from the measurement model
                                     nstarts = 50L, #50 random starts
                                     missing="FIML")
```

lavaan objects from measurement model

```
Str_model<-'
CCPolicySupport~SelfTran+Conser+SelfEnhan
'


BasicModel.Selection<-ModelSelection(dat=ESS8,
                                     S1 = list(NoOpen.HV.Metric.M2.Marker,
                                               CCPolSupport.PMetric.M1.MarkerSup2), ##objects with lavaan syntax for the measurement model
                                     S2 = Str_model,
                                     group = "country",
                                     clusters=c(1,8), ##run from 1-8 clusters
                                     seed = 100,
                                     s1_fit = list(NoOpen.HV.Metric.Fit2.Marker,
                                                   CCPolSupport.PMetric.Fit1.MarkerSup2), #the lavaan cfa objects from the measurement model
                                     nstarts = 50L, #50 random starts
                                     missing="FIML")

BasicModel.4clus<-MMGSEM(dat=ESS8,
                         S1 = list(NoOpen.HV.Metric.M2.Marker, CCPolSupport.PMetric.M1.MarkerSup2),
                         S2 = Str_model,
                         group = "country",
                         nclus=4, ##4-cluster solution
                         seed = 100,
                         s1_fit = list(NoOpen.HV.Metric.Fit2.Marker, CCPolSupport.PMetric.Fit1.MarkerSup2),
                         nstarts = 50L,
                         missing="FIML")


round(BasicModel.4clus$posteriors[,1:4],digits = 3) ##check the posterior membership probabilities

BasicModel.4clus$param$beta_ks ##Check the cluster-specific regression coefficients
```

lavaan objects from measurement model

Cluster 1:
Lithuania

Cluster 2:
Hungary

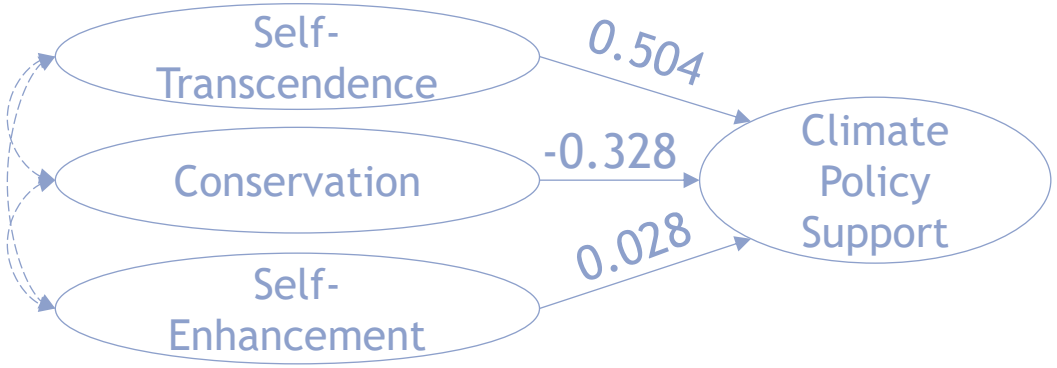
Cluster 3:
Austria, Belgium, Switzerland, Czech Republic, Germany, Spain, Finland, France, the UK, Italy, Netherlands, Norway, Portugal, Sweden

Cluster 4:
Estonia, Ireland, Israel, Iceland ($\hat{z}_{g4}$=0.995), Poland, Russia, Slovenia

Cluster 1:
Lithuania

Cluster 2:
Hungary

Cluster 3:
Austria, Belgium, Switzerland, Czech Republic, Germany, Spain, Finland, France, the UK, Italy, Netherlands, Norway, Portugal, Sweden



Cluster 4:
Estonia, Ireland, Israel, Iceland ($\hat{z}_{g4}$=0.995), Poland, Russia, Slovenia

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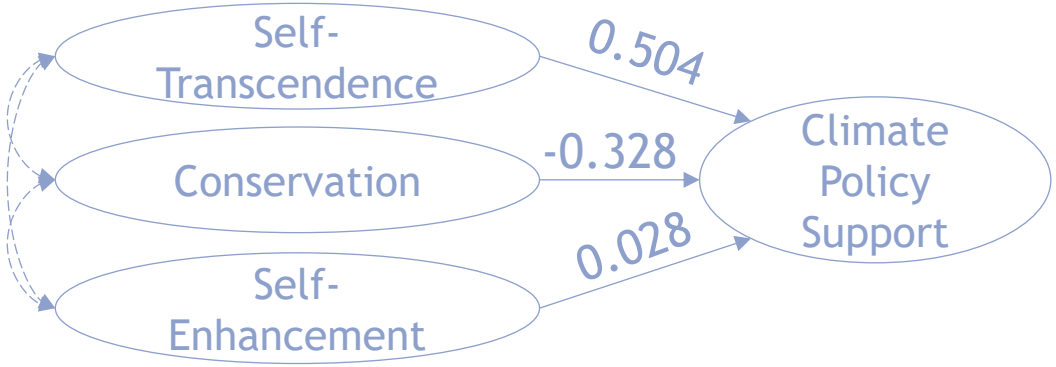

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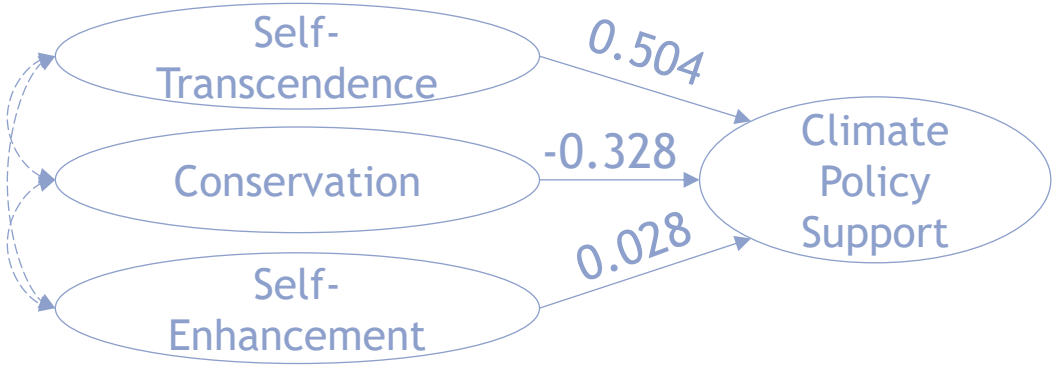

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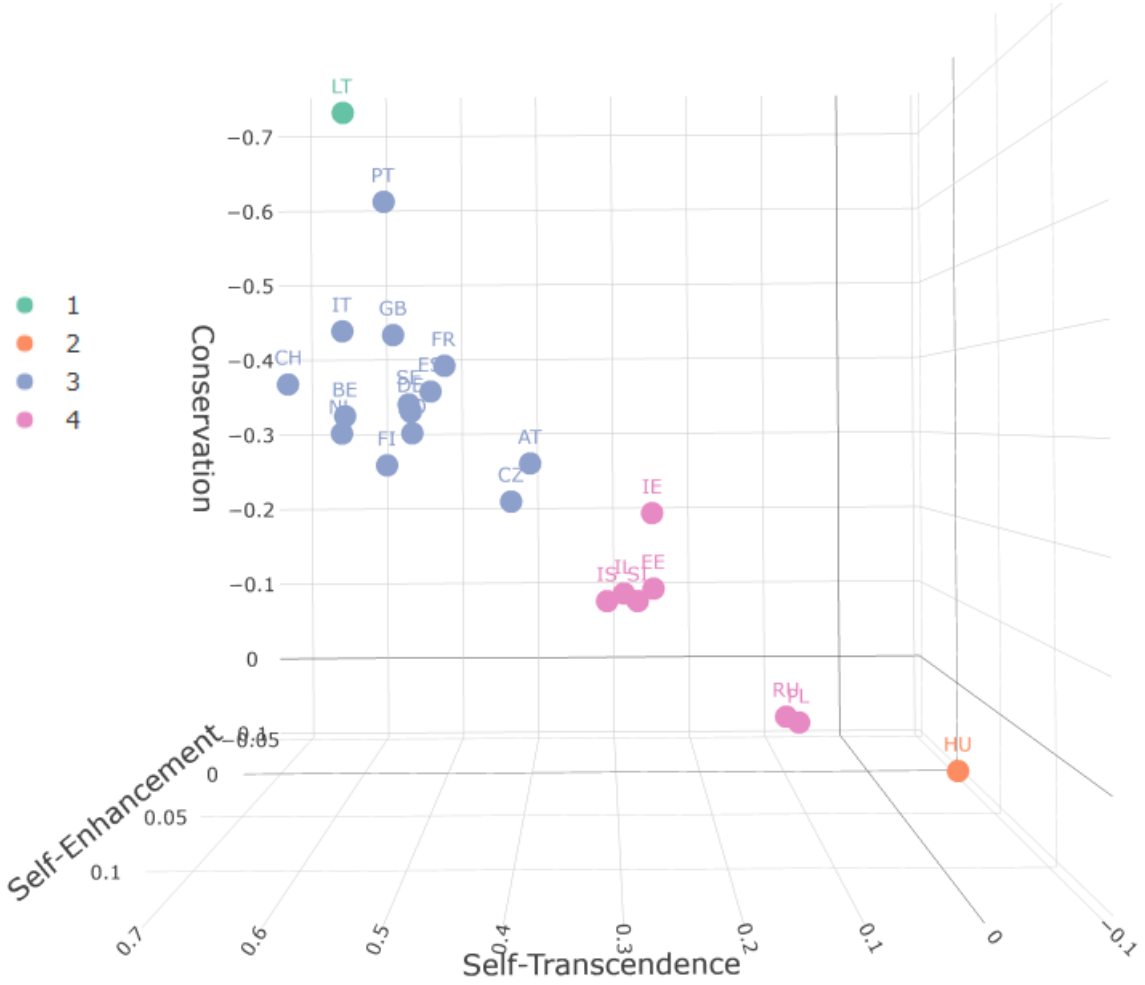
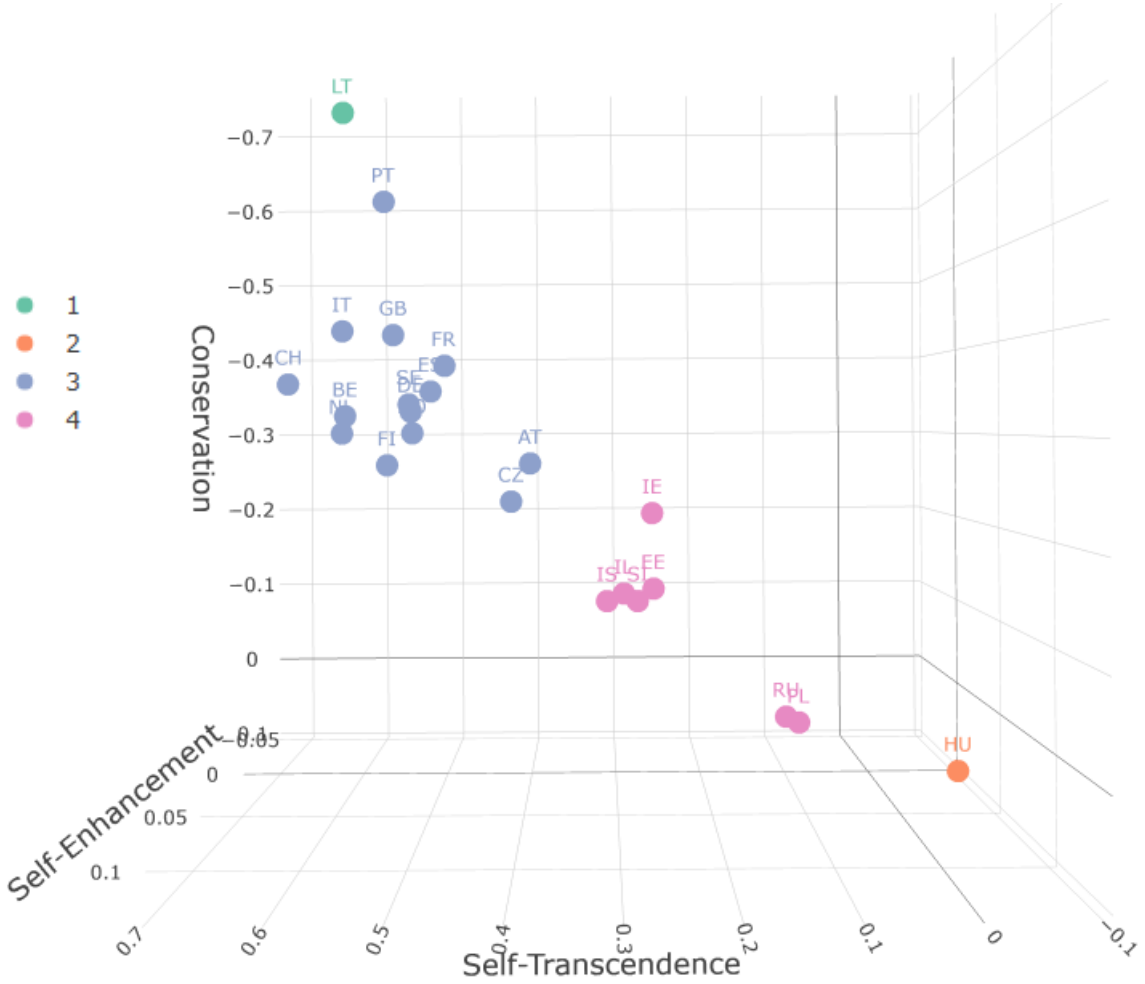
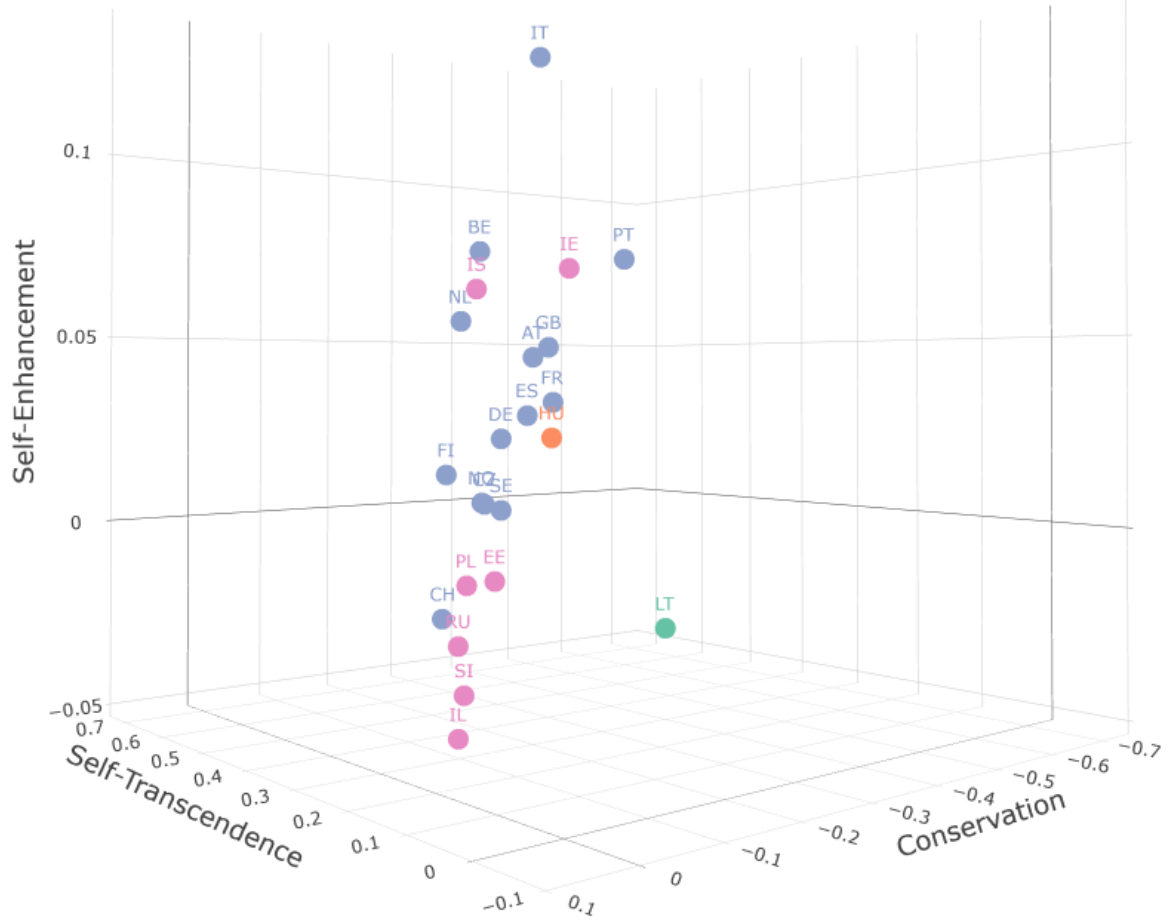
Step 3: Validation with SAM via MG-SEM estimation

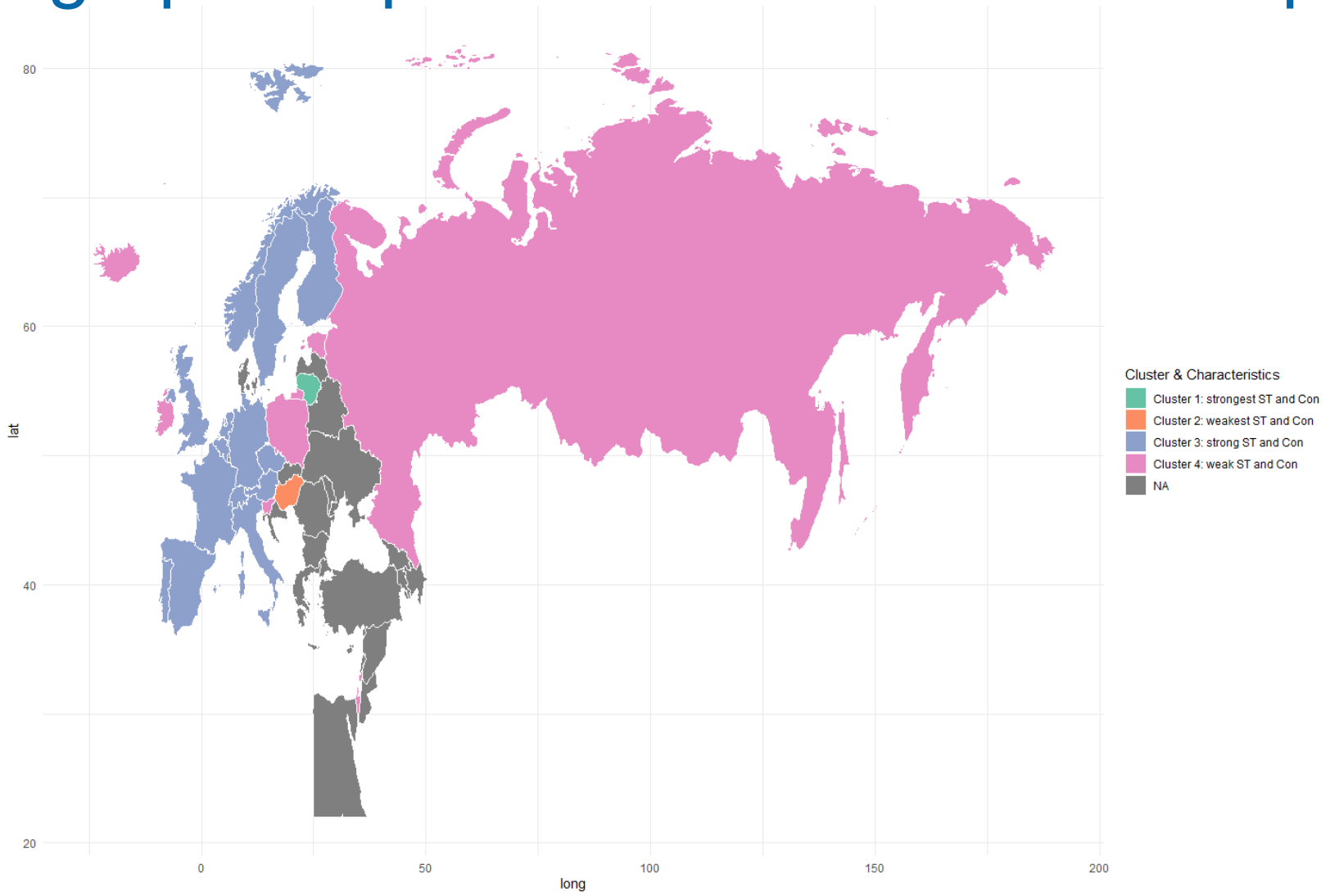


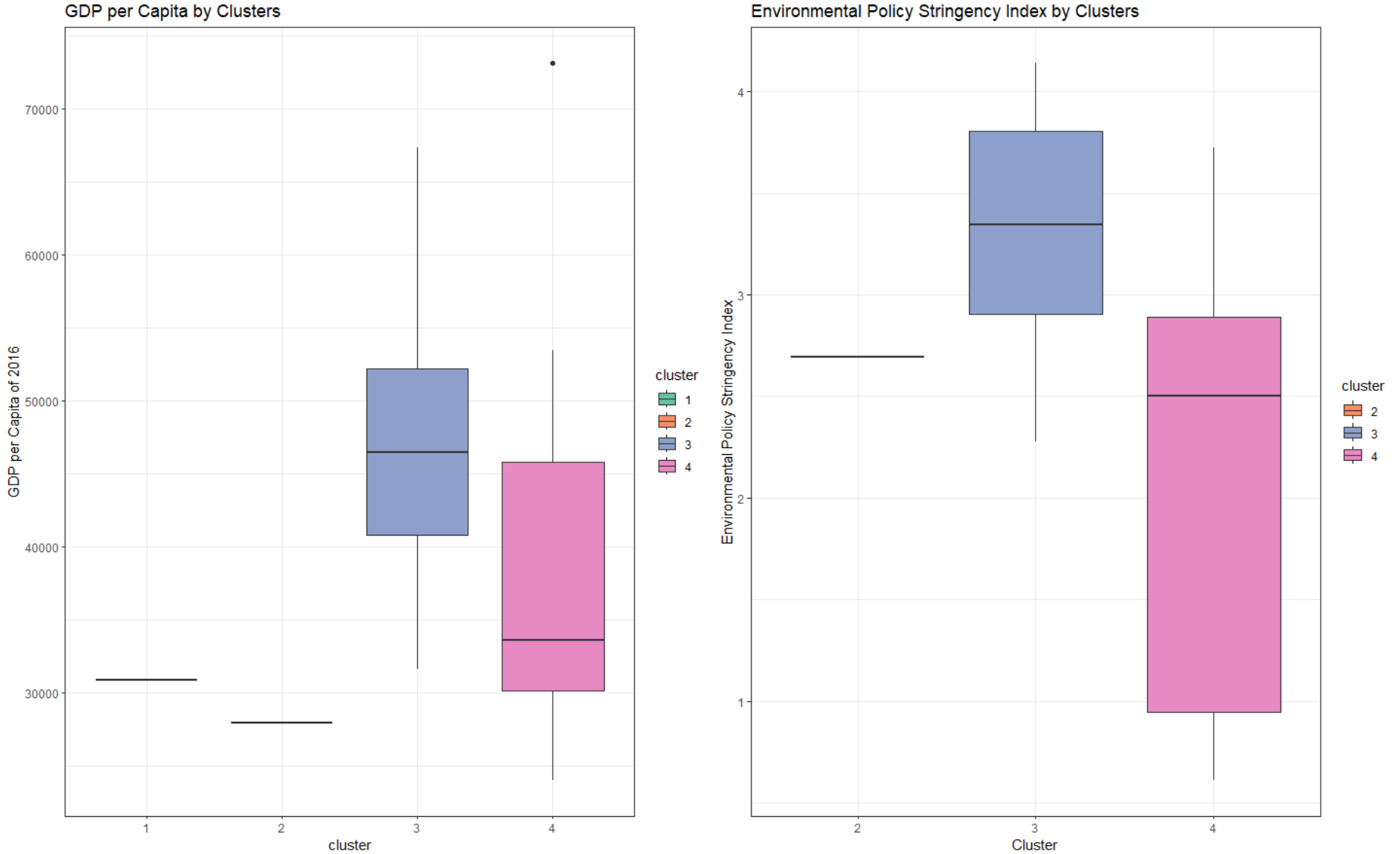
Step 3: Validation with SAM via MG-SEM estimation





Step 4: Geographical patterns and theoretical implications




GDP per Capita by Clusters
GDP per Capita of 2016
70000
60000
50000
40000
30000
1
2
3
4
cluster
cluster
1
2
3
4
Environmental Policy Stringency Index by Clusters
Environmental Policy Stringency Index
4
3
2
1
2
3
4
Cluster
cluster
2
3
4

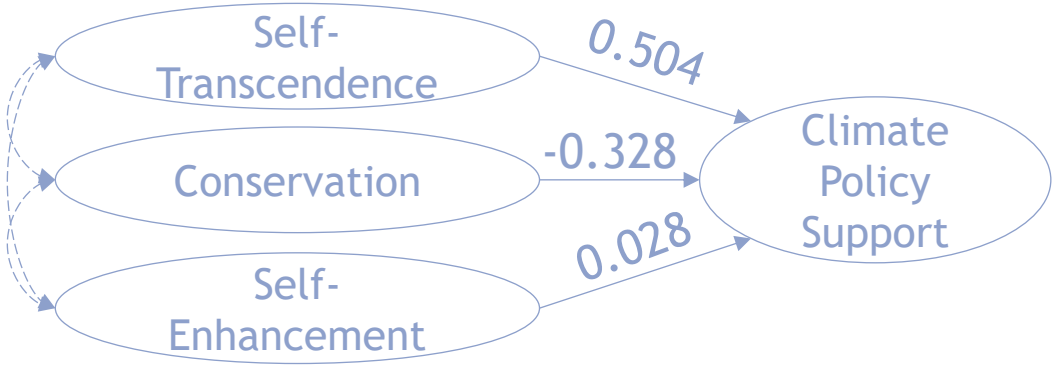
03

Mediation Model with MMG-SEM

Cluster 1:
Lithuania

Cluster 2:
Hungary

Cluster 3:
Austria, Belgium, Switzerland, Czech Republic, Germany, Spain, Finland, France, the UK, Italy, Netherlands, Norway, Portugal, Sweden



Cluster 4:
Estonia, Ireland, Israel, Iceland ($\hat{z}_{g4}$=0.995), Poland, Russia, Slovenia

Cluster 3:
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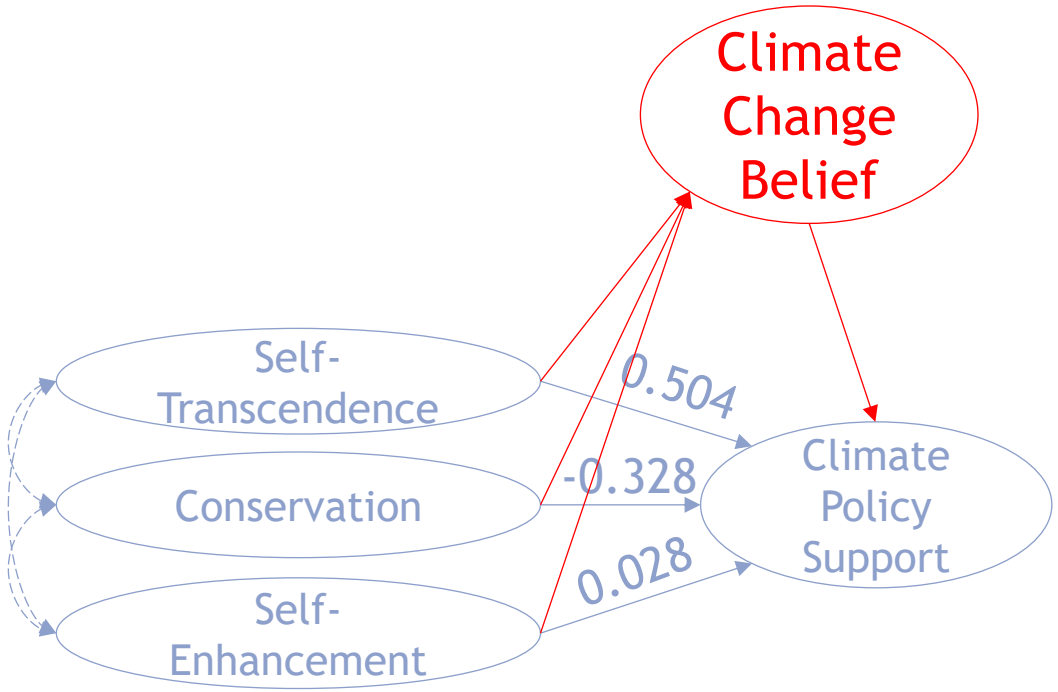

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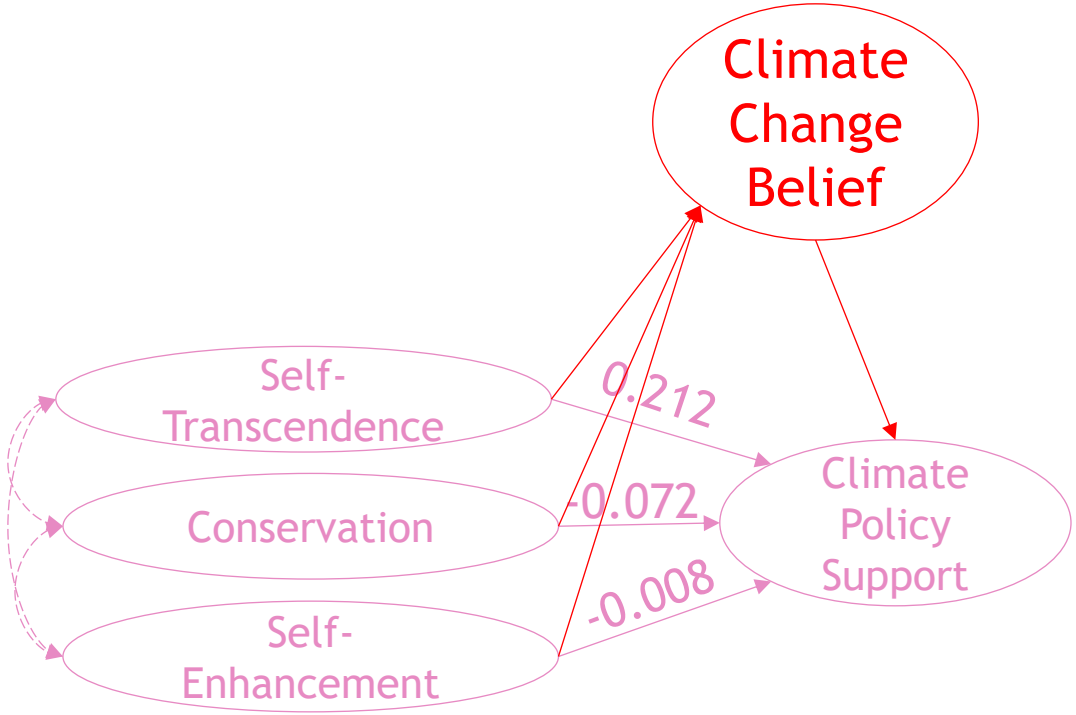
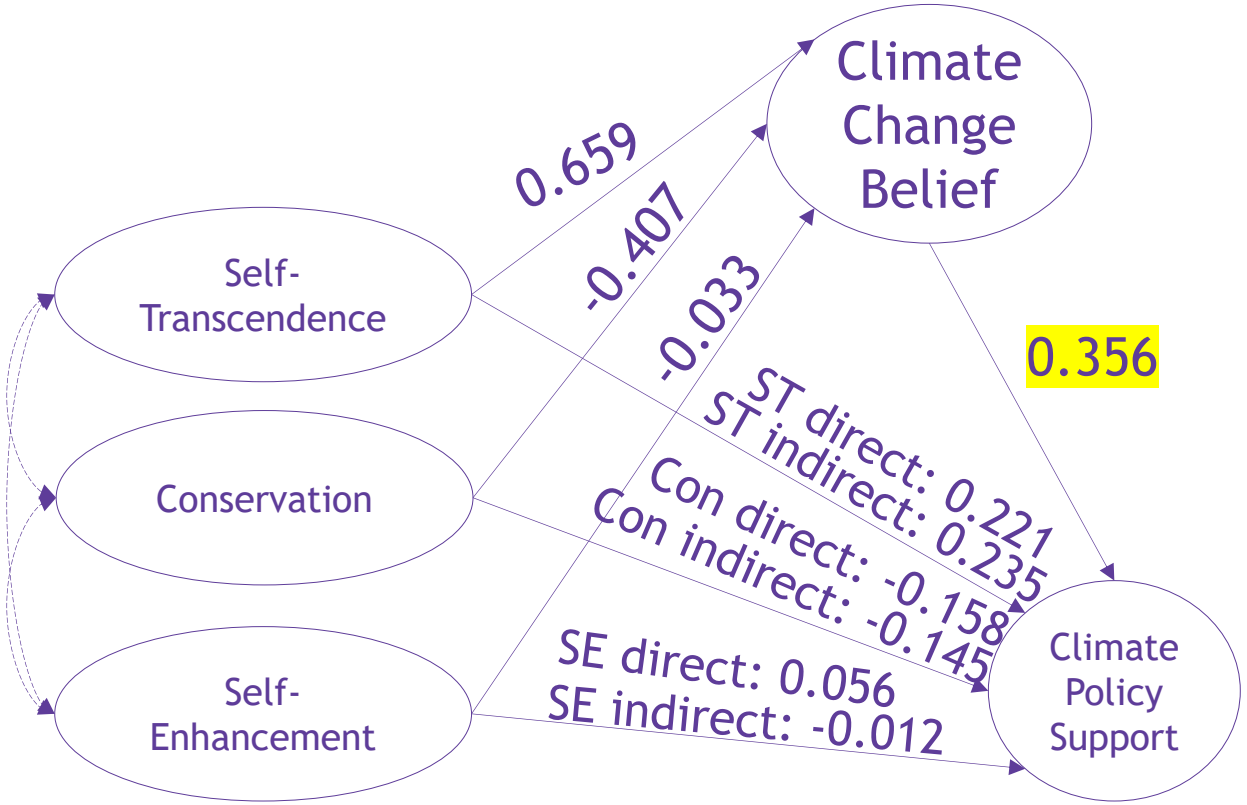
Cluster 4:
Estonia, Ireland, Israel, Iceland ($\hat{z}_{g4}$=0.995), Poland, Russia, Slovenia

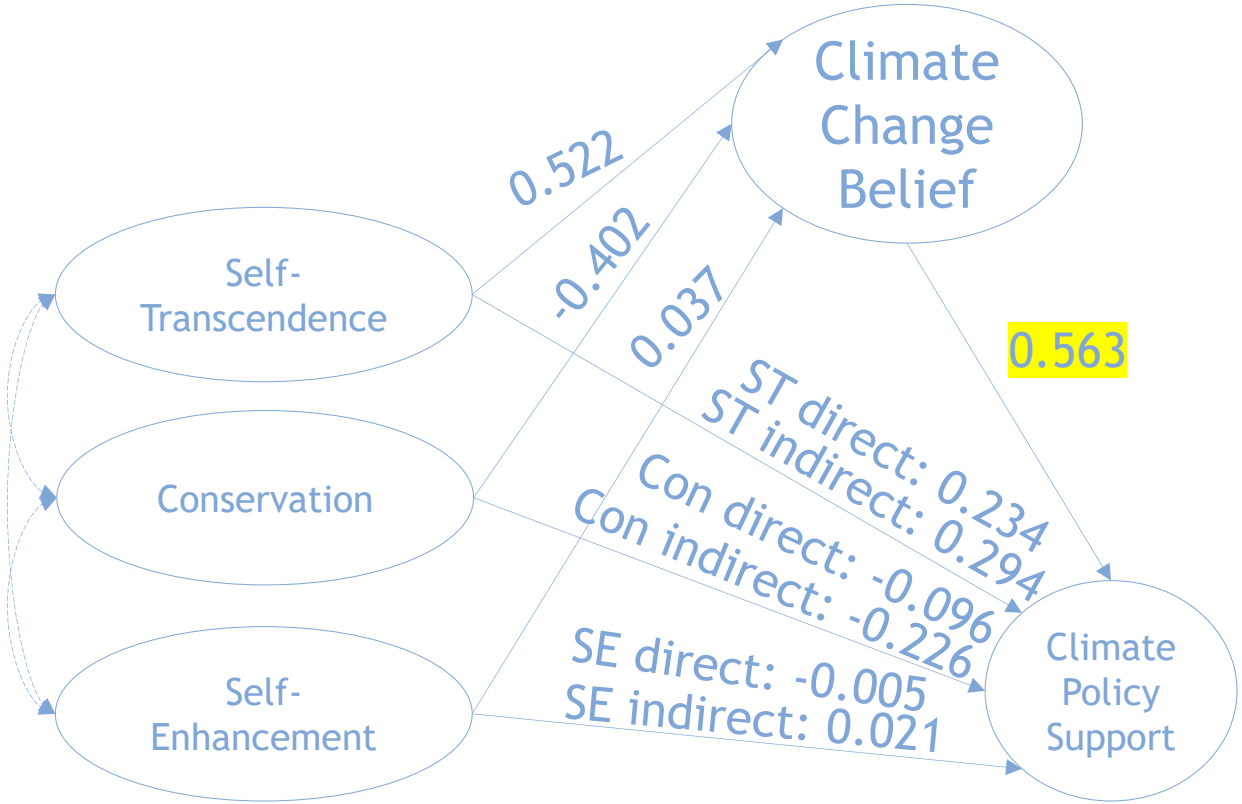


Cluster 3 (moderately strong self-transcendence and conservation effects) → 2 sub-clusters

Sub-Cluster 3.1:
Austria, Czech Republic, Spain, Italy

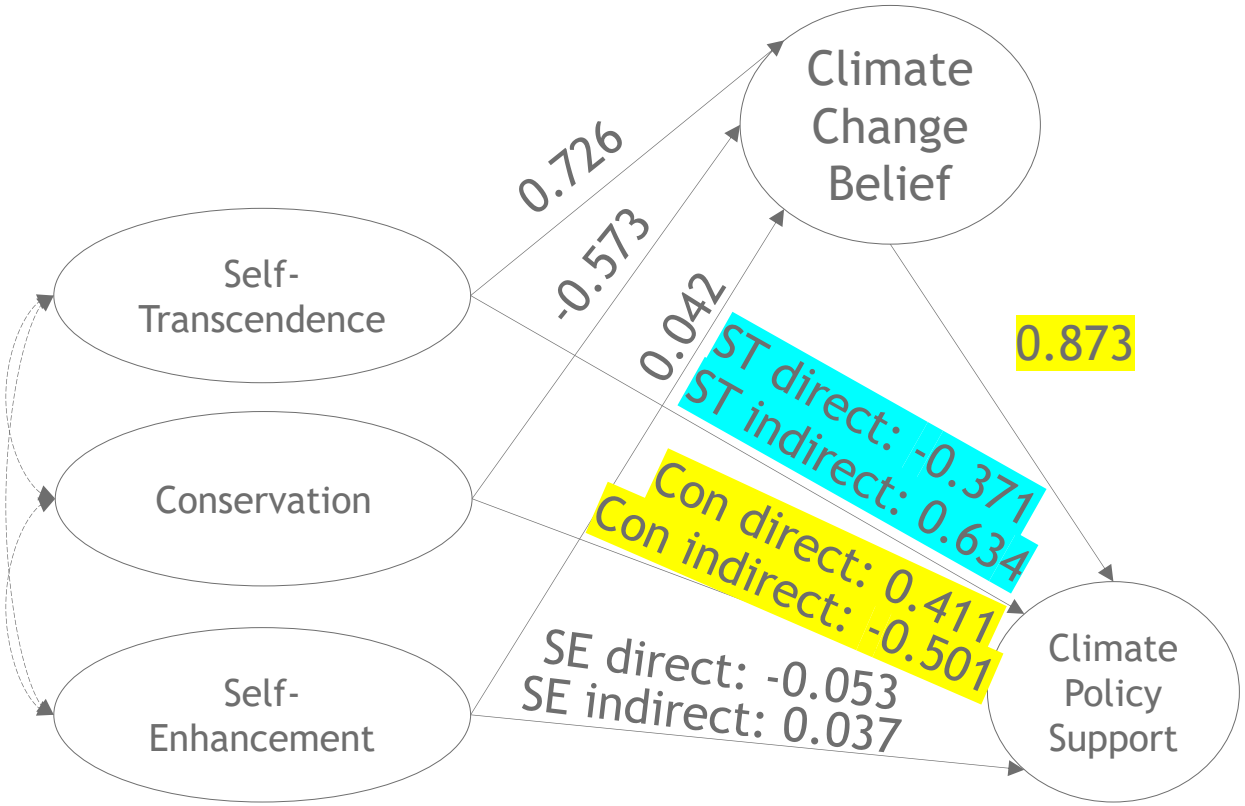


Sub-Cluster 3.2:
Belgium, Switzerland, Germany, Finland, France, the UK, Netherlands, Norway, Portugal, Sweden

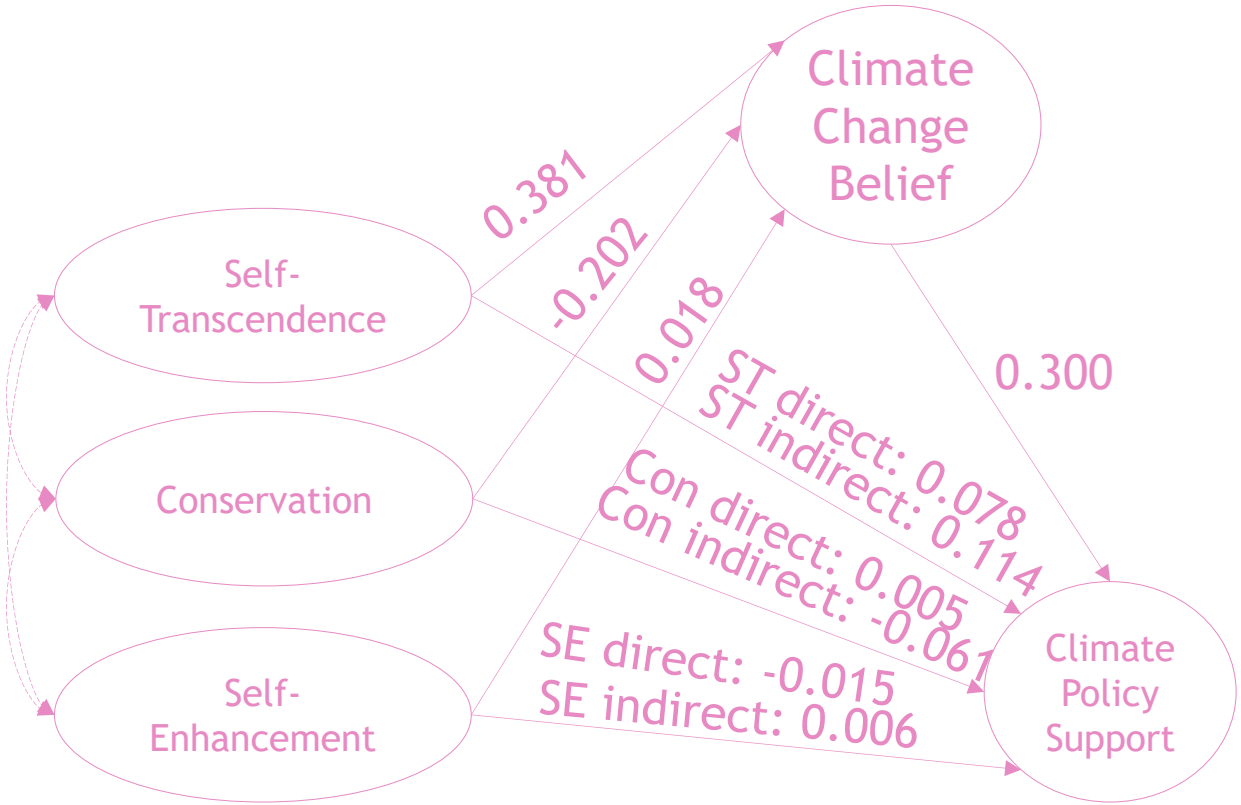


Cluster 4 (weak self-transcendence and conservation effects) → 2 sub-clusters

Sub-Cluster 4.1:
Israel, Iceland



Sub-Cluster 4.2:
Estonia, Ireland, Poland, Russia, and Slovenia



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Cluster 3:
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Sub-Cluster 3.1:
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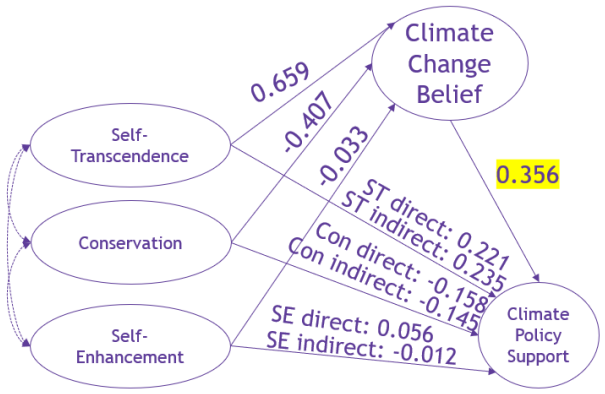
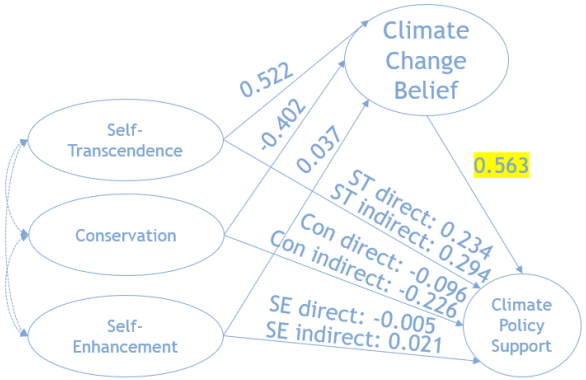


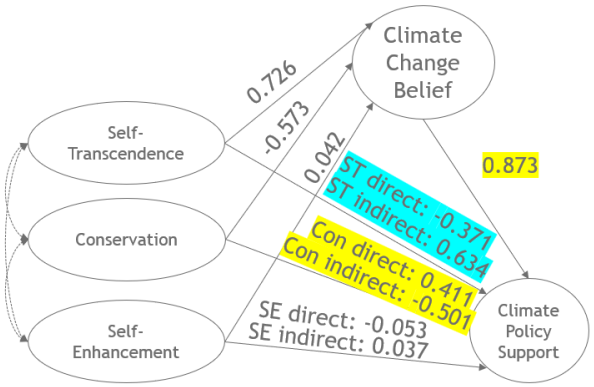
Value-driven but belief-cautious skeptics

Sub-Cluster 3.2:
Belgium, Switzerland, Germany, Finland, France, the UK, Netherlands, Norway, Portugal, Sweden



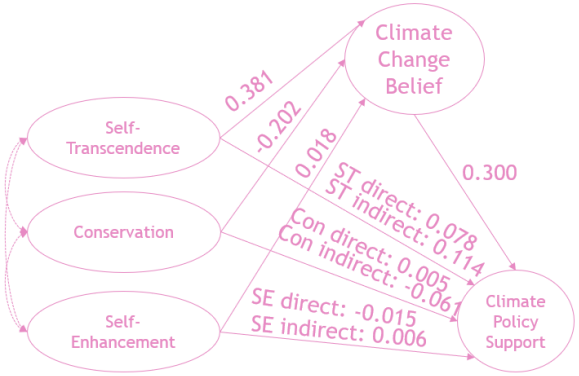
Value-driven and belief-amplifying advocates

Sub-Cluster 4.1:
Israel, Iceland



Paradoxical value-pathway actors

Sub-Cluster 4.2:
Estonia, Ireland, Poland, Russia, and Slovenia



Value-detached pragmatists

04

Discussion and conclusion

- Methodological contribution
  - MMG-SEM – a new tool for cross-cultural comparative research
  - Flexibility and efficiency in handling both basic model and complex model

- Theoretical contribution
  - Cross-national patterns
  - Typologies

- Limitation and next project
  - Neglect the heterogeneity within the countries (e.g., heterogeneity due to different demographic backgrounds and geographical regions)

  → Project 2: WGMix-SEM (Extension of MMG-SEM)

  - Most survey items are Likert scale

  → Next presentation by Andres: Extending MMG-SEM to deal with ordinal variables

Thank you!

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