Structural Equation Modeling of Seafood Consumption Behavior

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Motivation

- Consumption decisions are influenced by factors that are not directly observable
  - E.g., Environmental concern and purchase decision of hybrid vehicle
- They are measured with errors
- Need for a comprehensive treatment for such factors in modeling

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Structural Equation Modeling (SEM)

- Explicitly taking the measurement into account
- Unobserved (latent) variables usually measured with multiple items (indicators)
- More general case of systems of equation modeling

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Objectives

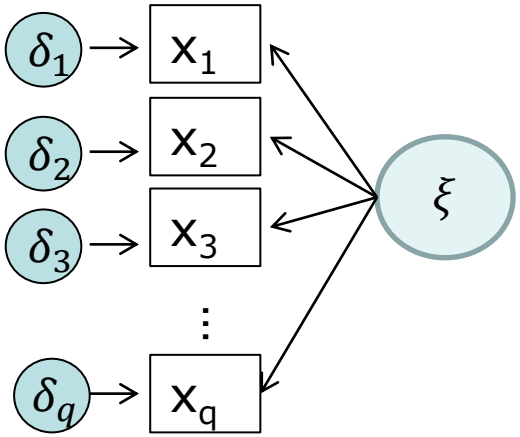
- Utilize the recently collected survey data on seafood consumtion behavior
  - Multi-species
  - Multi-countries
- Specifically for this peper
  - Explore the relationship among country image, product perceptions, and consumption frequency
  - Employ SEM to explicitly include the measurement of latent variables
  - Focused on salmon in Germany and France

Latent and Indicator Variables

- Unobserved unidimensional *concept*
- Theoretically motivated
- Measured by indicator variables

$$x_j = \lambda_j \xi + \delta_j, \qquad j = 1, \ldots, q$$

  - x is an indicator variable
  - ξ is a latent variable
  - λ is a coefficient relating x to ξ
  - δ is a random error with zero expectation and is uncorrelated to ξ



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Systems of Equations in Econometrics

$$\mathbf{y} = \mathrm{B}\mathbf{y} + \Gamma\mathbf{x} + \boldsymbol{\zeta}$$

- $\mathbf{y}$ is a $p \times 1$ vector of endogenous variables
- $\mathbf{x}$ is $q \times 1$ vector of exogenous variables
- B is a $m \times m$ matrix of coefficients
- Γ is a $m \times n$ matrix of coefficients
- $\boldsymbol{\zeta}$ is a $p \times 1$ vector of errors in the equations and uncorrelated to $\mathbf{x}$
- $(\mathrm{I} - \mathrm{B})$ is assumed to be nonsingular

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Measurement Models

$$\mathbf{x} = \boldsymbol{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta}$$

$$\mathbf{y} = \boldsymbol{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\epsilon}$$

- $\mathbf{x}$ and $\mathbf{y}$ are a $q \times 1$ and $p \times 1$ vectors of observed indicators
- Λ_x and Λ_y are a $q \times n$ and $p \times m$ matrices of coefficients
- $\boldsymbol{\xi}$ and $\boldsymbol{\eta}$ are $\mathrm{n} \times 1$ and $\mathrm{m} \times 1$ vectors of latent variables
- $\boldsymbol{\delta}$ and $\boldsymbol{\epsilon}$ are $q \times 1$ and $p \times 1$ vectors of measurement errors
- Assumes $E(\boldsymbol{\xi})=0$, $E(\boldsymbol{\delta})=0$, $\boldsymbol{\delta}$ uncorr. to $\boldsymbol{\xi}$ $\boldsymbol{\eta}$ and $\boldsymbol{\epsilon}$, $\boldsymbol{\epsilon}$ uncorr. to $\boldsymbol{\xi}$ $\boldsymbol{\eta}$ and $\boldsymbol{\delta}$

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Structural Equations

$$\boldsymbol{\eta} = \mathrm{B}\boldsymbol{\eta} + \Gamma\boldsymbol{\xi} + \boldsymbol{\zeta}$$
$$\mathbf{y} = \Lambda_y\boldsymbol{\eta} + \boldsymbol{\varepsilon}$$
$$\mathbf{x} = \Lambda_x\boldsymbol{\xi} + \boldsymbol{\delta}$$

- B is a $m \times m$ coefficient matrix
- Γ is a $m \times n$ coefficient matrix
- $\boldsymbol{\zeta}$ is a vector of random errors with zero expectations

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Hypothesis and Estimation

The general hypothesis: $\Sigma = \Sigma(\boldsymbol{\theta})$

Σ : the population covariance matrix of observed variables

$\Sigma(\boldsymbol{\theta})$: the covariance matrix based on the model parameters $\boldsymbol{\theta}$

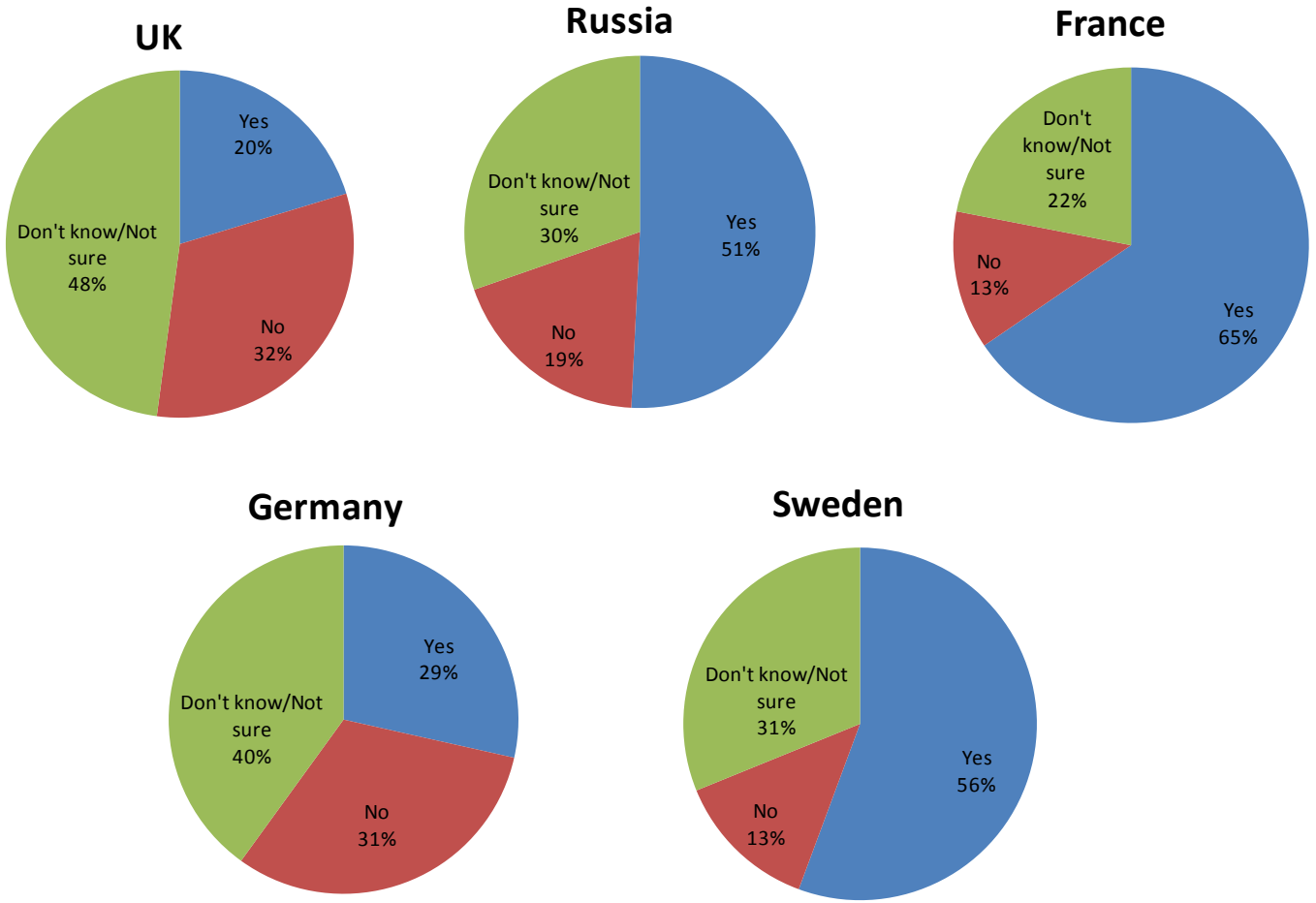
$$F_{ML} = log|\Sigma(\boldsymbol{\theta})| + \mathrm{tr}\{\mathrm{S}\Sigma^{-1}(\boldsymbol{\theta}) - log|\mathrm{S}| - (p+q)\}$$

where S is the sample covariance matrix of the observed data

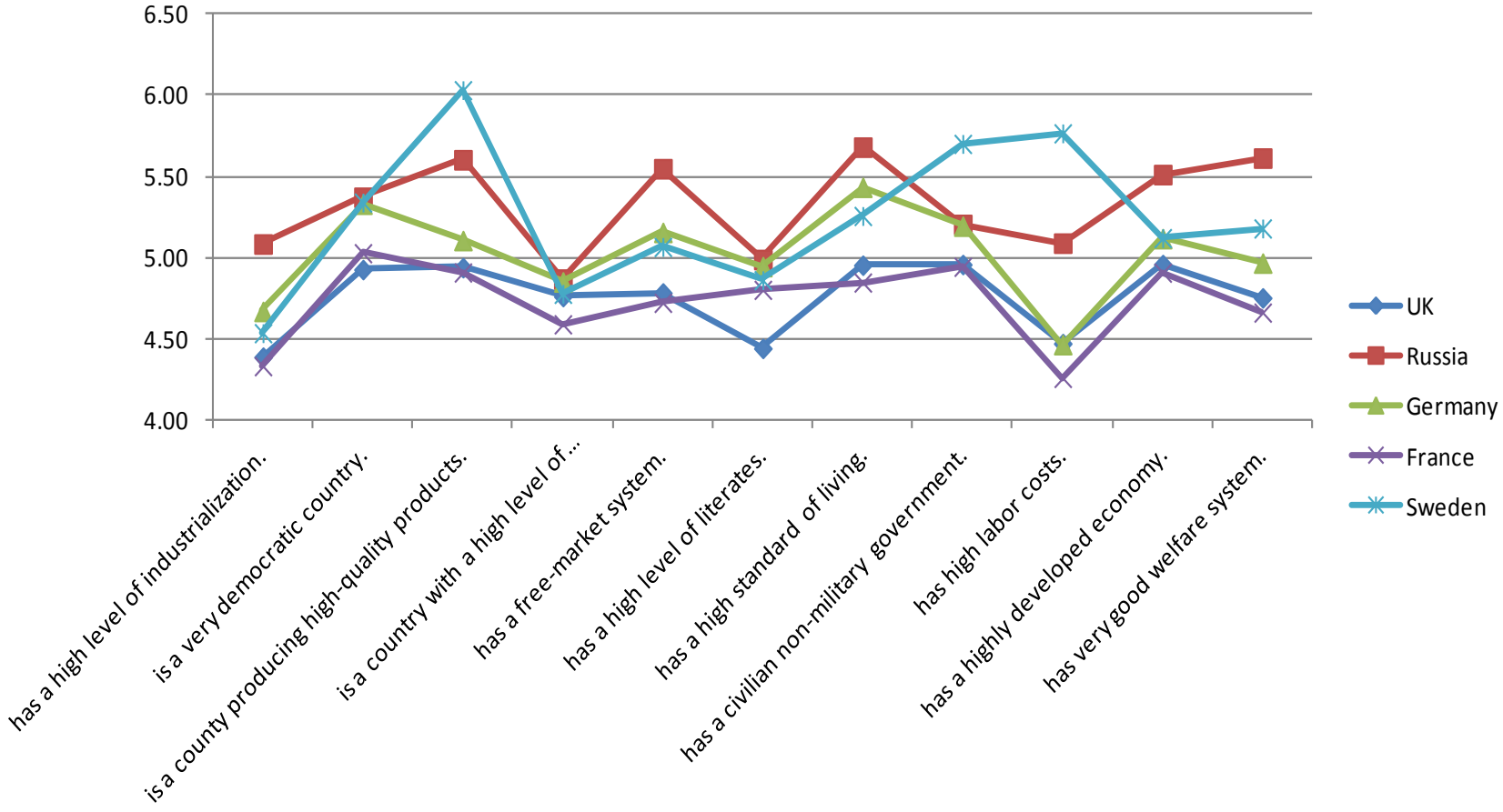
- The estimated coefficients $\widehat{\boldsymbol{\theta}}_{ML}$ minimizes the above likelihood function

Seafood Country of origin knowledge

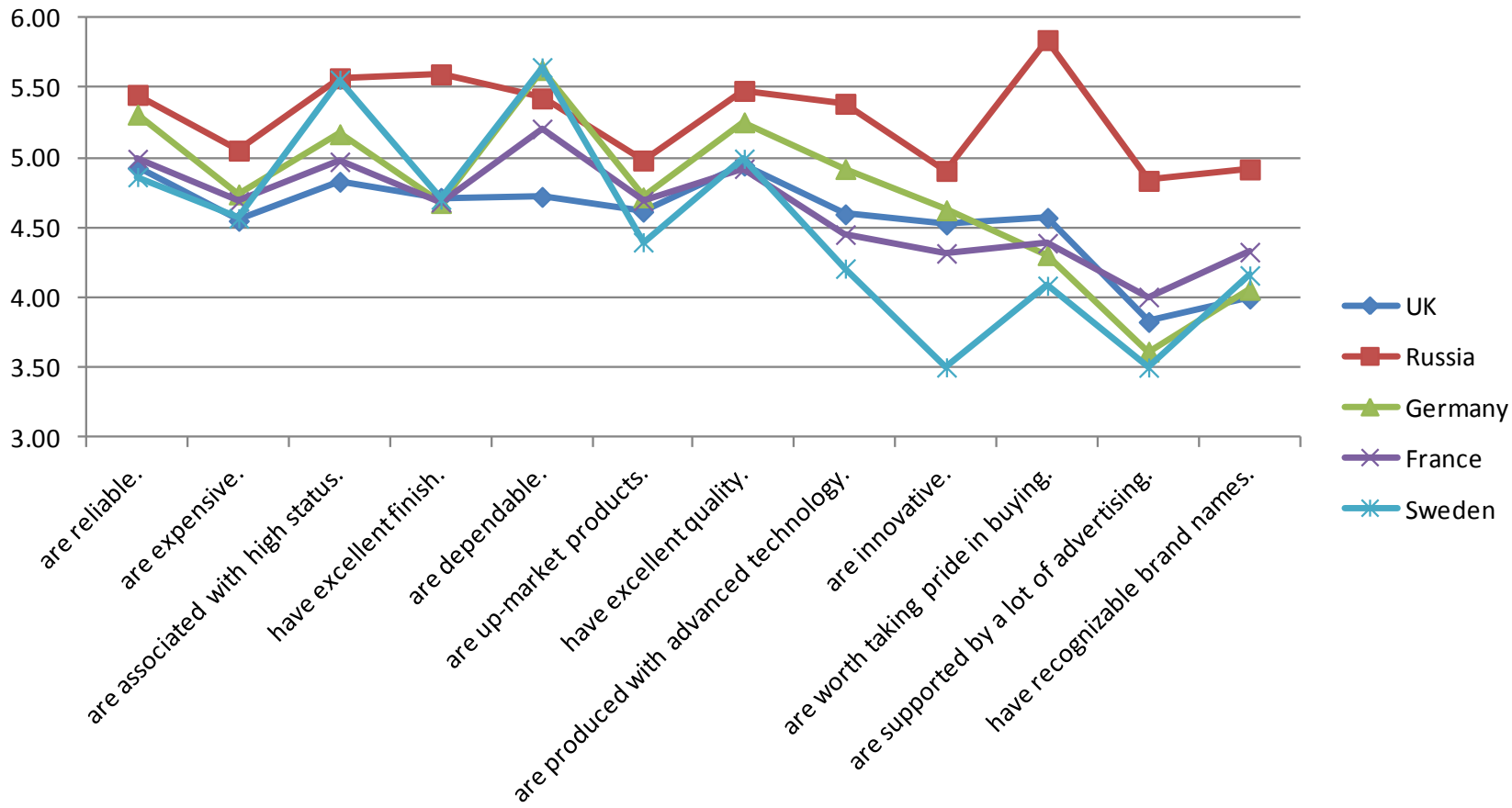
Q: Have you bought seafood products from Norway before?



Macro Country Image Mean Scores (Peppu, et al., 2007)



Micro Country Image (Norwegian Seafood Products) (Peppu, et al., 2007)



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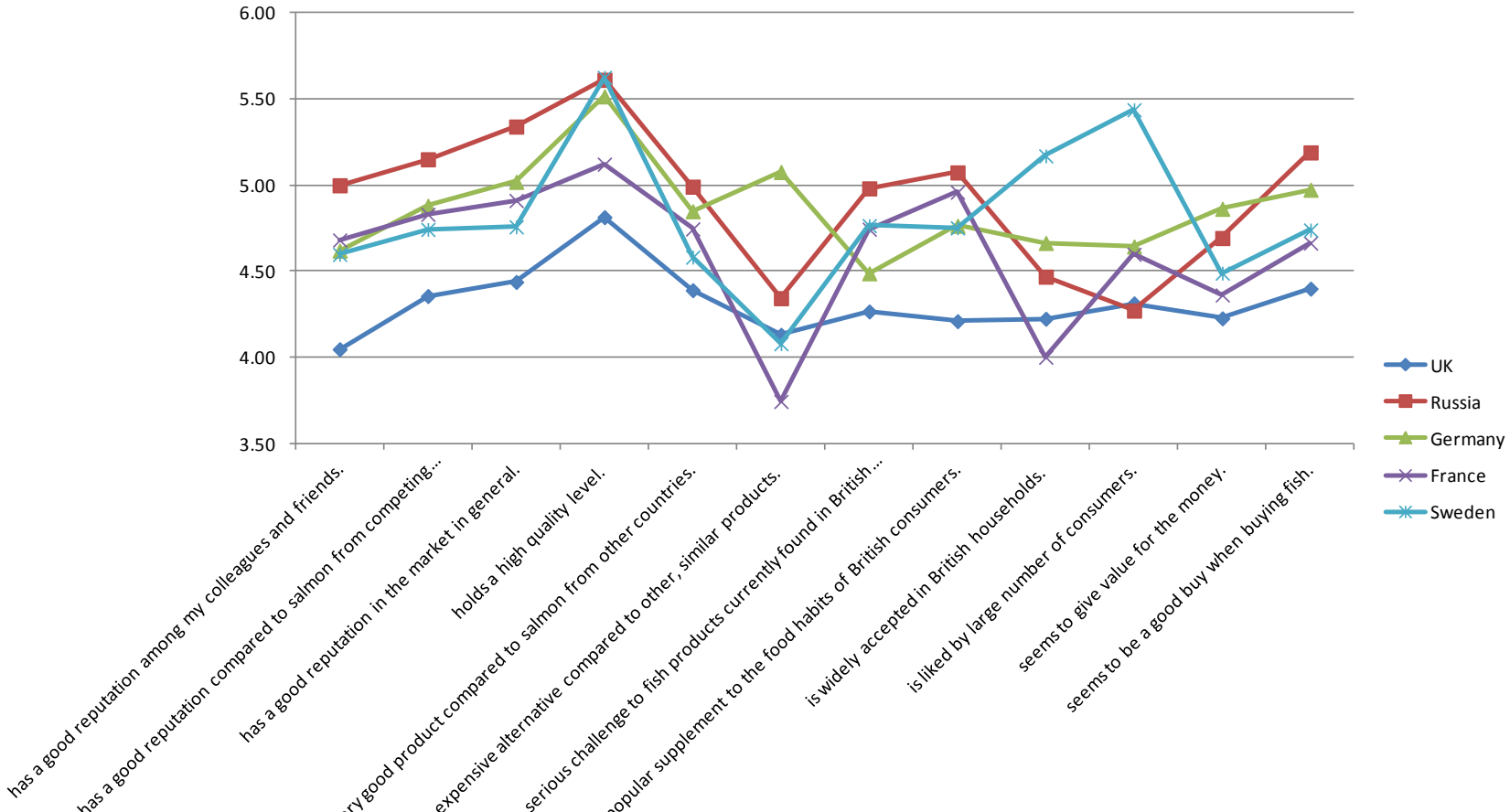
Product Perceptions of Norwegian Salmon



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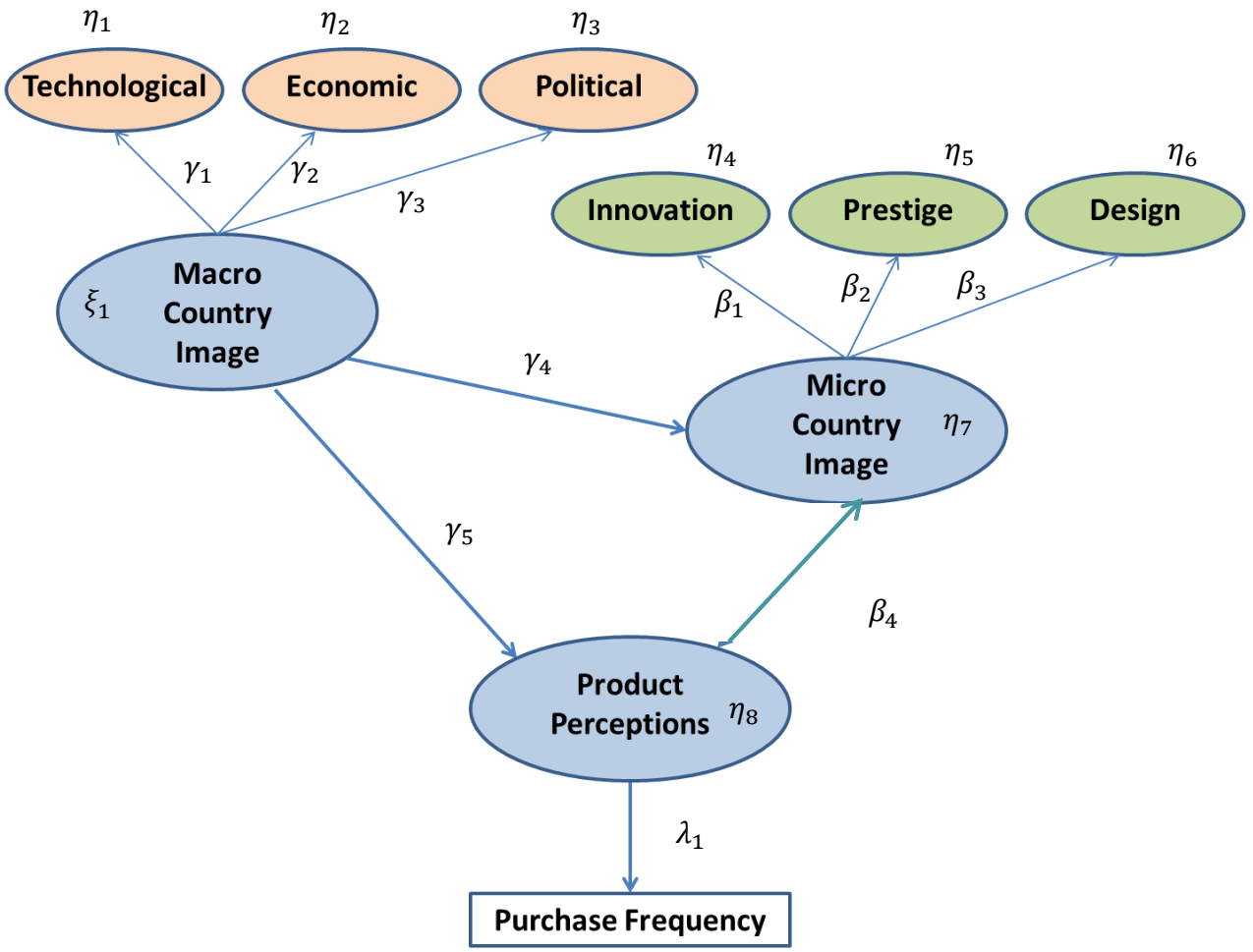
Conceptual Diagram



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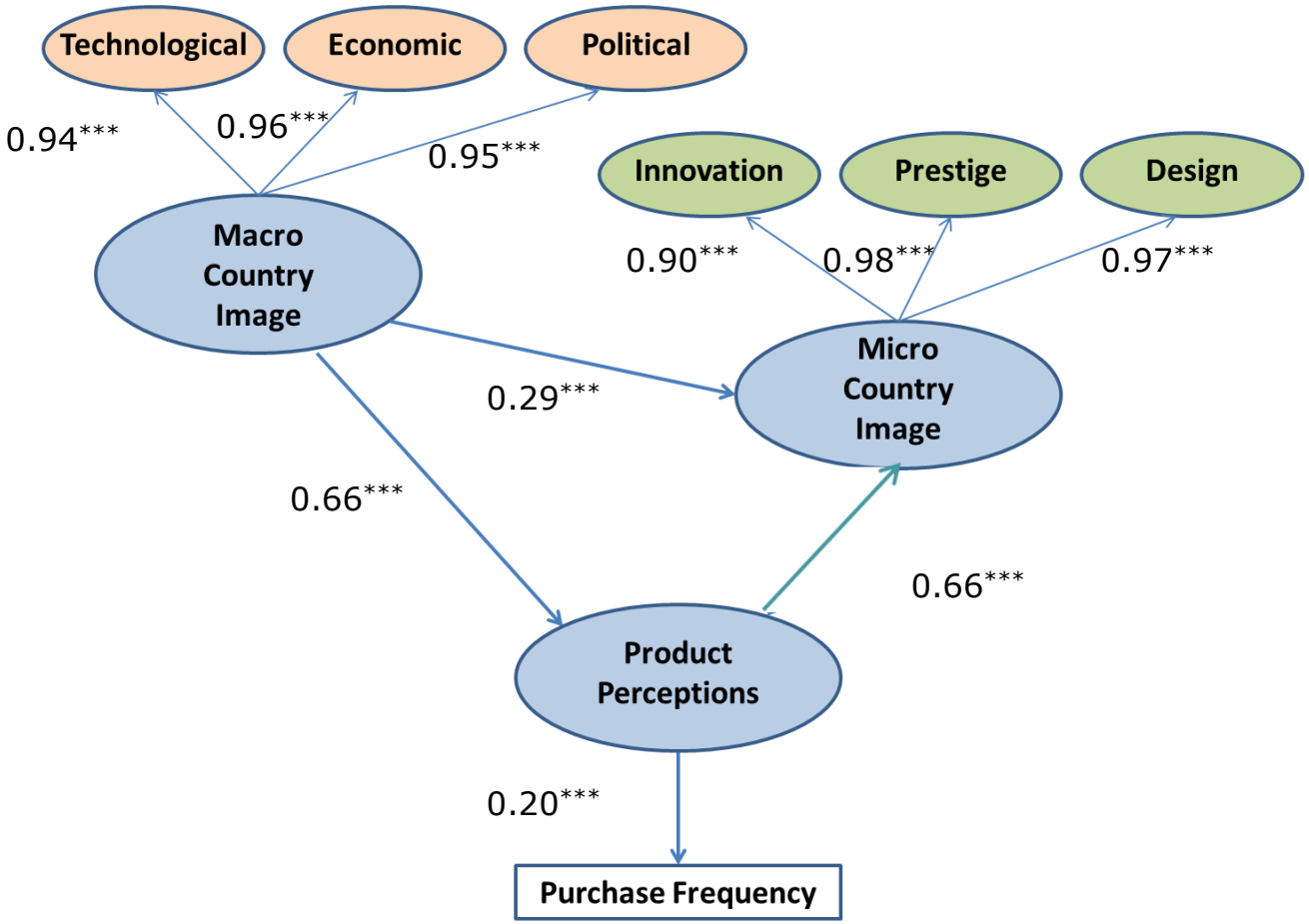
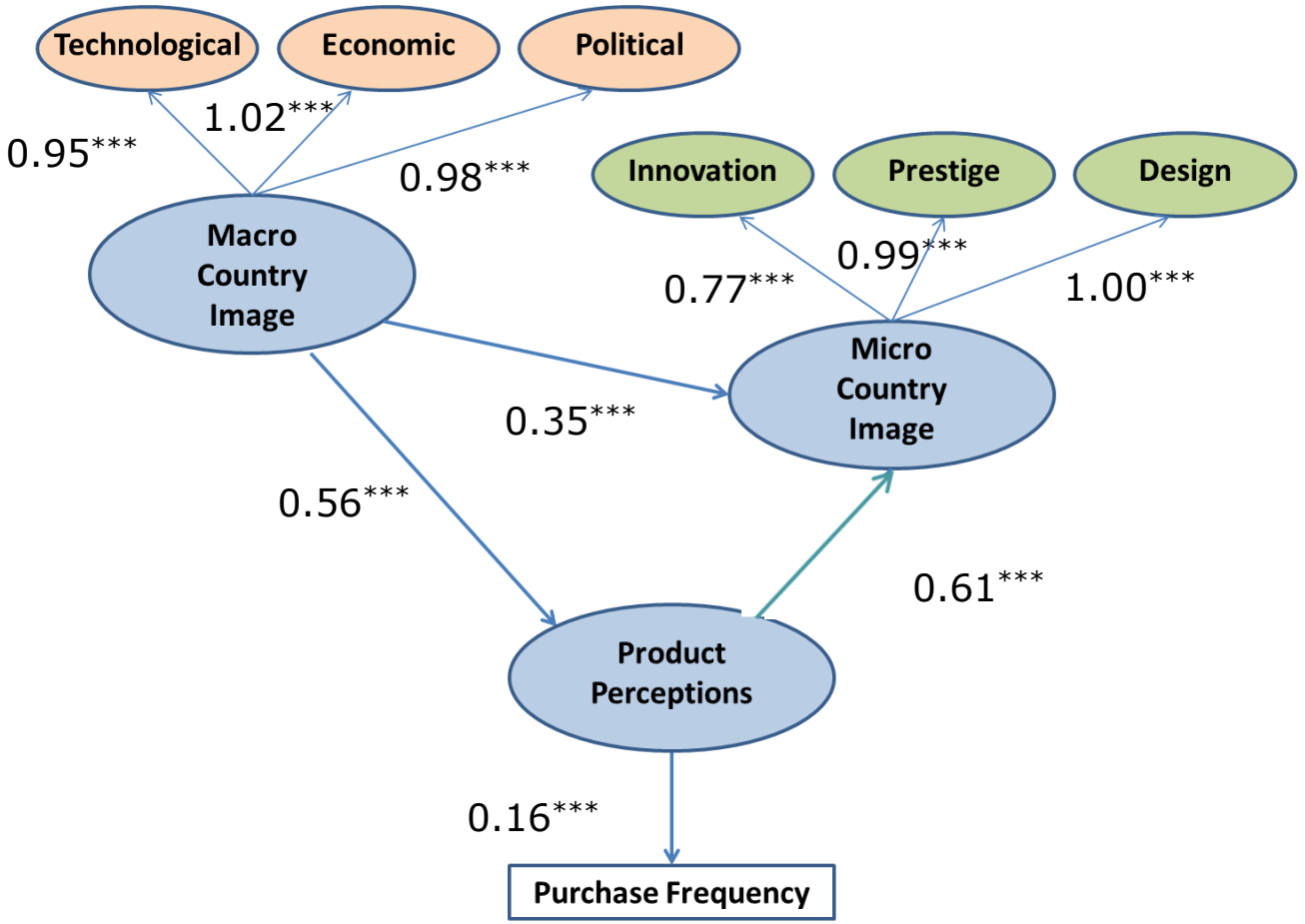
Estimation Results (Germany)



Estimation Results (France)



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Summary

- Macro image positively affects images of Norwegian seafood and salmon
  - Emphasizing Norway envokes positve image
- Also found positive association with the consumption frequency
- Perception of Norwegian salmon affects the image of Norwegian seafood
  - Improving the image of Norwegian salmon would also improve the image of Norwegian seafood
  - This may be different for other species
- Need to elaborate more on the relationship with the observed behavior

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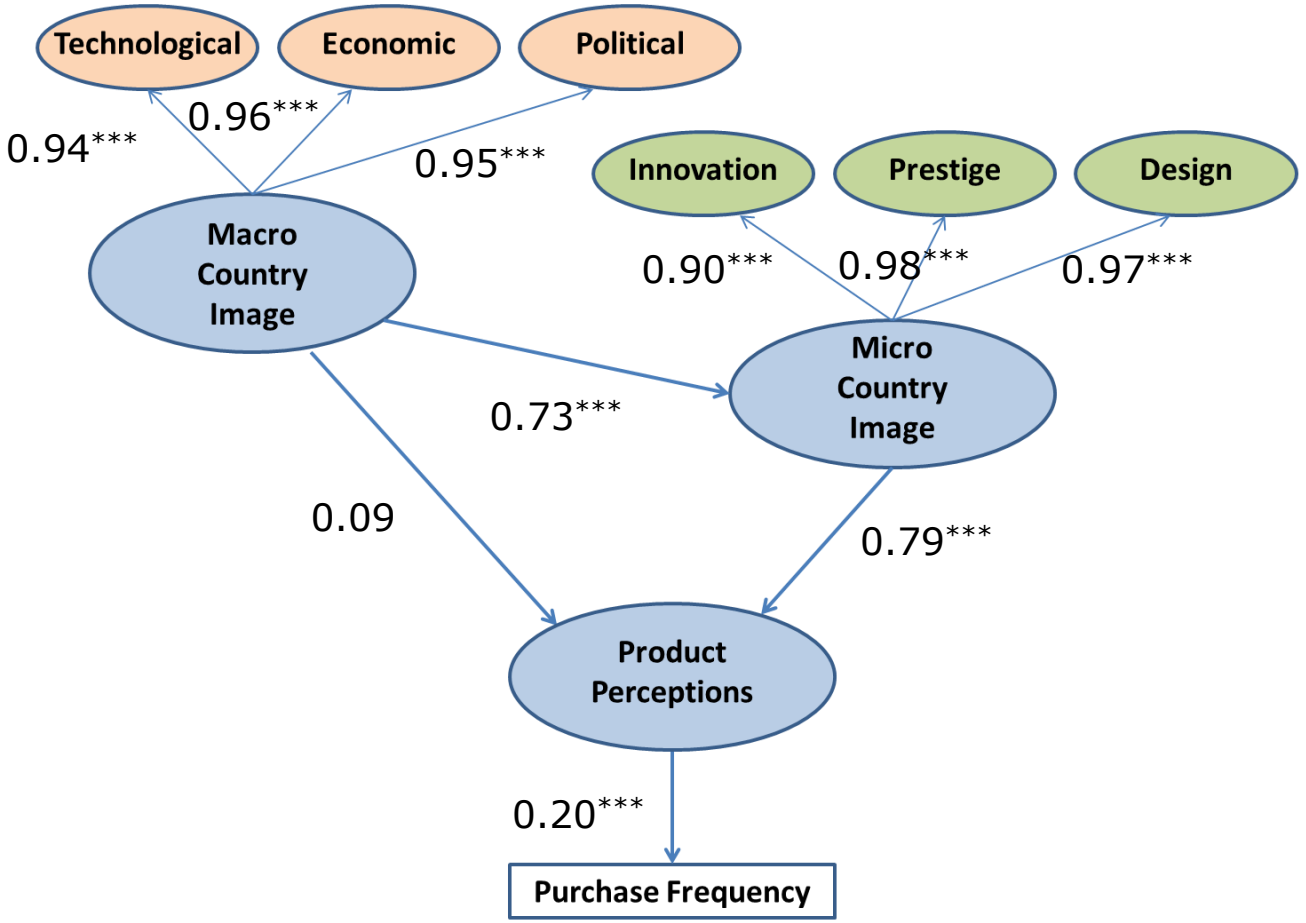
Alternative Specification (Germany)



Alternative Specification (Germany)