

# Structural Equation Modeling of Seafood Consumption Behavior

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# Motivation

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- 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

# Structural Equation Modeling (SEM)

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

# Objectives

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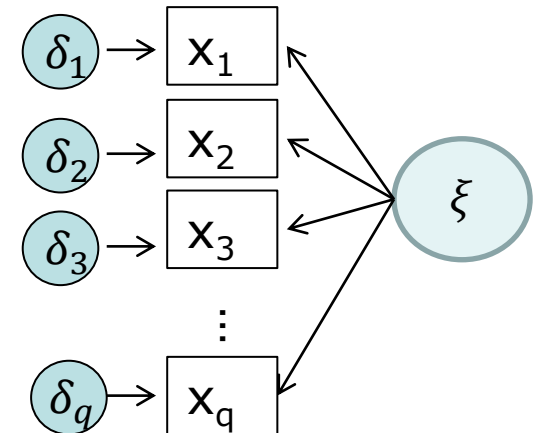
- Utilize the recently collected survey data on seafood consumption behavior
  - Multi-species
  - Multi-countries
- Specifically for this paper
  - Explore the relationship among country image, product perceptions, and consumption frequency
  - Employ SEM to explicitly include the measurement of latent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

# Latent and Indicator Variables

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

$$x_j = \lambda_j \xi + \delta_j, \quad j = 1, \dots, q$$

- $x$  is an indicator variable
- $\xi$  is a latent variable
- $\lambda$  is a coefficient relating  $x$  to  $\xi$
- $\delta$  is a random error with zero expectation and is uncorrelated to  $\xi$



# Systems of Equations in Econometrics

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

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

# Measurement Models

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$$\mathbf{x} = \Lambda_x \boldsymbol{\xi} + \boldsymbol{\delta}$$

$$\mathbf{y} = \Lambda_y \boldsymbol{\eta} + \boldsymbol{\epsilon}$$

- $\mathbf{x}$  and  $\mathbf{y}$  are a  $q \times 1$  and  $p \times 1$  vectors of observed indicators
- $\Lambda_x$  and  $\Lambda_y$  are a  $q \times n$  and  $p \times m$  matrices of coefficients
- $\boldsymbol{\xi}$  and  $\boldsymbol{\eta}$  are  $n \times 1$  and  $m \times 1$  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  $\boldsymbol{\delta}$

# Structural Equations

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$$\boldsymbol{\eta} = \mathbf{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta}$$

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

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

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



# Hypothesis and Estimation

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

$\Sigma$  : the population covariance matrix of observed variables

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

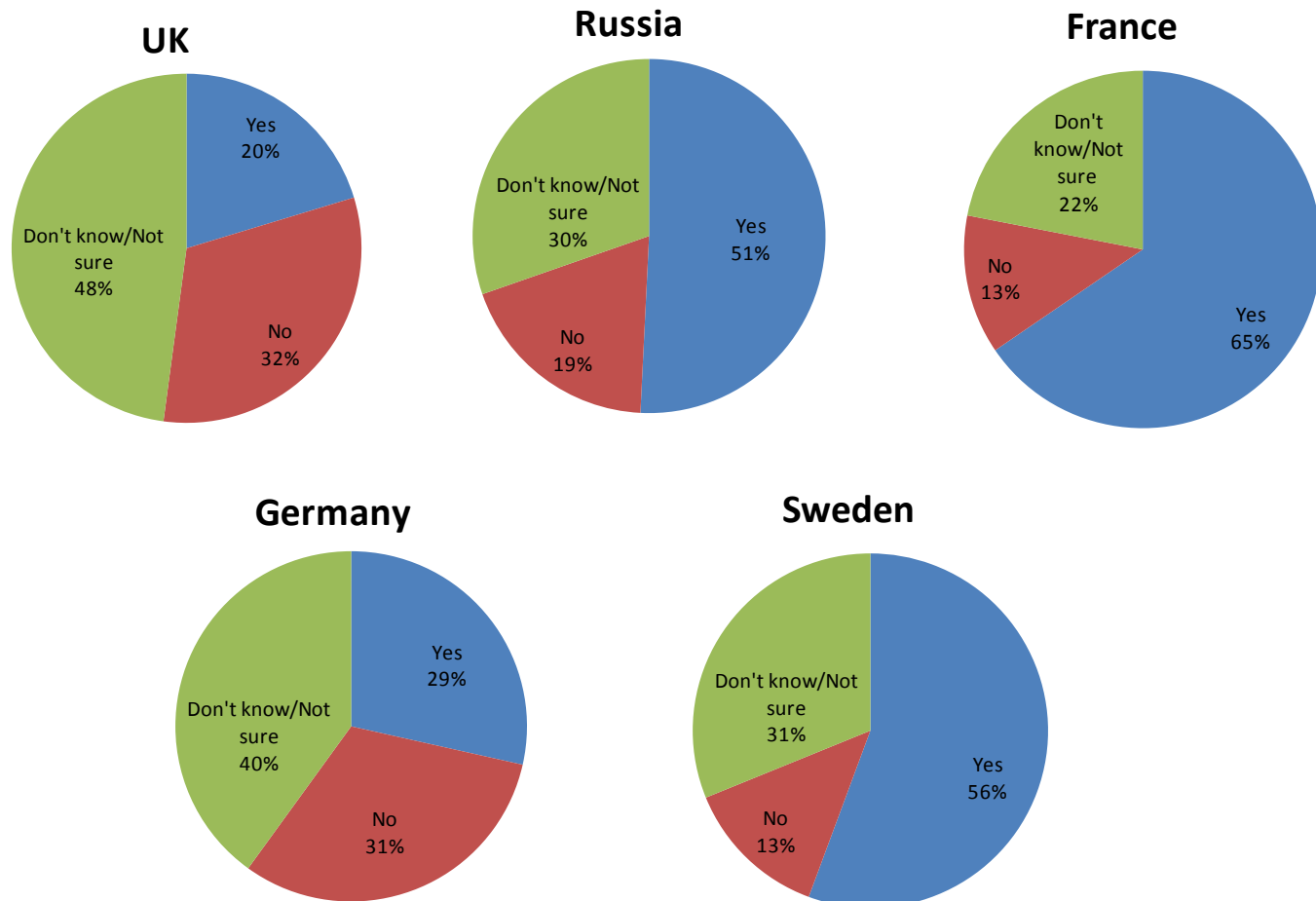
$$F_{ML} = \log|\Sigma(\boldsymbol{\theta})| + \text{tr}\{S\Sigma^{-1}(\boldsymbol{\theta}) - \log|S| - (p + q)\}$$

where  $S$  is the sample covariance matrix of the observed data

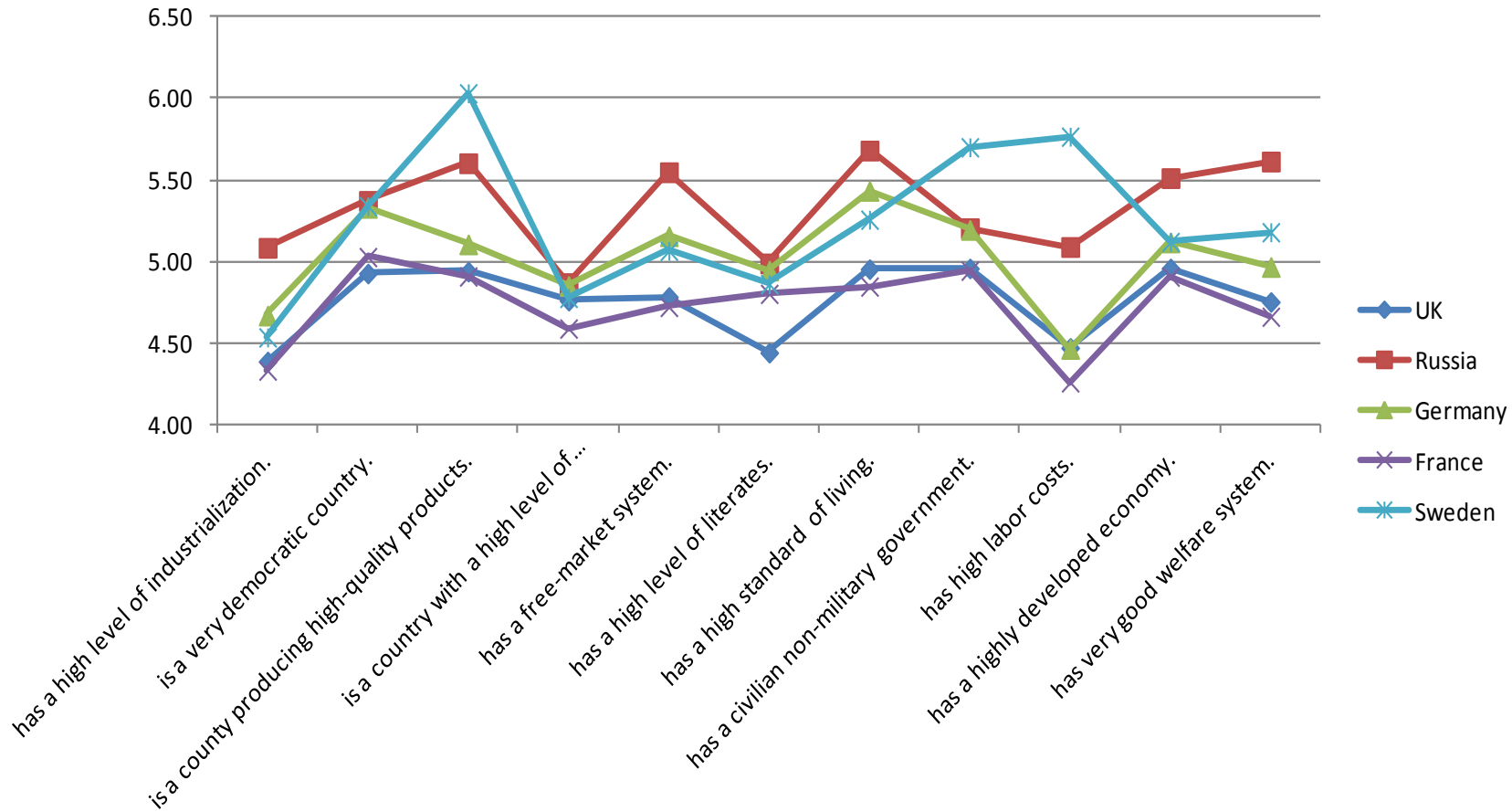
- The estimated coefficients  $\hat{\boldsymbol{\theta}}_{ML}$  minimizes the above likelihood function

# Seafood Country of origin knowledge

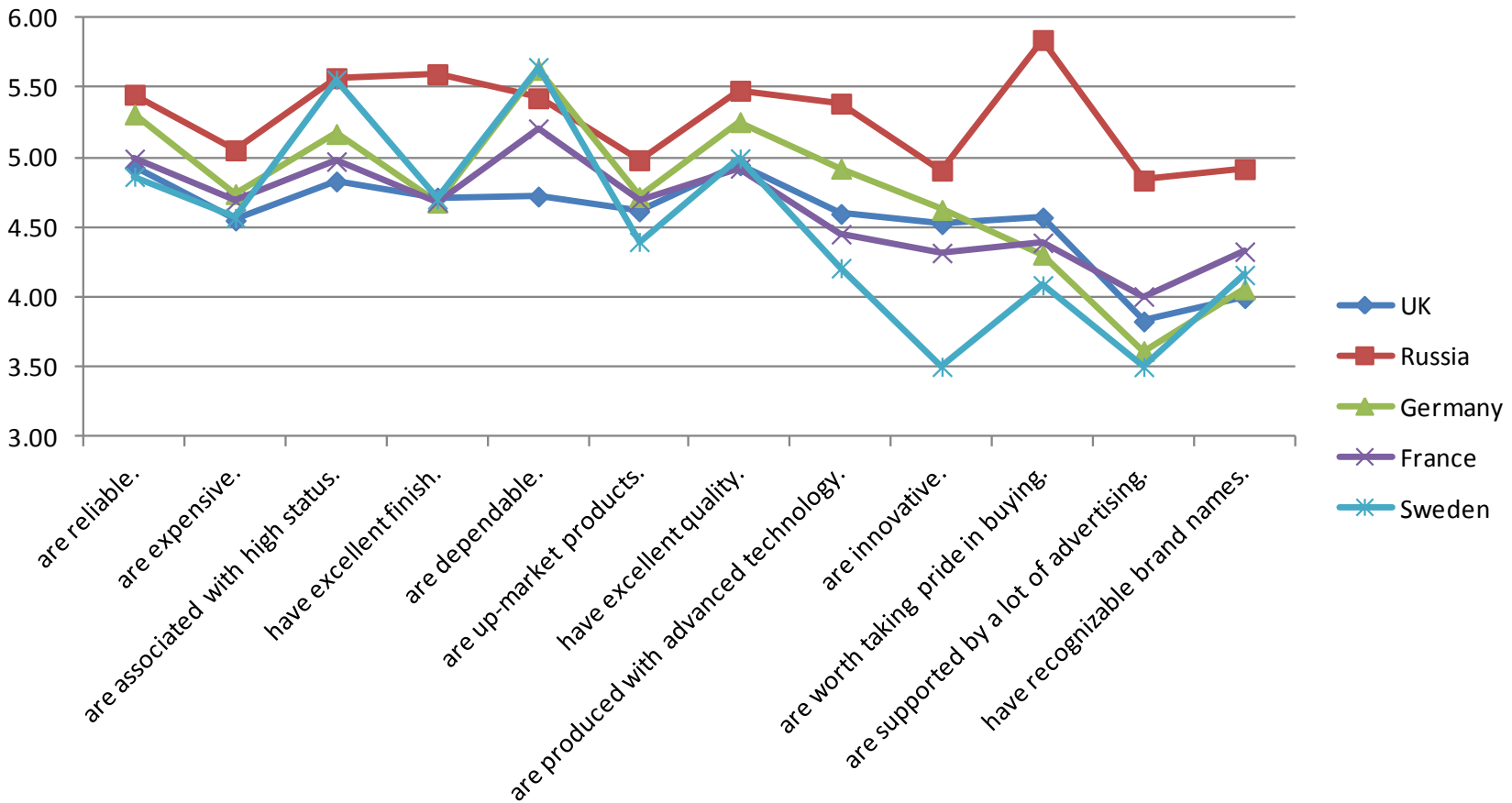
Q: Have you bought seafood products from Norway before?



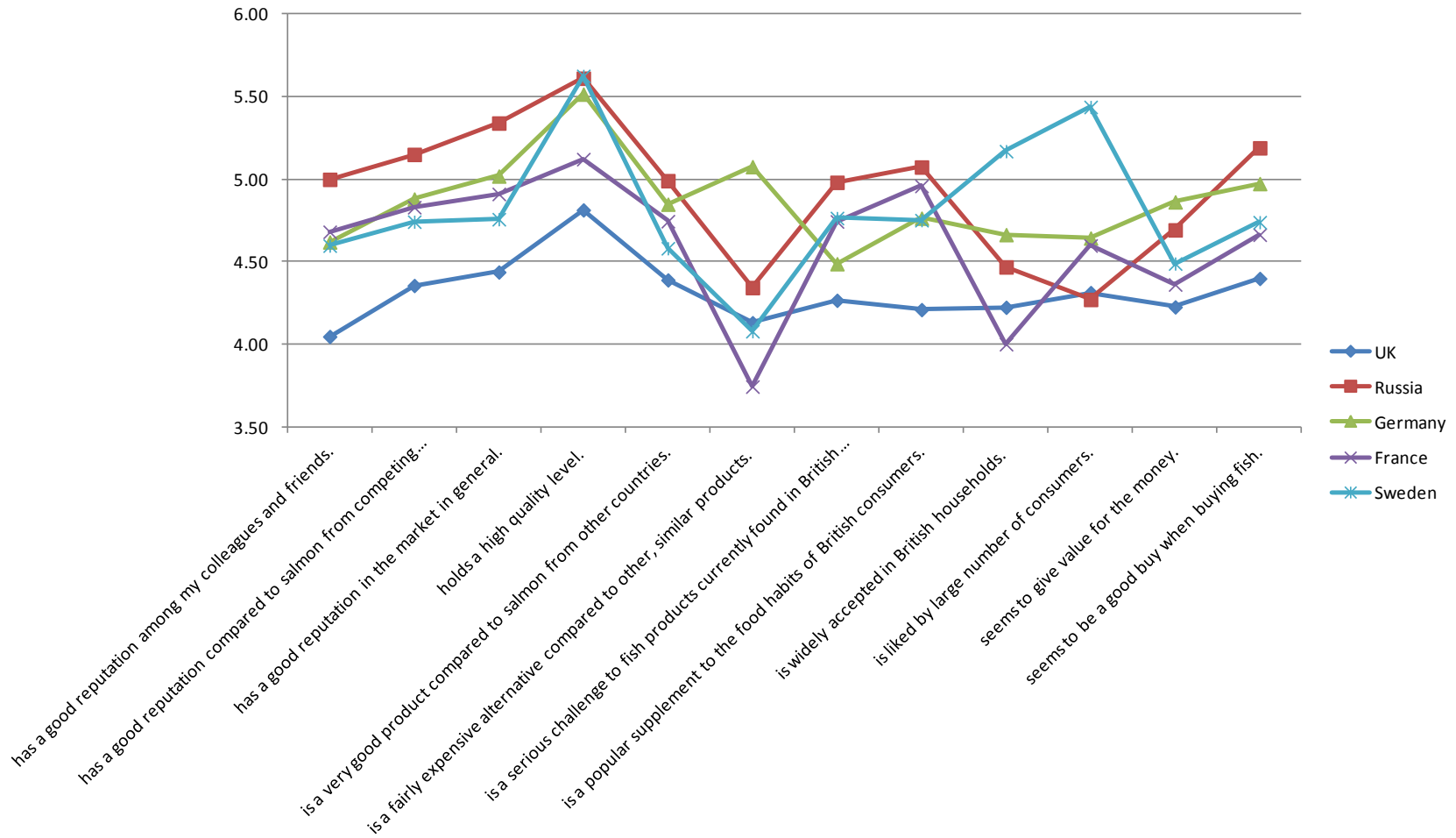
# Macro Country Image Mean Scores (Peppu, et al., 2007)



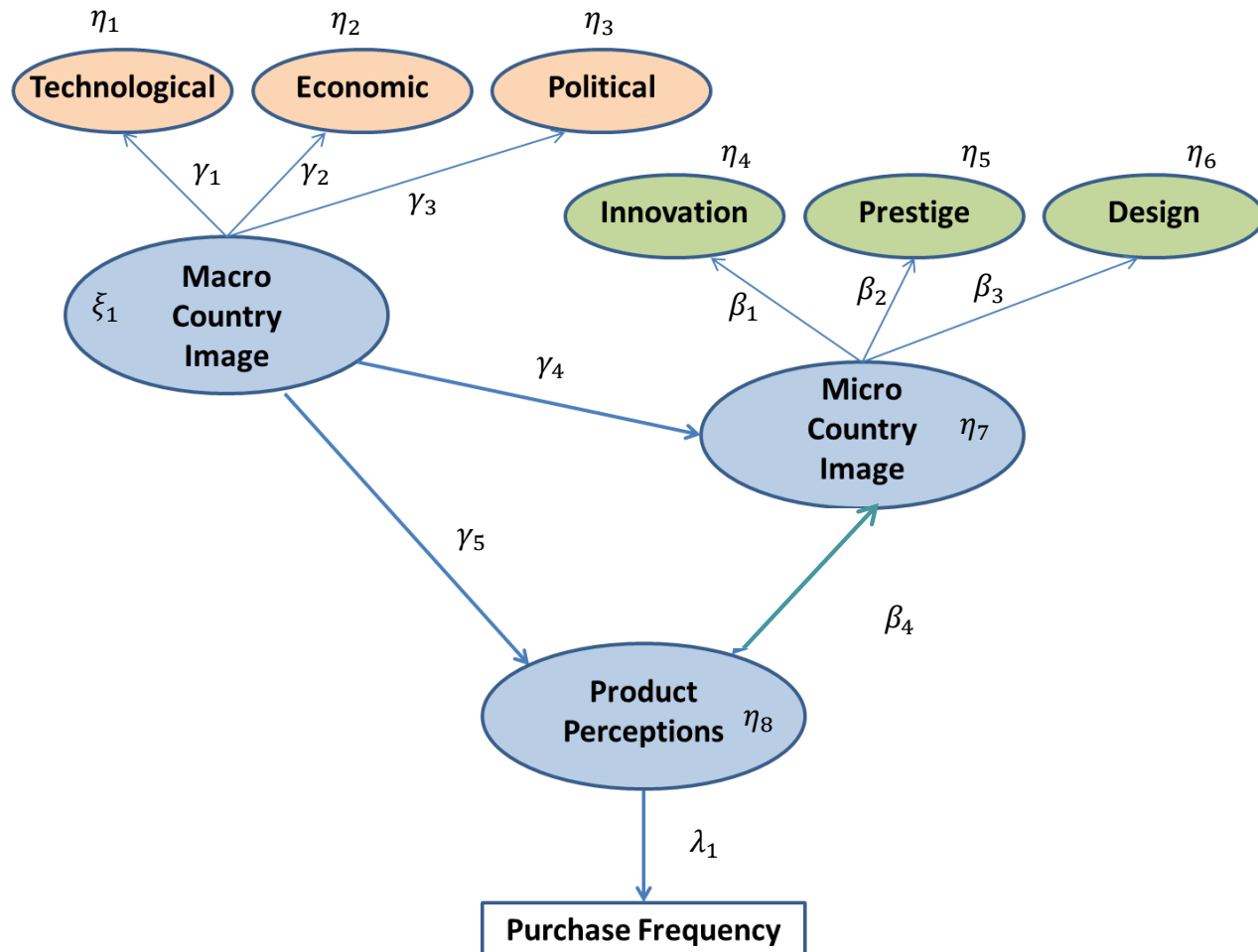
# Micro Country Image (Norwegian Seafood Products) (Peppu, et al., 2007)



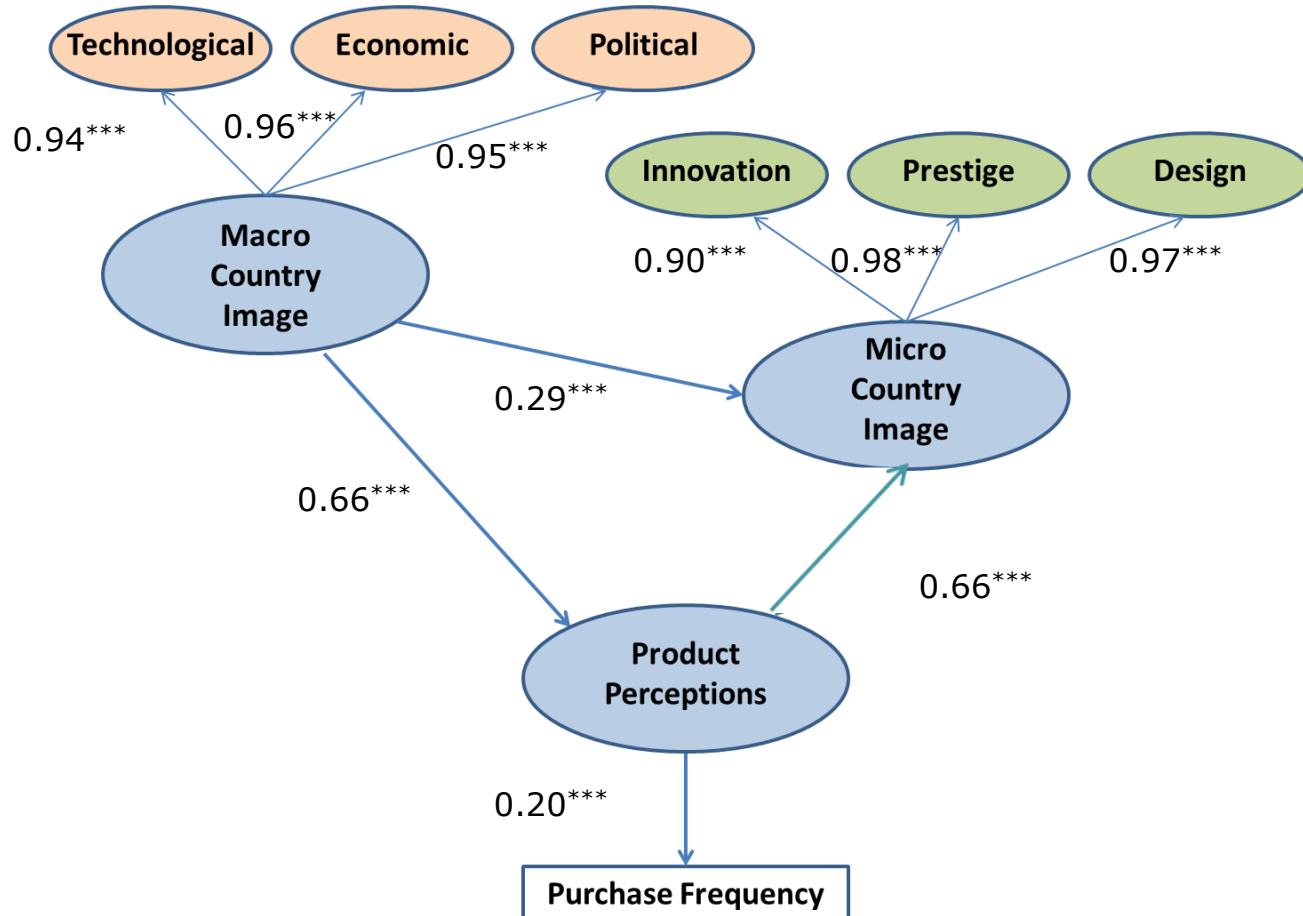
# Product Perceptions of Norwegian Salmon



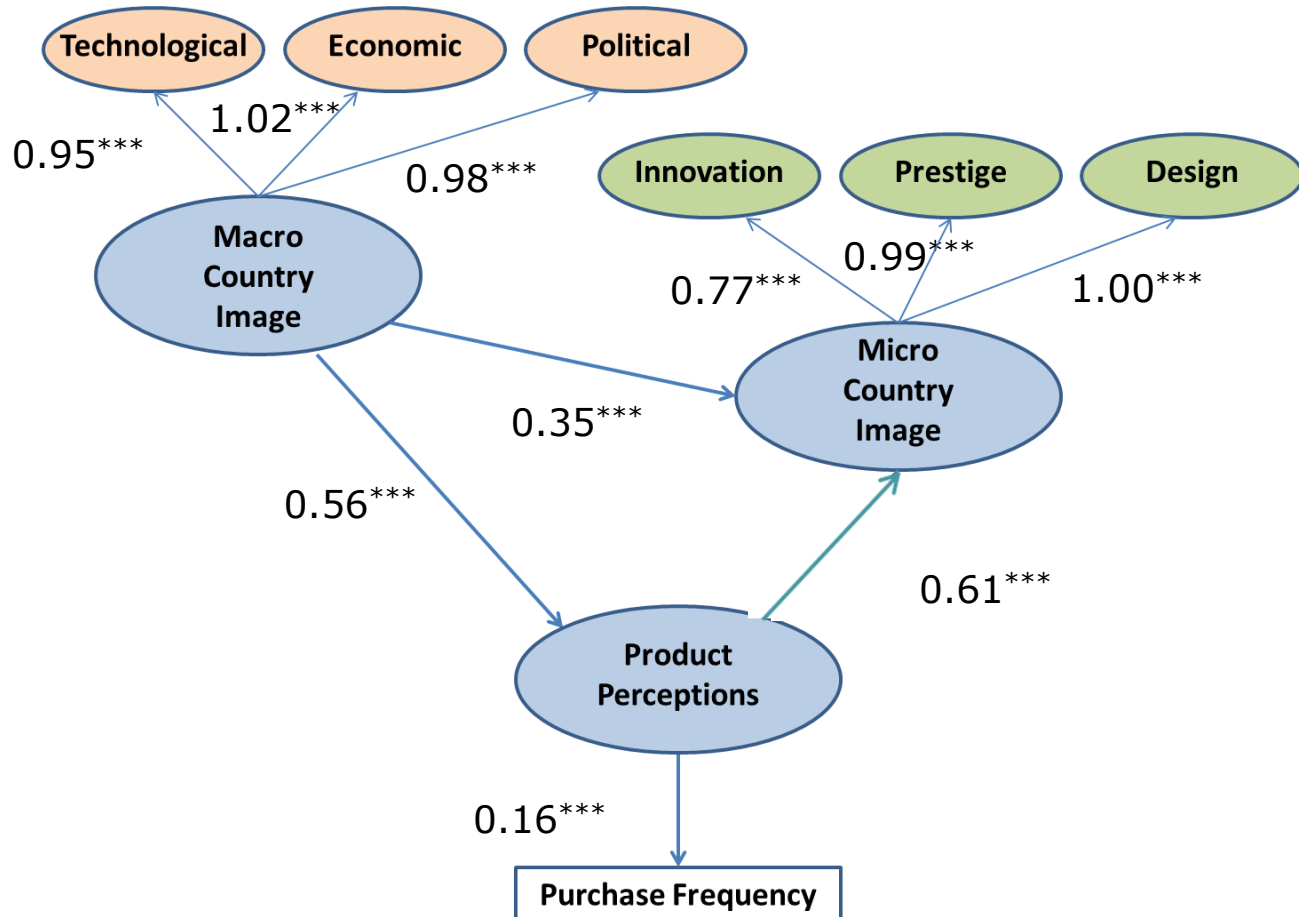
# Conceptual Diagram



# Estimation Results (Germany)



# Estimation Results (France)



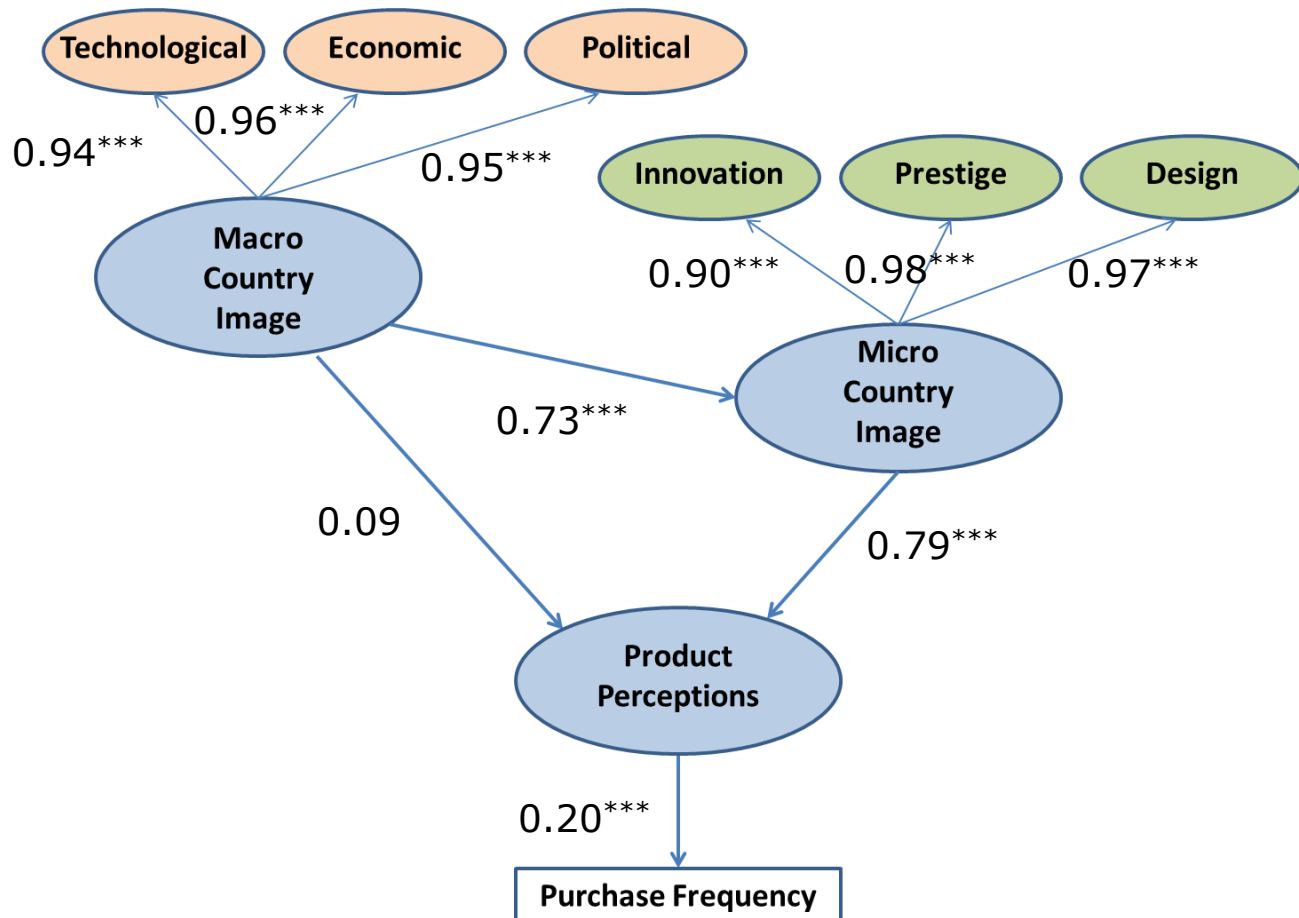


# Summary

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- Macro image positively affects images of Norwegian seafood and salmon
  - Emphasizing Norway evokes positive 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

# Alternative Specification (Germany)



# Alternative Specification (Germany)

