# 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



# 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



### **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

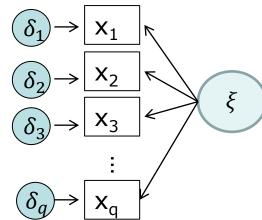


### Latent and Indicator Variables

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

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

- 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

$$y = By + \Gamma x + \zeta$$

- 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
- $\Gamma$  is a  $m \times n$  matrix of coefficients
- $\zeta$  is a  $p \times 1$  vector of errors in the equations and uncorrelated to x
- (I B) is assumed to be nonsingular

#### Measurement Models

$$x = \Lambda_x \xi + \delta$$
$$y = \Lambda_y \eta + \epsilon$$

- $\mathbf{x}$  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
- $\xi$  and  $\eta$  are  $n \times 1$  and  $m \times 1$  vectors of latent variables
- $\delta$  and  $\epsilon$  are  $q \times 1$  and  $p \times 1$  vectors of measurement errors
- Assumes  $E(\xi)=0$ ,  $E(\delta)=0$ ,  $\delta$  uncorr. to  $\xi$   $\eta$  and  $\epsilon$ ,  $\epsilon$  uncorr. to  $\xi$   $\eta$  and  $\delta$



### Structural Equations

$$\eta = B\eta + \Gamma\xi + \zeta$$
$$y = \Lambda_y \eta + \varepsilon$$
$$x = \Lambda_x \xi + \delta$$

- B is a  $m \times m$  coefficient matrix
- $\Gamma$  is a  $m \times n$  coefficient matrix
- ζ is a vector of random errors with zero expectations

### Hypothesis and Estimation

The general hypothesis:  $\Sigma = \Sigma(\theta)$ 

 $\boldsymbol{\Sigma}$  : the population covariance matrix of observed variables

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

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

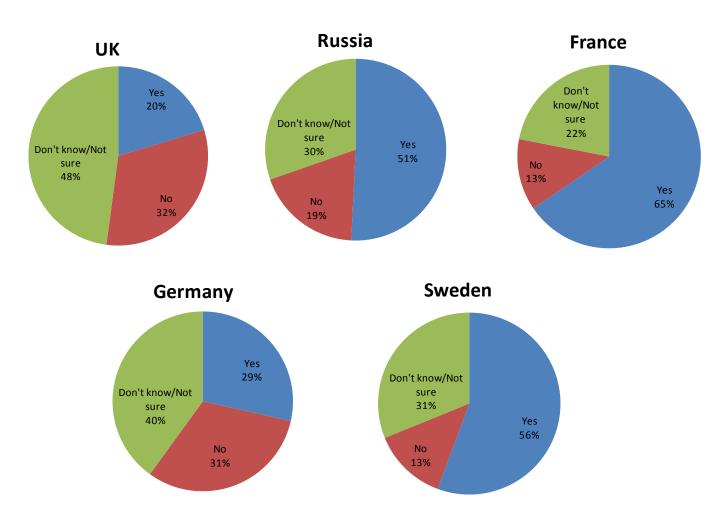
where S is the sample covariance matrix of the observed data

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



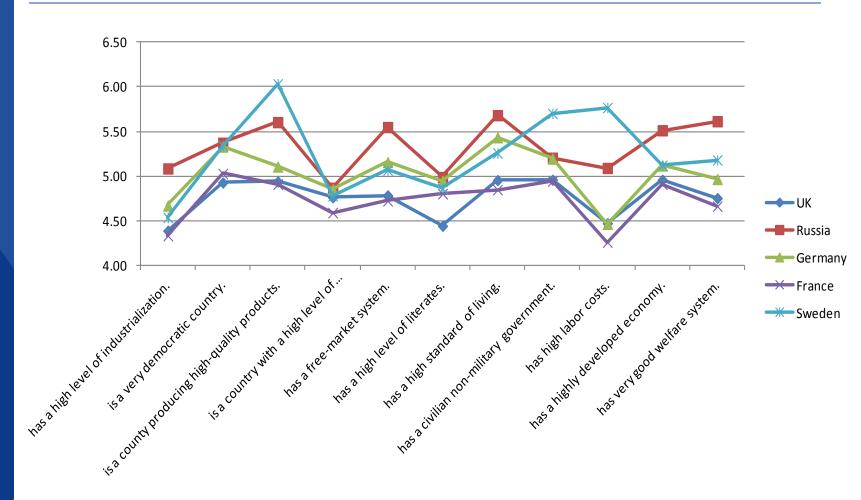
# Seafood Country of origin knowledge

Q: Have you bought seafood products from Norway before?



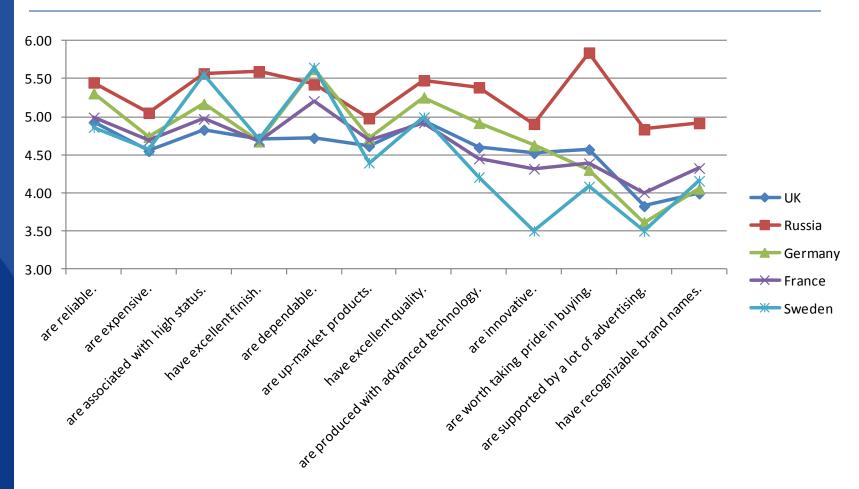


# Macro Country Image Mean Scores (Peppu, et al., 2007)



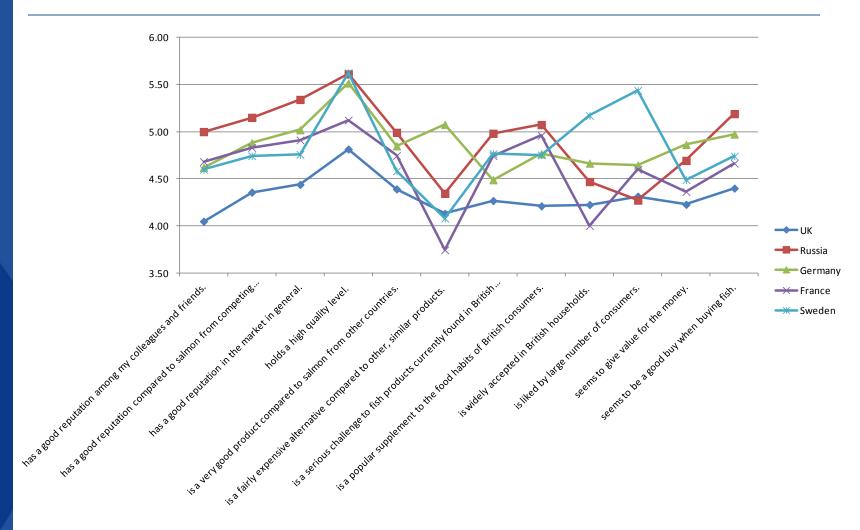


# Micro Country Image (Norwegian Seafood Products) (Peppu, et al., 2007)



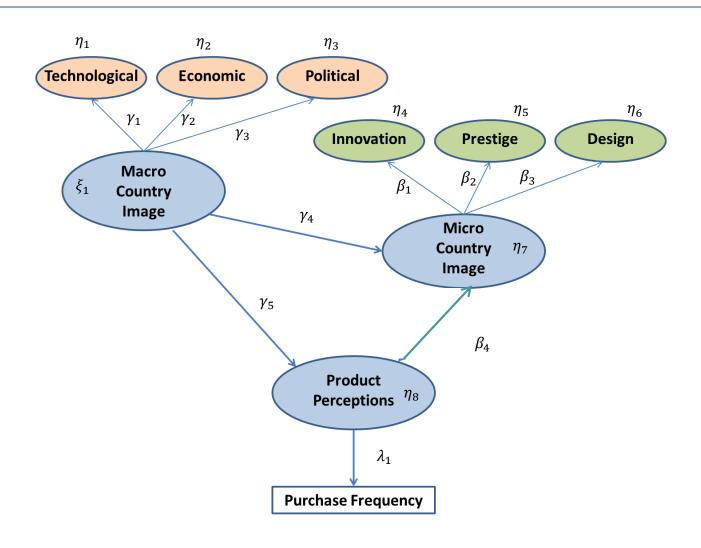


### Product Perceptions of Norwegian Salmon



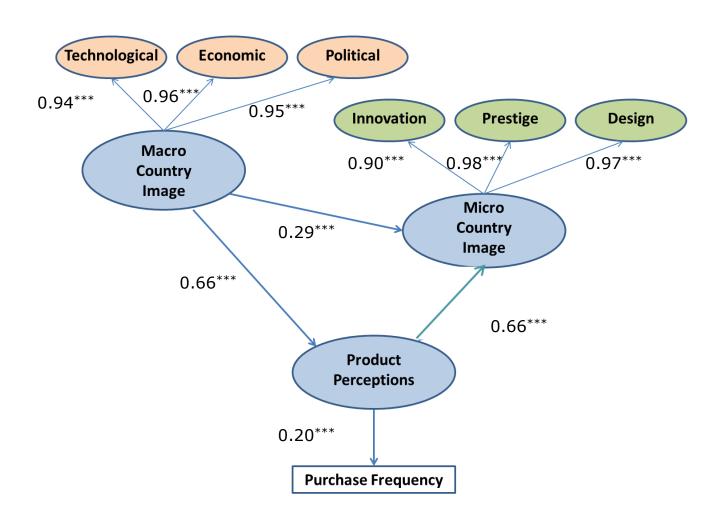


## Conceptual Diagram



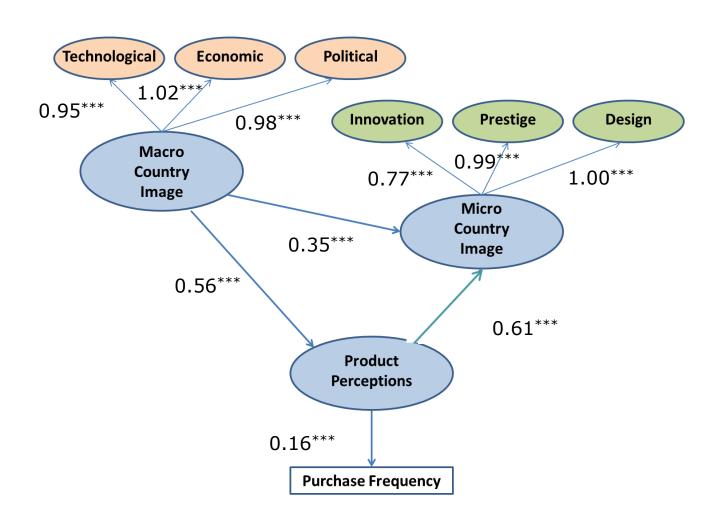


# Estimation Results (Germany)





# Estimation Results (France)



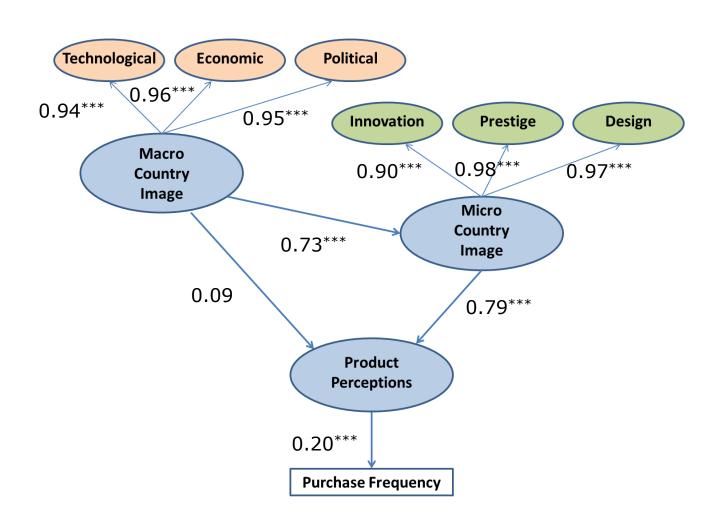


### Summary

- 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



## Alternative Specification (Germany)





## Alternative Specification (Germany)

