Model Fit & Counterfactual Simulations

Tyler Ransom

Duke University

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Model Fit

Model fit is an important dimension by which researchers gauge the quality of their work

- Particularly in structural work, where the model can at times do more of the talking than the data, assessing model fit is a requirement
- At the end of the day a researcher needs to demonstrate that her model reasonably approximates the real world

Model Fit

In a linear model, assessing model fit is quite simple:

- Generate $\hat{y} = X\hat{\beta}$, then compare y and $\hat{y}$
- R^2 a goodness-of-fit measure (but shouldn't be used to compare competing models—i.e. don't maximize R^2)

In a nonlinear model, where the dependent variable is not continuous, assessing model fit may not be quite as straightforward

- Discrete choice model: Match $\hat{P}_j$ with $(1/N)\sum_i 1[y = j]$, i.e. compare what the model predicts for the choice probabilities with what the data say
- Other nonlinear models: Match the average of some measure of the dependent variable with some average measure from data

Model Fit

- Nonlinear analog to R^2 is called the Likelihood Ratio Index (LRI):

$$LRI = 1 - \frac{\ln L}{\ln L_0}$$

  where $\ln L$ is the log likelihood for the full model and $\ln L_0$ is the log likelihood for the model with only an intercept.
- Other measures of goodness-of-fit are the Akaike Information Criterion (AIC) and the Bayes-Schwarz Information Criterion (BIC)
  - These measures are similar to adjusted R^2 in that they penalize the inclusion of more variables
- $BIC = -2 \ln L + k \ln (n)$, where k is the number of estimated parameters and n is the sample size
- $AIC = 2k - 2 \ln L$

Counterfactual Simulation

- Counterfactual simulation is the method by which structural empiricists simulate policy changes
- The main payoff to the structural approach (i.e. making a ton of assumptions—some more realistic than others) is that researchers can turn off certain channels of their model and literally see the effects of policy changes
- To the extent that the model is a good approximation to the real world, these counterfactual simulations can be quite enlightening
- A good structural model takes into account both direct and indirect effects (see below)
- The counterfactual simulation is able to account for what happens to both direct and indirect effects

Counterfactual Simulation Example 1

Let's look at how counterfactual simulation answers a research question in a discrete choice model (recreational choice)

- In this model, people choose from among J lakes to go fishing/boating/swimming in, or choose not to go at all
- People are utility maximizers, so the choice we observe is their utility maximizing choice (i.e. this is a random utility model)
- The following variables enter the utility function: travel distance, travel cost, park entry fees, lake amenities, fishing conditions, and congestion (how many other people are at the recreation site)
- The research question is "what are the environmental implications of (i.e. what happens to park attendance in response to) an entry fee subsidy or a gas tax?"

Counterfactual Simulation Example 1

We can answer our research question by completing the following steps:

- Simulate the effects of a gas tax by increasing travel costs for each person (proportional to travel distance)
- Simulate the effects of an entry fee subsidy by decreasing entry fees for each person
- Given these new values of the X variables, re-generate the $\hat{P}_j$ for each location
- Observe how $\hat{P}_{j,0}$ (the baseline choice probabilities) differ from $\hat{P}_{j,1}$ (the post-simulation choice probabilities)
- From this, the researcher can back out how many people go to each lake under the new scenario
- This can be informative of, e.g., the price elasticity of demand for lake recreation

Counterfactual Simulation Example 2

Let's consider a model of job search

- Person chooses to accept a job (if she receives an offer) based on the offered wage, offered hours/week, and offered health care benefits
- State variables are her own health status, the health status of her spouse, and the health care benefits from her spouse's job
- She accepts the job if her utility from accepting the offer is larger than her utility from rejecting the offer
- Now a researcher can simulate the effects of a health care policy change (e.g. insurance can be obtained cheaply while unemployed)
- What happens to the reservation wage of the workers?
- What happens to the duration of unemployment spells?

Conclusion

- Your econometric model should do a good job of fitting the data
- There are various metrics by which to gauge model fit
- Counterfactual simulation is a great way to answer economic questions
- When doing work with structural models, your reasearch question is not answered until you've completed the counterfactual simulation(s)