IDENTIFIABILITY & INFERENCE ROBUSTNESS

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IDENTIFIABILITY & PARAMETER ESTIMATION

• Identifiability—Is it possible to uniquely determine the parameters from the data?

• Unidentifiability & uncertainty

• Identifiable combinations

Example: $y = (m_1 + m_2)x + b$
DOES IT MATTER?

• Depends on the inference/question we’re trying to answer!

• For example—

• **Identifiability question**: from AFP surveillance alone, are the model parameters identifiable? (probably not)

• **Public health inference/question**: Will there be silent circulation after stopping OPV?
POLIO IDENTIFIABILITY & INFERENCE

• If the parameter combinations that yield the same AFP trajectory always also yield the same answer to silent circulation, OK

• If not, need additional data to answer the question of silent circulation risk (e.g. environmental surveillance)

• Many related questions of how vaccination history and strategies (e.g. whether to vaccinate adults, switch from trivalent to bivalent) will affect silent circulation risk
EXAMPLE: SIWR MODEL

- Multiple transmission pathways in environmentally transmitted disease
- Suppose either incidence or prevalence measurements over time

\[ R_0 = \frac{\beta_I + \beta_W}{\mu + \gamma} \]

Identifiability as $\xi \to \infty$

$\xi=0.01$

$\xi=100$

$\beta_w + \beta_I$ forms an identifiable combination

Eisenberg, Robertson, Tien 2013, JTB
SIWR EXAMPLE

• If our question is whether \( R_0 > 1 \)?
  Note that even when \( \xi \) is large, we can tell when \( R_0 \) crosses 1 because of the form of the ID combination

\[
R_0 = \frac{\beta_I + \beta_W}{\mu + \gamma}
\]

• However, if our major inference is to determine the contribution of each pathway, then identifiability analysis tells us we can’t from this data—additional data is needed
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- We are interested in how uncertainty in model & parameters affects practical decision-making
  - Are public health inferences preserved across parameter space?
  - Are they preserved across model structures?
  - If large uncertainty, should we collect more data? Depends! Value of information analysis can help