# Practical Evaluation of Proposals for Integration of Multiple Data Sources

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# Acknowledgements and Disclaimer

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The views expressed here are those of the speaker and do not represent the policies of the United States Census Bureau.

# Admirable Goal

Integrate multiple data sources to produce high-quality statistical information products and services on a sustainable and cost-effective basis

- Extensive recent discussion: Citro (2015), Rao and Molina (2015), CEP (2017), NASEM (2017), FCSM/WSS workshops, many others

# Data Integration – Four Examples (1)

Example A ("append microdata"): Link survey data with unit-level admin/commercial records

Goals: Reduce cost (expenditures, burden), improve quality, esp for high-cognitive load items

# Data Integration – Four Examples (2)

Example B ("backbone and bridge"):

- "Backbone": administrative record sets
- "Bridge": supplementary sample surveys to calibrate definitions; determine "domain sizes" in multiple-frame extensions

Longstanding case: Current Employment Survey

# Data Integration – Four Examples (3)

Example C: Multiple-source extensions of traditional multiple-frame/multi-mode methods

(e.g., Lohr and Raghunathan, 2017)

Crucial issue: ests of domain sizes, features

Example D: Small domain estimation

(Rao and Molina, 2015)

Crucial issues: predictor variables, quality of fit

# Data Integration – Four Examples (4)

All Four: Spectrum of Statistical Products:

- Tabular publications, graphs, maps

- Microdata releases (caution re disclosure)

- In-depth modeling results (per Commission on Evidence-Based Policymaking, 2017)

# One Remaining Question: How?

Practical Criteria for Evaluation of Proposals
for Capture and Integration of Multiple Sources

1. Trajectory of development – systems, products

2. Required information flow & decision points

3. Forestall distractions from both:
   - "Hype cycle" phenomena (Gartner, 2016)
   - Excessive skepticism

# Suggested Evaluation Criteria

I. Outcome Oriented: Quality, Risk, Cost

II. Cross-Cutting:

- Stakeholder Expectations
- Structure
- Processes
- Communication

# I. Outcome-Oriented Criteria

A. Quality – Interface of Product & User

Accuracy (main technical focus)

Relevance, Timeliness, Comparability, Coherence, Accessibility, Granularity

- Brackstone (1999), CNSTAT (2017)

# I.B. Quality – "Accuracy" Dimension

1. Anchor in inferential goals:

    a. Estimands, sources of uncertainty

    b. Exploratory vs. standardized production: reproducibility & replicability

# I.B. Quality – "Accuracy" Dimension

2. Extensions of "total survey error" terms, with extensive assessment of model fit

   Ex: Population coverage, linkage errors & entity resolution, definitional errors, incomplete data; est errors (Lohr & Raghunathan,2017; Elliott & Valliant, 2017, Meng, 2018)

# I.D. Other Dimensions of Quality

Relevance, Timeliness, Comparability,
Coherence, Granularity, Accessibility

Specific criteria often context-dependent:

- Users & uses
- Challenging with heterogeneous user base
- Use cases to connect specific criteria with concrete value delivered to key stakeholder?

# I.E. Outcome Criteria: Risk (1)

Identifiable system-level events that degrade sustainability: disclosure, “break in series”:

Ex: Failure in development timeline, system quality

Ex: Loss or undetected major change in data source

Describe: Worrisome events? Probability? Leading predictors? Impact? Mitigation methods & cost?

# I.E. Outcome Criteria: Risk (2)

Align with literature on:

- Complex supply chains
- Fault-tolerant designs
- “Normal accidents” (via complex and tightly coupled systems – Perrow, 1999)
- Related behavioral issues (e.g., risk homeostasis)

# I.F Outcome Criteria - Cost (1)

For proposed sources & integration methods, spell out:

- Cash expenditure – direct collection, systems
- Other scarce resources (burden, personnel)
- Contingencies for risk management

# I.F. Outcome Criteria - Cost (2)

Cost models for integration of multiple sources

- Expected value (upper quantiles?) for fixed and variable cost components

- Fixed budgets, cost over-runs & related incentives

- Depreciation of (intangible) capital investments, accounting for multiple-source uncertainties on duration & magnitude of use & maintenance?

# II. Cross-Cutting Issues: For Each of Quality, Risk and Cost

A. Stakeholder Expectations & Linkage w/Value

1. Context: One-off special study, prototype, pilot, or full-scale robust production?

2. Vision on quality/risk/cost criteria; related constraints; uncontrolled externalities?

3. Roles of inferential goals, data availability?

# II.B. Structural Effects - Scale

1. Scale Issues: Examples

   - Input data sources – number, complexity

   - Processing: Actions, time, resources

   - Output: Products and features thereof

# II.B. Structural Effects: Scale

2. For each example

   a. Relevant unit of scale?

   b. Dominant scale issues:
      occasional “surge”, steady change?

   c. Scale functions: predictors, curvature,
      asymptotes, quality of fit?

# II.C. Structural Effects: Constraints

1. Resources: Cash, Equipment, Calendar Time, Intangible Capital (especially human capital)

2. Optionality structure:

- Direct or indirect ability to adjust constraints?
- Cost of adjustment? Who pays? Incentives?

# II.D. Cross-Cutting: Processes

1. Technical Processes: Methodology, systems

   Directly applicable literature & practice?

2. Managerial Processes:

   - Transparent, Controllable, Accountable?
   - Internal: Financial, human resources
   - External: Contracting (multiple inputs)

# II.E. Cross-Cutting: Communication

1. Language and standards to provide sufficient clarity on answers & crucial nuances
   - Concrete anchors, images for stakeholders?

2. Consistent with cultural expectations on clarity & uncertainty?

- cf. Gartner “hype cycle” critiques; Perrow (1995) on adoption & diffusion of technology

# III. Conclusions

Evaluation of Proposals for Data Integration

A. Outcome Oriented: Quality, Risk, Cost

B. Cross-Cutting: Stakeholder Expectations
Structure, Processes, Communication

C. Capture and Use of Criteria at All Stages:
Exploratory, Prototype, Pilot & Production

# Thank You!

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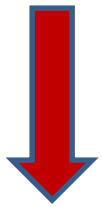
# Data Sources & Tools

Capture, Production, Dissemination



# Information Needs

# I.C. Quality – "Accessibility" Dimension

1. Dissemination Options (per CEP, 2017)

   a. Standard tables, graphs, maps – public

   b. Restricted-access research data centers

2. Impact of disclosure avoidance methods (changing technical and societal environment)