Prospective Application of Component and System Reliability Concepts and Methods to Analysis of Survey Participation

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Overview

I. Data from Complex Sample Designs

II. Survey Participation

III. Possible Component Reliability Approaches

IV. Possible System Reliability Approaches

V. Related Topics

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I. Data from Complex Sample Designs

A. Goals of Large-Scale Sample Surveys

1. Produce estimates for moderately large parameter vectors

   a. Finite population means, totals and ratios

   b. Related analytic parameters (generally represented as nonlinear functions of means)

2. Design: Balance multiple measures of cost, quality, risk
   - Often leads to complex sample designs, field methods

B. Estimator: $\hat{\bar{Y}} = \sum_{i \in s} w_i Y_i$

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II. Survey Participation

A. Most U.S. surveys are voluntary (*de jure* or *de facto*)

B. Major concern: Declining response rates

1. Bias: Proportional to $corr(Y_i, p_i)$ where

p_i = P(Respond | auxiliary information X_i)

commonly based on logistic or probit regression

X_i examples: characteristics of unit *i* and "treatments" (initial contact efforts, incentives, callbacks) received by *i*

2. Loss of efficiency (variance inflation, cost of follow-ups)

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III. Possible Component Reliability Approaches

A. Survey Initiation: For one unit *i* (the "component")

1. Simple approach:
   Up to T efforts to contact and persuade within D days (e.g., twice per day; 10 days)

2. Use component reliability methods to model the number of attempts required to produce response? (Analogous to number of periods before a component "event"/"failure")

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III. Possible Component Reliability Approaches

3. Notes on data:

    a. Randomized experiments on occasion, but observational data more common, per Bull & Spiegelhalter (2011, *Stat in Med*)

    b. Direct analogues to right and left censoring uncommon, except for curtailment of collection efforts due to budget constraints

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III. Possible Component Reliability Approaches

4. Related:

    a. Are we sending out initiation follow-ups (reminders, added incentives, offers of assistance) too quickly or too slowly?

    b. Would "time to event" models (time after issuing initial survey request) help to address question (a)? Presumably would choose to send follow-ups at the α quantile of the "time to event" distribution for $\alpha = 0.8, 0.9$

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III. Component Level (Continued)

B. Survey Attrition

1. One-time survey: Total of A sections

Some respondents will stop after B sections, due to perceived burden, sensitivity, other (analogous to component failure after B periods)

Result: A – B sections missing

Note: Sections possibly incomparable on burden and sensitivity

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III. Component Level (Continued)

2. Panel survey: try to interview unit on each of P periods ("waves")

   Some units stop responding after first K waves (analogous to equipment failing after first K periods)

   Result: Lost final P-K waves of data

III. Component Level (Continued)

3. Attrition analysis: Use component-reliability methods to develop models for observed attrition patterns in a way that accounts efficiently for:

   - Baseline information on unit (company size, industry, geography) known for all sample (or population) units

   - Survey data collected in first K periods

   - The wave (K+1) when attrition occurred

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III. Component Level (Continued)

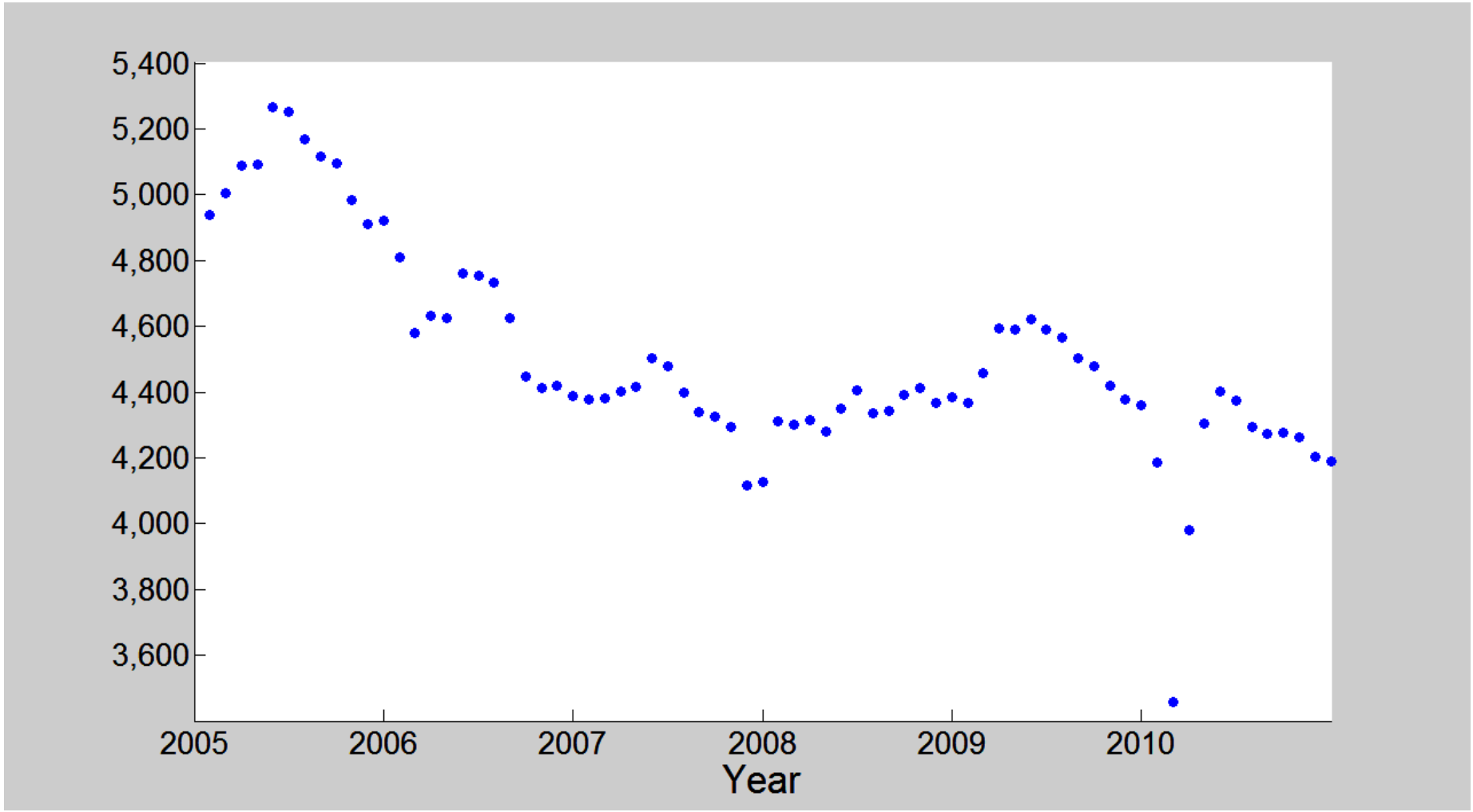
4. Examples of the combined effects of:

   - changes in the number of nominally selected sample units (not considered here)

   - initiation (often slow and expensive)

   - attrition

   on the number of respondents in a monthly establishment survey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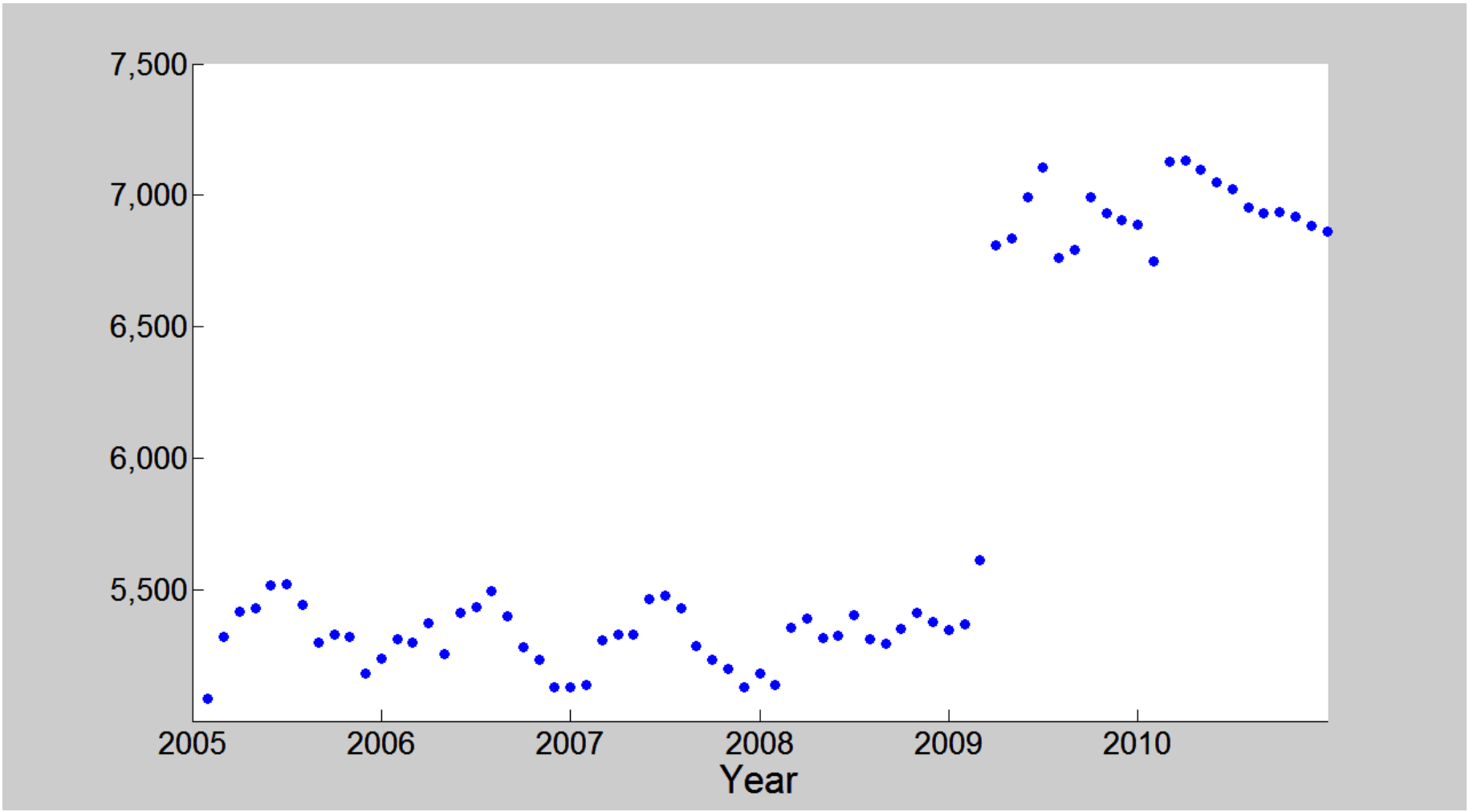
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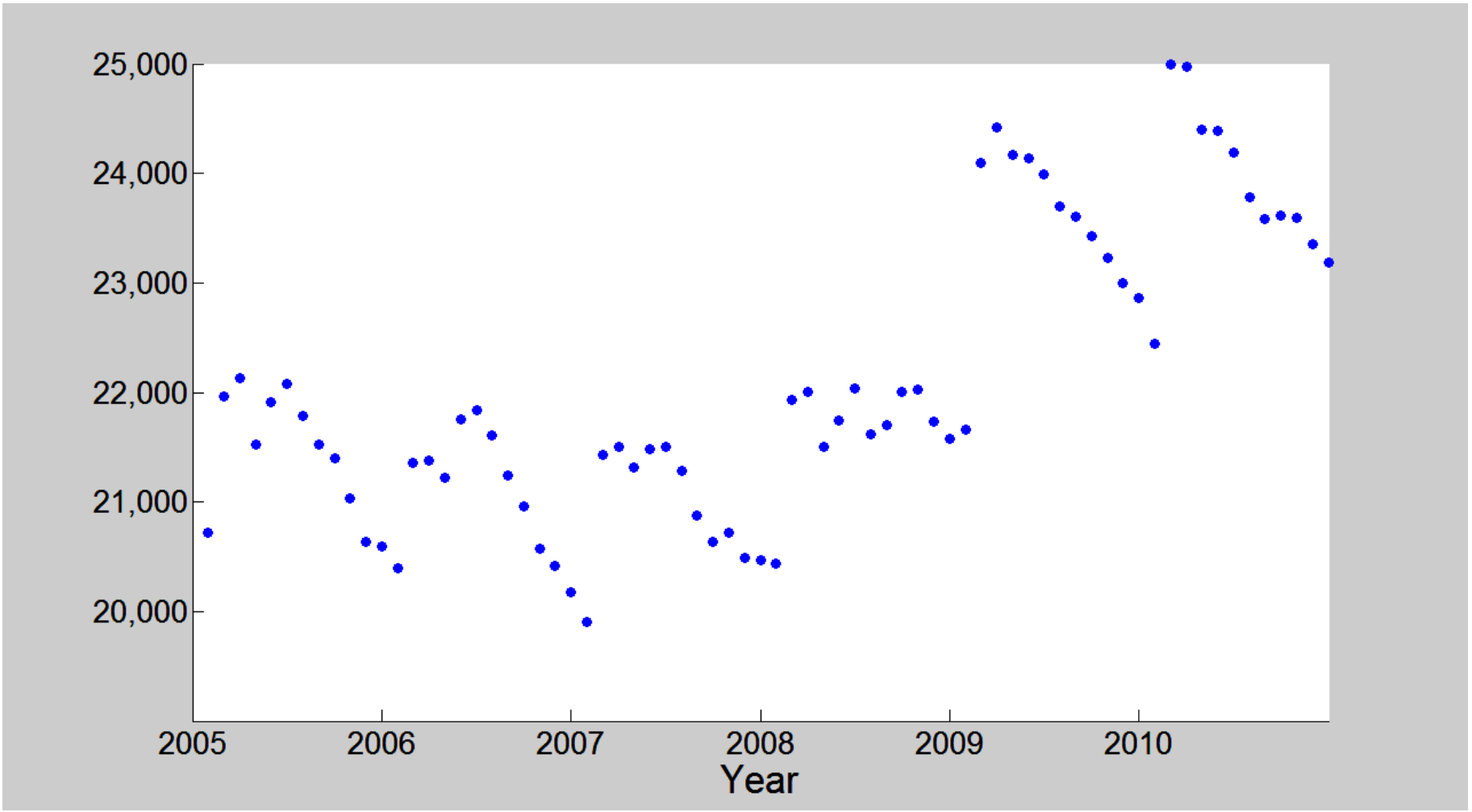
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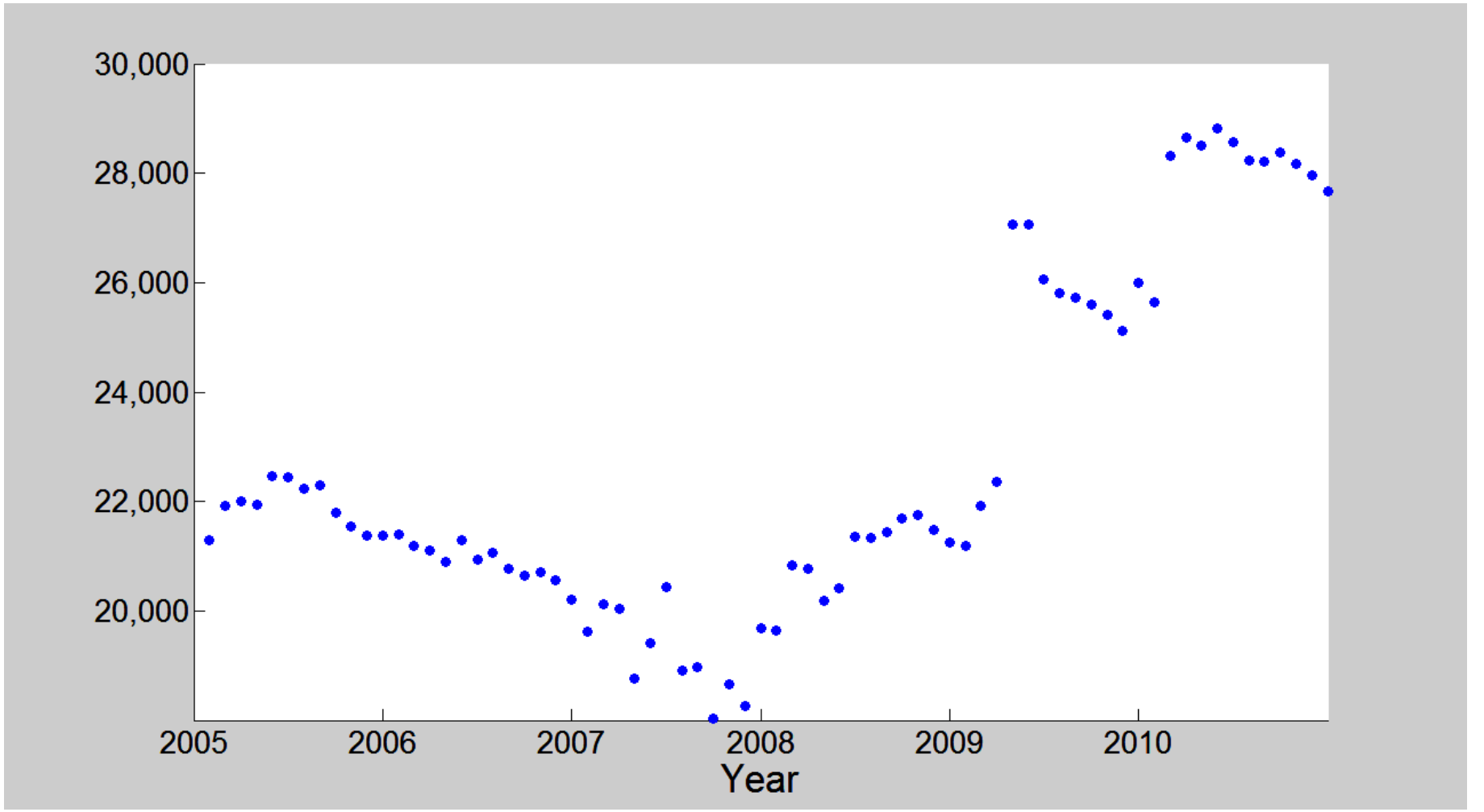

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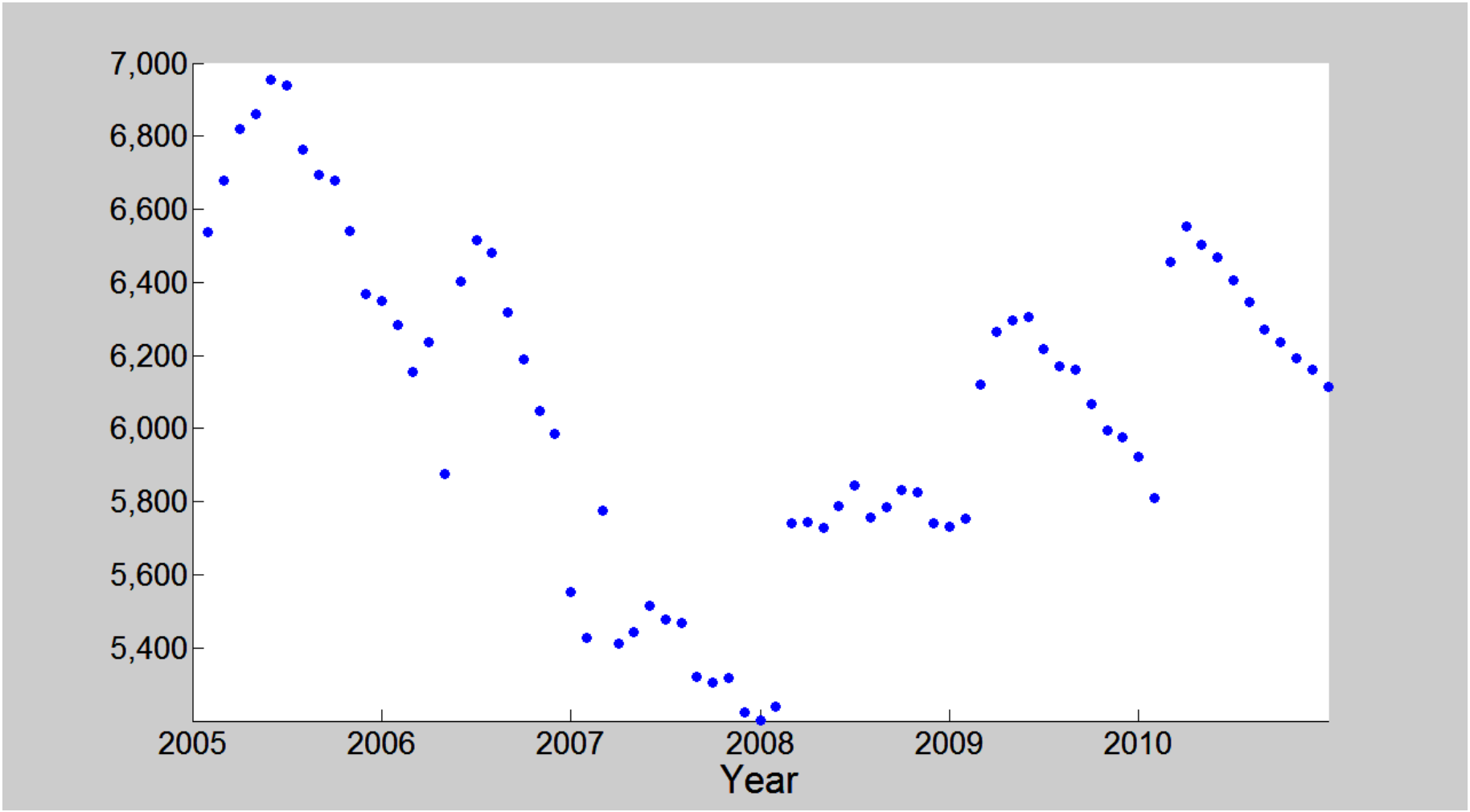

IV. Possible System Reliability Approaches

A. Component approach: single "event" is (non)participation of a given sample unit

B. May view some forms of unit nonparticipation as "system failures" resulting from combined effects of several component failures. (All of the efforts to interview a given unit are the "system" of interest.)

Note: For first two examples, the "failures" are still conceptually restricted to a given sample unit

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IV. System Approaches (continued)

1. Example:

   - Unit excessively burdened on previous interview (interviewer failed to pick up "signals")

   - Scheduling attempts for next interview blocked

   - "Reluctant respondent" efforts (e.g., reduced-burden offers) unsuccessful

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IV. System Approaches (continued)

2. Example: Some establishment surveys

- First few waves for a given unit:
  Computer-assisted telephone interview (CATI) (relatively expensive, but greater help for resp)

- Then try to move unit to web response or other less expensive response option (less guidance for respondent; frustrations with passwords; loss of engagement; agency fails to detect problem on time with reassignment to CATI)

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IV. System Approaches (continued)

3. Example:

- Interviewer hiring becomes less rigorous (previous screening criteria not met)

- Training not fully implemented

- Field supervision less rigorous

Note: The failures here arguably occurred at a coarser level (interviewer, field office or survey organization), even though the final "event" is nonresponse by a given unit.

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V. Related Topics

A. Preceding development focused on survey participation or nonresponse as readily identifiable outcomes

B. Harder to detect: Continued response of deteriorating quality

1. Examples: "straight line" or otherwise perfunctory answers

2. Arguably similar to "multiple types of failure"

VI. Summary

A. Use concepts and methods from component or system reliability to enrich the characterization and modeling of survey participation and nonresponse?

1. Improve understanding of nonresponse bias

2. Empirical results may lead to suggestions for design modifications, field interventions

B. Comments or suggestions welcome

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