Nonresponse Bias & Measurement Error in the Agricultural Resource Management Survey

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Outline

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Motivation

- Test the assumption that increased response rates mean an increase in data quality
  - Compare nonresponse bias across treatment & comparison group and within treatment group
  - Compare measurement error for ARMS respondents across treatment & comparison group and within treatment group

Background

- The Agricultural Resource Management Survey is a multi-stage survey of agricultural producers
  - Collects highly detailed economic data
  - Mainly done by personal enumeration
  - Many versions of ARMS – longer and shorter forms but length of interview regardless is long
    - Cost and Returns Report (CRR) is the version that was used for this study
  - Used to evaluate the financial performance of farms
  - Widely used to make agricultural policy decisions
  - Focus here is on final stage, Phase III
- Response rates for ARMS III have been steadily declining
- Calibration was effective at reducing some bias, but not all (ARMS III 2005, 2006, & 2008)

Background

- Proactively targeting nonrespondents may be another way to reduce bias
  - Likely nonrespondents were identified using an ensemble of classification trees (140 trees total)
    - Classification trees are a data mining approach that segments a dataset using a series of simple rules to maximize dichotomies
    - Identify a subset of operations that are less likely to respond
    - Any operation that has a nonresponse propensity >=0.70 in any tree is flagged as a likely nonrespondent
      - 140 trees identified 543 likely nonrespondent subgroups
      - These are the operations that were examined in this study

Background

- Special recruitment efforts for operations that were identified as likely nonrespondents tested in 2011(Earp et al., under review)
  - Recruitment efforts include sending specific people to the operation, sending a personalized pre-survey letter, giving a logo token item, giving a data product
  - Divided the sample into a treatment and comparison group (N=3,665)
    - 1,832 randomly assigned to treatment
    - 1,833 randomly assigned to comparison
  - Field Offices instructed to use extra efforts to reduce nonresponse in the treatment group; treat all others as usual
  - Quasi-experimental design to assess refusal conversion techniques
    - Refusal conversion techniques assigned by field office staff, not randomly
  - Examined response rates overall and within propensity score quintiles
    - Of these likely nonrespondents, there are a range of response propensities (approximately 12-85%)
    - 5 classes based on propensity to be respondent
      - Class 1: most likely to be a respondent
      - Class 5: least likely to be a respondent
  - Targeting was not that effective – results to follow

Purpose

- Compare the relative bias of the mean for key estimates overall and within treatment & comparison group
  - Decrease in bias reflects difference in converted nonrespondents are different than respondents
- Compare measurement error for key estimates overall and within treatment and comparison group for ARMS respondents
  - Did the converted nonrespondents introduce any measurement error?

Key Estimates

- Total Production Expenses
- Crop Expenses
- Fertilizer Expenses
- Chemical Expenses
- Hired Labor Expenses
- Livestock Purchases
- Feed Expenses
- Seed Expenses
- Fuel and Oil Expenses

Data

- 2012 Census Data was used as a proxy for ARMS III 2011 data
  - Census samples all operations
  - Has information on both ARMS respondents & nonrespondents
- Datasets
  - Census data compared for treatment and comparison operations

Methods

- Nonresponse bias estimates
  - Mean among entire matched sample: $\bar{y}_t$
  - Mean among ARMS III respondents: $\bar{y}_r$
  - Relative Bias of the Mean: $(\bar{y}_r - \bar{y}_t) / \bar{y}_t$
- Bias Measure *M*
  - used to meet specific assumptions of symmetry and scale invariance

$$M = \log(\bar{y}_r) - \log(\bar{y}_t) \approx (\bar{y}_r - \bar{y}_t) / \bar{y}_t$$

Methods

- Test Statistics
  - These estimates of bias were used to determine if the average bias (across the 20 estimate regions) was significantly different from zero
    - Statistical tests used: t-test, signed test, signed rank test

Methods

- Measurement error is the difference between the true value and the observed value
  - Can only examine measurement error for ARMS respondents
  - Reference point for true in our case are Census values
  - Observed value are the published ARMS values
- Compare the Census and ARMS values for key estimates as a measure of measurement error
  - Examine differences
  - t-test

Results from 2011 – Response rates for treatment and comparison group

	Average Nonresponse Propensities		Overall		Treatment		Comparison		χ^2	p	ϕ	$1-\beta$
	Min	Max	*N*	*RR*	*N*	*RR*	*N*	*RR*				
Overall	9.7%	87.9%	3,665	55%	1,833	56%	1,832	54%	1.46	0.12	0.02	0.22

Measurement Error & Nonresponse Bias in treatment vs comparison

- No significant measurement error
- No significant nonresponse bias

How effective are refusal conversion techniques within treatment group?

- Field offices tried to increase response rates
  - Sending a specific person (director, statistician, etc) to operation
  - Sending a personalized letter
  - Providing a logo token item
  - Providing a data item
  - etc
- These techniques were not all used for operations and not randomly assigned so it's not a true experiment
  - Compare response rates among refusal conversion techniques
  - Only providing logo token item increased response rates significantly
    - Look at that group further – does that appear to increase nonresponse bias or measurement error?

Response Rates from 2011 study within treatment group – logo/no logo

	Average Nonresponse Propensities		Overall		Logo Item		No Logo Item		χ^2	p	ϕ	$1-\beta$
	Min	Max	*N*	*RR*	*N*	*RR*	*N*	*RR*				
Overall	9.7%	87.9%	1,833	56%	869	65%	964	47%	62.51	<.01	0.18	>.99

Measurement Error & Non-Response Bias within treatment group for logo/ no logo

- Measurement error
  - 6/9 variables mean measurement error lower for treatment
  - No significant measurement error
- Nonresponse bias
  - 6/9 variables mean nonresponse bias lower for treatment
  - Significant bias for crop expenses
  - Marginally significant for feed & fertilizer expenses
- Correlation between ME & NR bias: -0.50

Response Rates for propensity groups for 2011 study: within treatment group – logo/no logo

	Average Nonresponse Propensities		Overall		Logo Item		No Logo Item		χ^2	p	ϕ	$1-\beta$
	Min	Max	*N*	*RR*	*N*	*RR*	*N*	*RR*				
Overall	9.7%	87.9%	1,833	56%	869	65%	964	47%	62.51	<.01	0.18	>.99
Class One	9.7%	42.0%	389	61%	156	72%	233	53%	14.49	<.01	0.19	0.96
Class Two	43.2%	48.0%	366	63%	178	72%	188	55%	10.84	<.01	0.17	0.89
Class Three	48.3%	63.0%	356	54%	195	60%	161	46%	6.99	<.01	0.14	0.72
Class Four	64.0%	86.0%	381	53%	170	66%	211	43%	20.39	<.01	0.23	0.99
Class Five	87.0%	87.9%	341	47%	170	58%	171	36%	16.54	<.01	0.22	0.98

Measurement Error & Non-Response Bias within treatment group for logo/ no logo – class 1

- No significant measurement error
- Marginally significant nonresponse bias for feed expenses
- Correlation between ME & NR bias: 0.19

Measurement Error & Non-Response Bias within treatment group for logo/ no logo – class 2

- No significant measurement error
- Significant nonresponse bias for crop expenses
- Marginally significant nonresponse bias for seed expenses
- Correlation between ME & NR bias: 0.31

Measurement Error & Non-Response Bias within treatment group for logo/ no logo – classes 3-5

- No significant measurement error for class 3 & 4
- Marginally significant measurement error in class 5 for hired labor expense
- No significant nonresponse bias
- Correlation between ME & NR bias
  - For class 3: 0.31
  - For class 4: 0.50
  - For class 5: -0.32

Conclusions

- We hoped targeting would help but for a survey already conducted by personal interview, like ARMS, singling out hard to get operations doesn't help much

- Refusal conversion techniques didn't improve response rates appreciably in our case
  - Very few cases of significant bias or measurement error

Limitations/Future Work

- Wanted to look at reported versus edited values for measurement error but that data was not available

- Look at other key estimates
  - Other variables examined in 2011 study
  - Demographic variables

- Examine measurement error and bias across rest of types of treatment

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