Behavioral Response to China’s 2002-2003 SARS Epidemic

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China’s SARS Epidemic of 2002-2003

- SARS = “Severe Acute Respiratory Syndrome”
- Began late autumn, 2002
- Spread from south China to Hong Kong, Southeast Asia, Beijing, elsewhere
SARS epidemic notable for:

1. Deadliness

2. Small number of cases (8,083 including Hong Kong and Macao)

3. Ease with which virus spreads

4. Apparently pronounced impact on local economies and everyday lives
Claimed impact of epidemic:

• Migration from rural to urban areas temporarily halted

• Migrants went home from urban areas to rural places of origin

• Economic activity declined precipitously
What really happened?

• Chinese gov’t appears not to have published own studies

• World Tourism and Travel Council has web-published assertions about impact of SARS on China’s economy, basis unknown

• Outside of biomedical fields, research on SARS in China has tended to be psychological
• Anecdotally, know gov’t created forms for process-generated data at village level

• Don’t know whether comparable forms exist for urban areas

• Can’t get access to process-generated data

• Solution: Collect own data
Our Study

• With D.J. Treiman, I had completed a pretest for a survey in 2002

• For 2003, planned full-scale pilot study of feasibility of generating true probability sample of the population of China, with emphasis on migrants
• Focus was on areas where migrants were likely to be. Could we find them? If so, how?

• China’s internal passport (*hukou*) system no longer tightly run

• Planned to concentrate on urban and rural-urban transitional areas

• Carry out local population enumeration and probability list-sampling
• Full-scale pilot was set to be carried out in Spring, 2003.

• As field work began, central gov’t announced that SARS epidemic existed, and took steps to contain it. (April 20, 2003—crucial date.) Field work stopped.

• Before epidemic was over, we designed SARS questionnaire module.

• Went back to field in October, 2003.
Questions we address:

1. What steps did people take to avoid infection?
2. Organized social response to epidemic?
3. Employment altered?
4. Travel altered?
5. Individual response contextually driven?
6. Sociodemographic basis to response?
Nature of Survey

• Probability sample of individuals, realized $N = 1,059$.

• By design, sampled in four province-level areas (2 high SARS, 2 low SARS)

• Goal: Incomplete balanced design: High SARS vs. Low SARS province by rural-urban subclassification.

• Each province contributes three cells in one and only one SARS category.
• Questionnaire, manuals, study design, sampling design by UCLA team.

• Field work: Survey team consisted of graduate students and faculty at a Beijing university.

## Table 1. Distribution of Sampled Places

<table>
<thead>
<tr>
<th>Place Type</th>
<th>High SARS</th>
<th>N</th>
<th>Low SARS</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rural</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedroom village</td>
<td>Beijing</td>
<td>97</td>
<td>Suzhou</td>
<td>102</td>
</tr>
<tr>
<td>In-migrant village</td>
<td>Guangzhou</td>
<td>101</td>
<td>Chengdu</td>
<td>99</td>
</tr>
<tr>
<td>Factory dormitory</td>
<td>Guangzhou</td>
<td>101</td>
<td>Chengdu</td>
<td>100</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural-urban trans.</td>
<td>Beijing</td>
<td>102</td>
<td>Suzhou</td>
<td>98</td>
</tr>
<tr>
<td>Low SES</td>
<td>Guangzhou</td>
<td>98</td>
<td>Chengdu</td>
<td>97</td>
</tr>
<tr>
<td>Medium to High SES</td>
<td>Beijing</td>
<td>6</td>
<td>Suzhou</td>
<td>58</td>
</tr>
</tbody>
</table>
Village-in-city, Guangzhou
High income neighborhood, Beijing
In-migrant village, Chengdu
• Did not achieve balance, due to access problems in high SES neighborhoods.

• Interested in High SARS vs. Low SARS contrast.

• Thus, although not primary interest in SARS analysis, need to control rural-urban subclassification—as well as individual-level characteristics.
Analytic Focus

1. Specific behaviors of individuals during SARS epidemic, including
   — everyday activities
   — work interruptions
   — travel

2. Reports on organizational and aggregate actions or behaviors
Table 2. Selected SARS Individual Behavioral Items

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Definition</th>
<th>Prop. “Yes”</th>
</tr>
</thead>
<tbody>
<tr>
<td>knew</td>
<td>Knew about SARS before April 20, 2003</td>
<td>.69</td>
</tr>
<tr>
<td>medical</td>
<td>Took “medical measures” to prevent SARS</td>
<td>.46</td>
</tr>
<tr>
<td>hoard</td>
<td>Accumulated food or other goods</td>
<td>.13</td>
</tr>
<tr>
<td>avoid</td>
<td>Tried not to shop or go out for entertainment</td>
<td>.62</td>
</tr>
<tr>
<td>wash</td>
<td>Washed hands more than before epidemic</td>
<td>.73</td>
</tr>
<tr>
<td>gongshou</td>
<td>Used gongshou (instead of hand shake)</td>
<td>.09</td>
</tr>
<tr>
<td>mask</td>
<td>Wore a mask</td>
<td>.44</td>
</tr>
<tr>
<td>fencan</td>
<td>Began to use fencan (serving chopsticks)</td>
<td>.05</td>
</tr>
</tbody>
</table>
Table 3. Respondent-Provided Reports of Socially Organized or Aggregate Response to SARS Epidemic

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Definition</th>
<th>Prop. “Yes”</th>
</tr>
</thead>
<tbody>
<tr>
<td>disinfect</td>
<td>Was your place of work or residence disinfected?</td>
<td>.85</td>
</tr>
<tr>
<td>restrict</td>
<td>Did your place of work or residence restrict entry and exit?</td>
<td>.63</td>
</tr>
<tr>
<td>quarantine</td>
<td>At your place of residence were suspected SARS patients quarantined?</td>
<td>.46</td>
</tr>
<tr>
<td>spitting</td>
<td>Did spitting in public decrease around your place of residence?</td>
<td>.67</td>
</tr>
</tbody>
</table>
## Sociodemographic Covariates
(all dummies or dummy classifications)

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hukou status</td>
<td>1 = permanent local <em>hukou</em>; 0 = other</td>
</tr>
<tr>
<td>Education</td>
<td>None or primary; lower middle school; upper middle school; post-upper middle school</td>
</tr>
<tr>
<td>Gender</td>
<td>1 = male; 0 = female</td>
</tr>
<tr>
<td>Age</td>
<td>20-29; 30-39; 40-49; 50-63</td>
</tr>
<tr>
<td>Occupation</td>
<td>Nonmanual; manual; none</td>
</tr>
<tr>
<td>Party membership</td>
<td>1 = party member; 0 = other</td>
</tr>
</tbody>
</table>
Modeling SARS Item Responses (Cross-sectional)
Logistic Regression for SARS Items

\( i = \text{individual} \)
\( j = \text{SARS item} \)
\( DSARS = \text{High SARS vs. Low SARS place} \)
\( x = \text{covariates} \)

\[ \eta_{ij} = \logit(\Pr(Y_{ij} = 1 | DSARS_i, x_i)) = \beta_{0j} + \beta_{1j} \text{DSARS}_i + \sum_{k=2}^{K} \beta_{kj} x_{ik} \]
Table 4. Associations Between SARS Items and Whether R Lives in High SARS Place (Proportions and Proportionate Differences)

<table>
<thead>
<tr>
<th>SARS Item</th>
<th>High SARS Areas: Prop. “Yes”</th>
<th>Uncontrolled</th>
<th>Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>knew</td>
<td>.76</td>
<td>.12***</td>
<td>.11***</td>
</tr>
<tr>
<td>medical</td>
<td>.52</td>
<td>.12***</td>
<td>.08***</td>
</tr>
<tr>
<td>hoard</td>
<td>.18</td>
<td>.09***</td>
<td>.06***</td>
</tr>
<tr>
<td>avoid</td>
<td>.70</td>
<td>.16***</td>
<td>.15***</td>
</tr>
<tr>
<td>wash</td>
<td>.80</td>
<td>.10***</td>
<td>.06*</td>
</tr>
<tr>
<td>gongshou</td>
<td>.09</td>
<td>.04</td>
<td>.02</td>
</tr>
<tr>
<td>mask</td>
<td>.55</td>
<td>.22***</td>
<td>.20***</td>
</tr>
<tr>
<td>fencan</td>
<td>.07</td>
<td>.03</td>
<td>.01</td>
</tr>
</tbody>
</table>

12/21/2005 paa 2005 sars 25
Table 5. Signs of Statistically Significant Relationships for Covariates in Logistic Regressions for Each SARS “Individual” Item

<table>
<thead>
<tr>
<th>Cov.</th>
<th>knew</th>
<th>med</th>
<th>hoard</th>
<th>avoid</th>
<th>wash</th>
<th>gongs</th>
<th>mask</th>
<th>fencan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phukou</td>
<td>-</td>
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<td>-</td>
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<td>Educ</td>
<td>+</td>
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<td>Male</td>
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<td>Age</td>
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<td>Pmemb</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>disinfect</td>
<td>X</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>restrict</td>
<td>X</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>quarant</td>
<td>X</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>spitting</td>
<td>X</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
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</tr>
</tbody>
</table>
Take-away: Determinants of Responses to Individual SARS Items

1. Epidemiological context matters a lot
2. So does organized social response
3. Perceptions of aggregate behavioral change also appear to affect individual behavior
4. Hand washing—the only genuinely prophylactic behavior—is a function of education in a meaningful way
5. Sociodemographically defined position relatively unimportant determinant of behavior
6. Considerable uniformity of reported individual behavior
7. Considerable uniformity of socially organized response
Work Stoppage & Travel Interruption Setup

• Compare 2003 with 2002
• Treat both problems as counting processes
• Divide each year into periods (WHO travel advisories):
  – 1: Spring Festival to March 31
  – 2: April 1 to April 19
  – 3: April 20 to May 23 (April 20 is significant)
  – 4: May 24 to June 23
  – 5: June 24 to September 30
More on Work Stoppage & Travel Interruption Setup

• Count number of events per individual per period
• Turns into 2-level problem
• Adjust for period width
• Fit exponential regression
2-Level (GEE) Poisson Regression for Work Stoppage

\[ C_{ij} = \exp\{\ln(E_i) + \beta_0 + \sum_{i=2}^{i=10} \delta_i P_i + \beta_1 DSARS_j + \sum_{k=2}^{K} \beta_k x_{jk}\} \]

\((i = \text{time period}; \ j = \text{individual}; \ k = \text{covariate})\)
Figure 1. Estimated Daily Rate of Per Individual Work Stoppage, from Spring Festival to October, 2002 and 2003
Take-away, Work Stoppage
Multivariate Analysis

• *None* of the included controls affect the temporal pattern of work stoppage: individual sociodemographic characteristics; high SARS vs. Low SARS place

• No high SARS vs. Low SARS effect

• But, there is a general epidemiological effect that we have seen in the figure
2-Level (GEE) Negative Binomial Regression of Travel

\[ C_{ij} = \exp\{\ln(E_i) + \beta_0 + \sum_{i=2}^{i=10} \delta_i P_i + \beta_1 DSARS_j + \sum_{k=2}^{K} \beta_k x_{jk} + \varepsilon_{ij}\} \]
• Expect seasonality in travel rates

• *All other things equal*, expect higher travel rates in 2003 than in 2002, due to memory decay

• *Without SARS epidemic*, expect additivity of year and period within year

• We find instead that the data support a constrained interaction between year and period within year
The constraint is to include only a single interaction between year and period within year.

The relevant period is period 3 (April 20 to May 23) in 2003. The constrained interaction can be written as:

\[
\gamma Year + \sum_{s=2}^{s=5} \lambda_s T_s + \tau Year \cdot T_3
\]
Figure 2. Estimated Daily Rate of Per Individual Travel, From Spring Festival to October, 2002 and 2003
Take-away From Travel Multivariate Analysis

• The travel rates for 2003 are greater than those for 2002, except for period 3 in 2003.

• As just seen, there is a clear “epidemiological” effect—the rate of travel declined during the period when efforts to contain SARS were at their peak in 2003.

• The “SARS effect” in the last figure can be explained statistically and plausibly by two additional interactions:
  – Permanent hukou ● Period 3 ● 2003
  – High SARS place ● Period 3 ● 2003
Specifically:

- Travel dropped in high SARS places in period 3 in 2003
- Travel during period 3 of 2003 was lower for those with permanent hukou. That is, the difference between migrants and nonmigrants in travel rates increased in period 3 of 2003, with nonmigrants traveling less during this period. These two factors explain travel decline for period 3 in 2003.
Conclusions

• The SARS epidemic
  – Precipitated individual as well as socially organized efforts to self-protect
  – Led to job loss
  – Decreased travel

• Response was
  – Widespread
  – Still, there was epidemiologically structured as well as *independent* socially organized response
  – Not a lot of socioeconomic/sociodemographic differentiation
Final Observation

• This has been an exercise in the identification of contextual effects, although not intentionally so.

• To the extent that contextual effects are present, we were able to identify them because they are exogenous—the result of an epidemiological “shock.”