Investigation of Service Distortion in China's New Cooperative Medical Scheme

Ruoding Shi and Wen You
Department of Agricultural and Applied Economics, Virginia Tech
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**Background: Program Infrastructure and Procedure**

**The Central Government**
- Guidelines

**Province Government**
- Guidelines

**County Government**
- Design NCMS benefit plans
- Daily operations
- Funding and risk pooling

**NCMS**
- Operate

**Households**
- Voluntary, Fixed risk premium

**Health facilities**
- Township health centers
- County hospitals
- Higher level hospitals

**Fund**

**Approve**

**Pay**
- Provide health services

**Partial cover**
Motivation: Concerns of NCMS

The central government

- Small budget (Wagstaff et al., 2009; You & Kobayashi, 2009; Meng & Xu, 2014; Li & Zhang, 2013)

County governments

- Adverse selection (You & Kobayashi, 2009; Wagstaff et al., 2009)
- Cost control (Yip & Hsiao, 2009)

Households

- Complicated claim process
- Low reimbursement rates
- Service-level distortion
- Increasing out-of-pocket health spending (Wagstaff & Lindelow, 2008; Hou et al., 2014)
Objectives

- Identify which health services are under- or over-covered due to county governments’ cost-control incentives.

- Understand the influencing factors of the degree of distortion
Theoretical model—outline

- We use a principal-agent model (Frank et al., 2000) to characterize interactions between local governments and households.

- The decision-process timeline:
  - The governments design the benefit plan
  - Households decide whether or not to participate
  - Medical expenditures incur and NCMS benefit is obtained
Theoretical model—households

Households are uncertain about their healthcare spending before participating NCMS

• Assume there are **two types of households:**
  unhealthy and healthy

• Household $i$ ‘s **expected NCMS benefit** on health service $s$ is

$$\hat{m}_{is} = \lambda_i \cdot \overline{m}_{is} + (1 - \lambda_i)\underline{m}_{is}, \hspace{1em} 0 < \lambda_i < 1$$

For household $i$,

• $\lambda_i$ is the probability of being unhealthy type in the next year.
• $m_{is}$ is the insurance benefit on service $s$: $\overline{m}_{is}$ if unhealthy, and $\underline{m}_{is}$ if healthy
Theoretical model—households

The **utility of participating NCMS** for household $i$ is

$$u_i(\hat{m}_i) = v_i(\hat{m}_i) + \mu_i - c_i$$

Where

$$v_i(\hat{m}_i) = \sum_s v_{is}(\hat{m}_{is})$$

- $\mu_i$: utility independent of plan benefits.
- $c_i$: cost of enrolling and obtaining insurance benefits
- $v_{is}(\cdot)$: utility of expected insurance benefit $\hat{m}_{is}$

Let $u^0_i$ be household $i$’s reservation utility if uninsured, its **probability of enrolling the NCMS** is

$$Prob(u_i(\hat{m}_i) > \hat{u}^0_i) = Prob \left( \mu_i > \hat{u}^0_i + c_i - v_i(\hat{m}_i) \right)$$

$$1 - F[\hat{u}_i^0 + c_i - v_i(\hat{m}_i)] \equiv n_i(\hat{m}_i, \hat{u}_i^0, c_i)$$

- $F(\cdot)$: the cumulated distribution function of $\mu_i$
Theoretical model—service-level coverage

It is measured by shadow price (Keeler et al., 1998): a threshold that a household’s marginal valuation has to exceed to qualify for reimbursements.

\[ p_s = v_{is}'(\hat{m}_{is}) \]

The higher \( p_s \), the less coverage on service \( s \) provided by the plan.
Theoretical model—social optimal shadow prices

Social optimal condition requires

• Marginal valuations of different services are equalized
  \[ v'_{is}(m^*_{is}) = v'_{is'}(m^*_{is'}) \text{ for } s \neq s' \, \forall s = 1, 2, 3, \ldots, S \]

• Shadow prices of different services are the same: \( p^*_s / p^*_{s'} = 1 \) because
  \[ p^*_s = v'_s(m^*_s) = v'_s(m^*_{s'}) = p^*_{s'} \]

• If \( p^*_s / p^*_{s'} > 1 \), we can say service \( s \) is under-covered;
  If \( p^*_s / p^*_{s'} < 1 \), we can say service \( s \) is over-covered
Theoretical model—the local government

We assume the local government determines a vector of shadow prices \( \mathbf{p} = [p_1, p_2, \ldots, p_S] \) to maximize expected plan profit:

\[
\max_{\mathbf{p}} \pi(\mathbf{p}) = \sum_i \left[ n_i \left[ \hat{m}_i(p), \hat{u}_i^0, c_i \right] \times \left[ r_i - \sum_s \hat{m}_{is}(p_s) \right] \right]
\]

F.O.C.

\[
p_s^* = \frac{\sum_i n_i \hat{m}_{is}}{\sum_i F_i \hat{m}_{is} \cdot (r_i - \sum_s \hat{m}_{is})}
\]

Risk premium paid by household \( i \)

Expected plan profit from household \( i \)
How population characteristics affect the shadow prices?

- A government has to predict $\hat{m}_{is}$ based on population health status and household observable characteristics
  1. Parameter $\lambda_i \approx \lambda$: portion of the unhealthy population in a county
  2. Parameter $\theta_s$: discrepancy in NCMS benefit distribution on service $s$ between two groups
  3. $m_{is}^B$: baseline predicted insurance benefit $m_{is}^B$ based on household $i$’s observable characteristics

\[
\hat{m}_{is}(p_s) = \lambda_i \cdot \bar{m}_{is} + (1 - \lambda_i)m_{is} \\
\hat{m}_{is}(p_s) \equiv \lambda \bar{\theta}_s m_{is}^B(p_s) + (1 - \lambda)\bar{\theta}_s m_{is}^B(p_s)
\]
How population characteristics affect the shadow prices

First-best: no asymmetric information

\[ p_s^* = \frac{\sum_i n_i \hat{m}_{is}}{\sum_i F'_i \hat{m}_{is} \cdot (r_i - \sum_s \hat{m}_{is})} \]

Second-best: asymmetric information

\[ p_s^{second} = \frac{\sum_i n_i m^B_{is}}{\sum_i F'_i m^B_{is} \cdot (r_i - \sum_s [\lambda \theta_s + (1 - \lambda) \theta_s] m^B_{is})} \]

Holding other factors the same, a county government distorts \( p_s^* \) upwards (under-cover service \( s \)) if

1. A higher portion of its residents are unhealthy (\( \lambda \uparrow \))
2. Unhealthy households get higher benefit than healthy households (\([\theta_s - \theta_s] \uparrow\))
Data Set: China Health and Nutrition Survey data

• Carolina Population Center and Chinese National Institute for Nutrition and Health


• Based on the level of economic development, CHNS sample can be divided into four major regions:

Source: https://www.cpc.unc.edu/projects/china/about/proj_desc/chinamap
Empirical Methods

\[
p_s^{\text{second}} = \frac{\sum_i n_i m_{is}^B}{\sum_i F_i m_{is}^B \cdot (r_i - \sum_s \left( \lambda \overline{\theta}_s + (1 - \lambda) \bar{\theta}_s \right) m_{is}^B)}
\]

To calculate \( p_s^{\text{second}} \), we need risk premium \( r_i \), \( m_{is}^B \), \( \lambda \) and the parameters \( \theta_s \).

Predict \( m_{is}^B \) and \( r_i \) in 2011 based on 2009 information

<table>
<thead>
<tr>
<th>Risk Premium ( r_i )</th>
<th>Information Assumption ( m_{is}^B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0  Actual NCMS premium</td>
<td>Less information ( (r_{A0}, \hat{m}^L) )</td>
</tr>
<tr>
<td>A0  Actual NCMS premium</td>
<td>More information ( (r_{A0}, \hat{m}^M) )</td>
</tr>
<tr>
<td>A1  Average spending covered by NCMS</td>
<td>( (r_{A1}, \hat{m}^L) )</td>
</tr>
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<td>( (r_{A1}, \hat{m}^M) )</td>
</tr>
<tr>
<td>A2  Semi-ACG risk-adjusted</td>
<td>( (r_{A2}, \hat{m}^L) )</td>
</tr>
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<td>( (r_{A2}, \hat{m}^M) )</td>
</tr>
</tbody>
</table>

Note: ACG represents Ambulatory Care Group risk-adjustments algorithm
### $\lambda$ and $\theta_s$

<table>
<thead>
<tr>
<th>Type of services</th>
<th>Less-information set</th>
<th>More-information set</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northeast</td>
<td>Central</td>
</tr>
<tr>
<td>Percent of the unhealthy population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.57</td>
<td>0.35</td>
</tr>
<tr>
<td>Discrepancy in insurance benefit ($\Delta \theta_s = \bar{\theta}_s - \theta_s$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive Services</td>
<td>-0.04</td>
<td>-0.05</td>
</tr>
<tr>
<td>Inpatient costs</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>Outpatient costs</td>
<td>0.21</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Results: Estimated relative shadow prices under actual NCMS risk premium in 2011

<table>
<thead>
<tr>
<th>Type of services</th>
<th>Mini. Adj (RMB)</th>
<th>Less information set</th>
<th>More information set</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preventive services</td>
<td>Inpatient services</td>
<td>Outpatient services</td>
</tr>
<tr>
<td>Northeast</td>
<td>950.00</td>
<td>1.00</td>
<td>197.80</td>
</tr>
<tr>
<td>Central</td>
<td>270.00</td>
<td>1.00</td>
<td>1.65</td>
</tr>
<tr>
<td>Western East</td>
<td>420.00</td>
<td>1.00</td>
<td>51.02</td>
</tr>
<tr>
<td>Coast</td>
<td>30.00</td>
<td>1.00</td>
<td>3.45</td>
</tr>
</tbody>
</table>

*Current NCMS risk premium with adjustments*

*Note: All shadow prices are relative to the category of preventive services, so the shadow prices for this category are normalized to 1.00 in all case.*
**Results: Estimated relative shadow prices under alternative risk adjustment systems in 2011**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Preventive services</td>
<td>Inpatient services</td>
<td>Outpatient services</td>
</tr>
<tr>
<td>Northeast</td>
<td>(-)</td>
<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>Central</td>
<td>1.00</td>
<td>1.09</td>
<td>1.11</td>
</tr>
<tr>
<td>Western</td>
<td>1.00</td>
<td>1.69</td>
<td>1.53</td>
</tr>
<tr>
<td>East Coast</td>
<td>1.00</td>
<td>1.16</td>
<td>1.22</td>
</tr>
</tbody>
</table>

*Risk premium adjusted by the regional mean benefit in 2009*

*Risk premium adjusted by disease groups and disability status*

| Northeast        | (-)              | (-)                  | (-)                  | 1.00                | 1.05                | 1.09                |
| Central          | 1.00             | 0.90                 | 1.05                 | 1.00                | 0.93                | 1.07                |
| Western          | 1.00             | 1.06                 | 1.43                 | 1.00                | 0.94                | 0.90                |
| East Coast       | 1.00             | 0.91                 | 1.14                 | 1.00                | 0.97                | 1.21                |

*Note:* (-) indicates the estimated shadow price is negative. All shadow prices are relative to the category of preventive services.
Conclusions

❖ **NCMS:**
  • Challenges of financial sustainability
    ✓ Local residents are relatively unhealthy: Northeast
  • The incentives of under-covering a service is high when
    ✓ Local governments are less informed
    ✓ That service is highly demand by unhealthy group: inpatient care

❖ **Modified NCMS:**
  • Distortions can be reduced if its risk premium are adjusted
Limitations and ongoing work

- Limitation
  - Limited health service types
  - Short durations of utilization

- Ongoing work:
  - Modify objectives of local governments
  - Uncertainty of estimated shadow prices
For more information, please contact us at

Ruoding Shi  
(ruoding@vt.edu)

Wen You  
(wenyou@vt.edu)

Thank you! Questions?


