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

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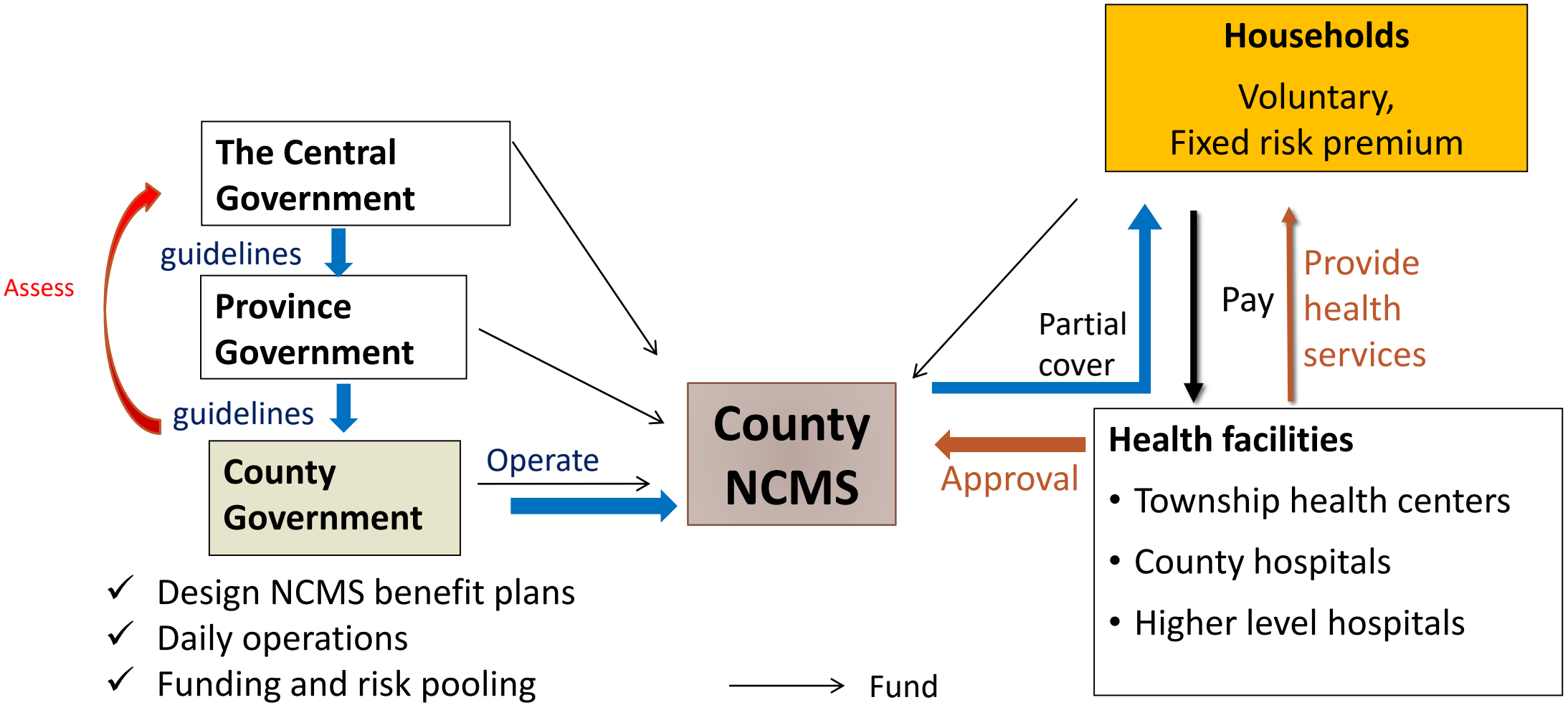
Background: Program Infrastructure and Procedure



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)

Complicated claim process

Low reimbursement rates

Service-level distortion

Households

Increasing out-of-pocket health spending (Wagstaff & Lindelow, 2008; Hou et al., 2014)

Objectives

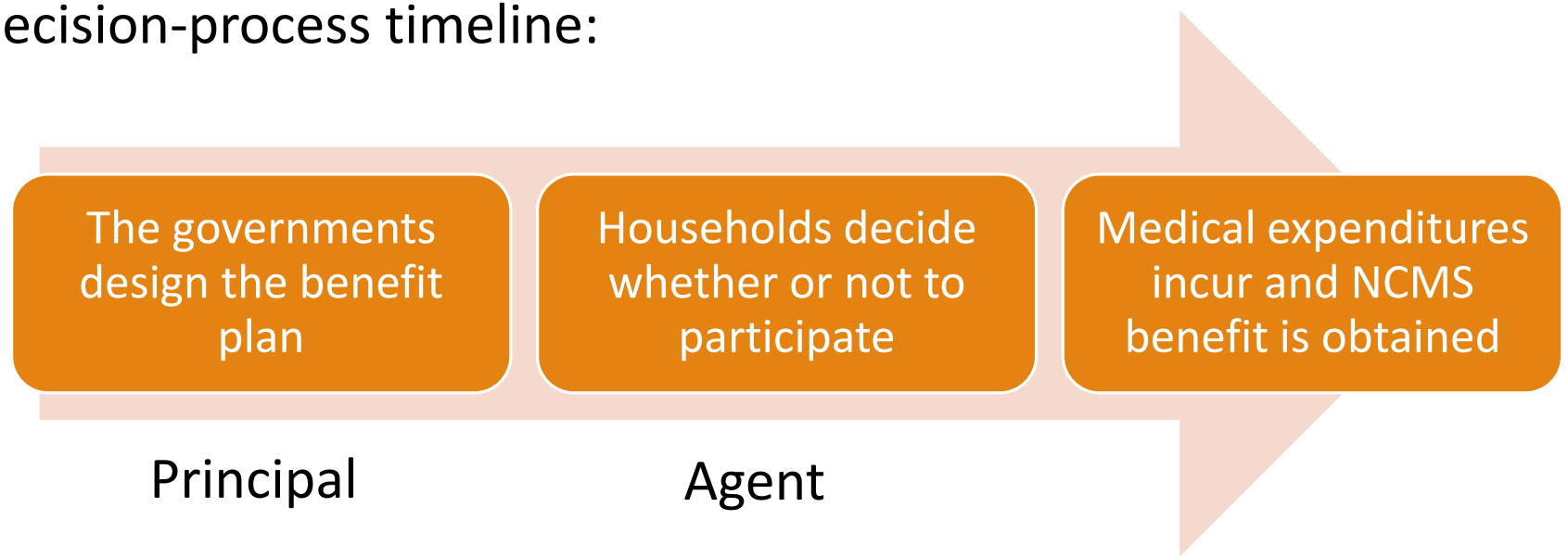
- **Identify which health services are under- or over-covered due to county governments' cost-control incentives.**

- **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:

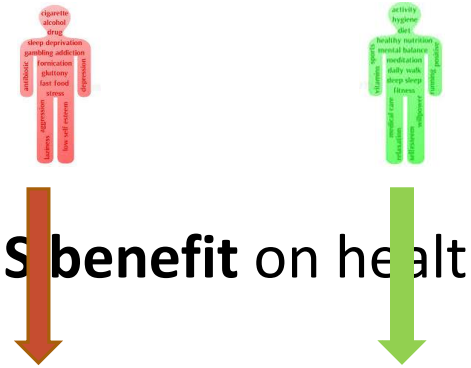


Theoretical model—households

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

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

For household i,

- λ_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

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

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

Let u_i^0 be household i's reservation utility if uninsured, its **probability of enrolling the NCMS** is

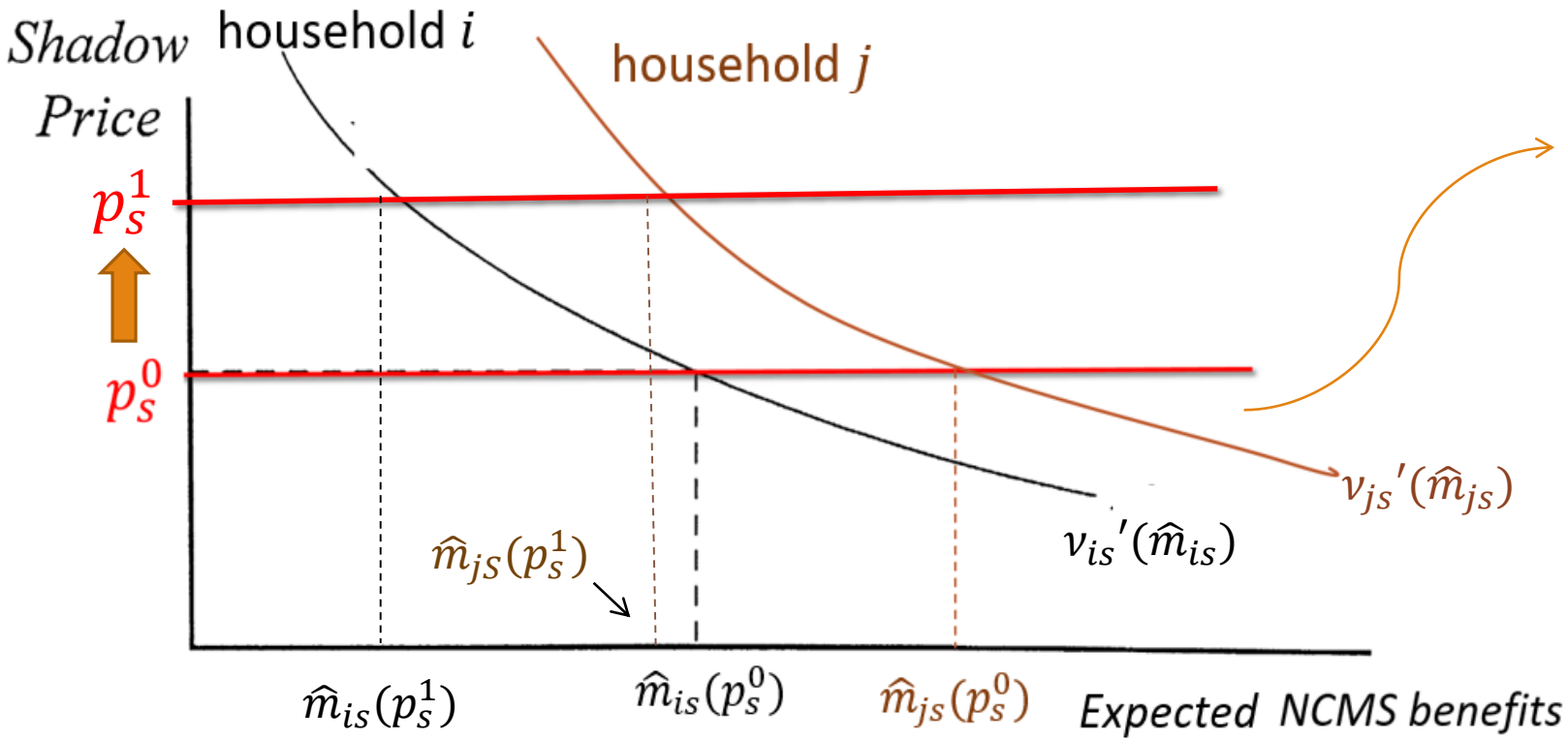
$$Prob\left(u_i(\hat{m}_i) > \hat{u}_i^0\right) = Prob\left(\mu_i > \hat{u}_i^0 + c_i - v_i(\hat{m}_i)\right)$$

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

- $\mathrm{F}(.)$: the cumulated distribution function of μ_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.



Inverse demand of NCMS benefits of two households

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

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

$$v'_{is}\left(m^*_{is}\right) = v'_{is'}\left(m^*_{is'}\right) \text{ for } s \neq s' \ \ \forall s = 1, 2, 3, \ldots, S$$

- 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** $\boldsymbol{p}=[p_1, p_2, \dots, p_S]$ to maximize expected plan profit:

Risk premium paid by household i

$$\max_{\boldsymbol{p}} \pi(\boldsymbol{p}) = \underbrace{\sum_i \left[n_i \left[\hat{m}_i(\boldsymbol{p}), \hat{u}_i^0, c_i\right]\right]}_{Probability\ of\ participation} \times \underbrace{\left[r_i - \sum_s \hat{m}_{is}(p_s)\right]}_{Expected\ plan\ profit\ from\ household\ i}$$

F.O.C.

$$p_s^* = \frac{\sum_i n_i \hat{m}_{is}}{\sum_i \mathrm{F}_i' \hat{m}_{is} \cdot \left(r_i - \sum_s \hat{m}_{is}\right)}$$

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 θ_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

$$\hat{m}_{is}(p_s) = \lambda_i \cdot \bar{m}_{is} + (1-\lambda_i)\underline{m}_{is} \quad \Rightarrow \quad \widehat{\hat{m}_{is}(p_s)} \equiv \lambda\bar{\theta}_s m_{is}^B(p_s) + (1-\lambda)\underline{\theta}_s m_{is}^B(p_s)$$

How population characteristics affect the shadow prices

First-best: no asymmetric information

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

Second-best: asymmetric information

$$p_s^{second} = \frac{\sum_i n_i m_{is}^B}{\sum_i \mathrm{F}_i' m_{is}^B \cdot (r_i - \sum_s \left[\lambda \overline{\theta}_s + (1-\lambda)\underline{\theta}_s\right] m_{is}^B)}$$

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 ($[\overline{\theta}_s - \underline{\theta}_s] \uparrow$)

Data Set: China Health and Nutrition Survey data

- Carolina Population Center and Chinese National Institute for Nutrition and Health
- Longitudinal: 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011 and 2015
- Based on the level of economic development, CHNS sample can be divided into four major regions:

Northeast China

East Coast

Central China

Western China

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

Empirical Methods

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

To calculate p_s^{second}, we need risk premium r_i, m_{is}^B, λ and the parameters θ_s

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

	Risk Premium r_i	Information Assumption m_{is}^B	
		Less information	More information
A0	Actual NCMS premium	$(r_{A0},\ \hat{m}^L)$	$(r_{A0},\ \hat{m}^M)$
A1	Average spending covered by NCMS	$(r_{A1},\ \hat{m}^L)$	$(r_{A1},\ \hat{m}^M)$
A2	Semi-ACG risk-adjusted	$(r_{A2},\ \hat{m}^L)$	$(r_{A2},\ \hat{m}^M)$

Note: ACG represents Ambulatory Care Group risk-adjustments algorithm

λ and θ_S

Type of services	Less-information set: Northeast	Central	Western	East Coast		More-information set: Northeast	Central	Western	East Coast
Percent of the unhealthy population									
λ	0.57	0.35	0.24	0.36					
Discrepancy in insurance benefit ($\Delta\theta_s = \bar{\theta}_s - \underline{\theta}_s$)									
Preventive Services	-0.04	-0.05	-0.04	-0.04		0.08	0.08	0.08	0.09
Inpatient costs	0.44	0.44	0.44	0.45	<	0.51	0.53	0.52	0.52
Outpatient costs	0.21	0.19	0.19	0.20		0.23	0.21	0.25	0.25

Results: Estimated relative shadow prices under actual NCMS risk premium in 2011

Type of services	Mini. Adj (RMB)	Less information set			More information set		
		Preventive services	Inpatient services	Outpatient services	Preventive services	Inpatient services	Outpatient services
Current NCMS risk premium with adjustments							
Northeast	950.00	1.00	197.80	6.45	1.00	1.11	1.14
Central	270.00	1.00	1.65	1.86	1.00	1.63	9.29
Western	420.00	1.00	51.02	5.29	1.00	1.18	1.15
East Coast	30.00	1.00	3.45	6.46	1.00	0.89	1.62

*Note: A*ll 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

Type of services	Mini. Adj (RMB)	Less-information set			More-information set		
		Preventive services	Inpatient services	Outpatient services	Preventive services	Inpatient services	Outpatient services
Risk premium adjusted by the regional mean benefit in 2009							
Northeast		(-)	(-)	(-)	1.00	2.65	2.22
Central		1.00	1.09	1.11	1.00	1.00	1.07
Western		1.00	1.69	1.53	1.00	1.08	1.08
East Coast		1.00	1.16	1.22	1.00	0.96	1.11
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

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Thank you! Questions?

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