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#### **Preparing for population ageing: estimating the cost of formal aged care in China**

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## Preparing for population ageing: estimating the cost of formal aged care in China

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### **Abstract**

China, in common with many other countries in Asia, will confront rapidly increasing demand for formal Long-term Care (LTC) over coming decades. This paper uses a unique regional monthly database on utilization of comprehensive care in Qingdao, China, to estimate transition probabilities and compute duration of care, using Markov chain simulations. Duration of care estimates are then combined with price per unit of care to calculate the total cost of care for the disabled elderly. Results show that the transition probabilities from institutional care to home care are ten times higher than those in the opposite direction; the average support duration in the plan is about 53 months, including both home and institutional care, when admitted at the age of 60, and 44 months if admitted at the age of 85, with costs ranging from RMB 40-120,000 per recipient. The cost analysis suggests that this provision model is an affordable comprehensive care model for elderly Chinese.

Key words: Long-term care, China, Mortality, Markov Chain Model

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## 1. Introduction

China, in common with many other countries in Asia, will confront rapidly increasing demand for formal Long-term Care (LTC) over coming decades. In a region which has traditionally subscribed to the importance of providing family support for the older generation, the twin social forces of reduced fertility and urbanisation are placing this source of support under strain. Financing LTC will become an increasing challenge (Assous 2001, Castries 2009). The Chinese Government now recognises this reality, and has adopted a range of pilot programs to gain insight into what might be a future policy position on LTC.

LTC, whether provided formally or informally, is expensive. Private LTC insurance has not proved widely successful (McShane and Cox 2009; Brown and Finkelstein 2007 and 2011; McNamara and Lee, 2004; Finkelstein and McGarry, 2006). Most developed countries have an LTC policy which subsidises LTC recipients and their families, and China is following in this tradition, examining alternative social insurance schemes.

Studies of China-based LTC mainly focus on frailty prevalence and mortality hazard ratios (Gu et al., 2006; Jin, 2006; Leung et al., 1997; Millan et al., 2010). Almost no cost estimates exist. The aim of this paper is to analyze a comprehensive care insurance<sup>1</sup> program in Qingdao, China, modelling its cost structure at the individual level and discussing implications for other regions in China or other countries. We estimate a multi-state transition model of an elder entering LTC with either institutional or home service, the average duration of care for eligible members at specific ages, and the total cost of comprehensive care for the average disabled elder in the program. Similar exercises are available in some developed countries (Dilnot Commission 2011, Kemper et al. 2005, Favreault and Dey 2015), but this represents the first attempt to estimate part of the cost of comprehensive care based on actual utilization data for disabled elders in China.<sup>2</sup>

The Qingdao program provides comprehensive care for institutional recipients, but only medical-related comprehensive care for home recipients. Social care, which includes house cleaning, meal preparation, personal hygiene support, etc., is not included in the program (it is covered by another welfare program with means-test provisions). As home recipients' social care is not included, the estimated cost is less than a complete service package. However, the transition probability, duration, and current cost structure can provide insights to inform the design of a more comprehensive system. The exercise represents the first-stage cost mechanism for the most severely disabled elders. The next section introduces the Comprehensive Care Insurance for Disabled Elders (CCIDE) pilot project in Qingdao, China.

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<sup>1</sup> In this paper, we treat comprehensive care in a similar way as LTC. The current China case study provides LTC for institutional recipients, but only medical-related comprehensive care for home-based recipients.

<sup>2</sup> Thereafter the mortality is often defined as the exit ratio of the LTC system as a small proportion of the members recover; however, from the system cost point of view, this state is equivalent to death.

Section 3 discusses the data and model, followed by results and simulation analysis in section 4. Section 5 concludes.

## **2. The Comprehensive Care for Disabled Elderly Pilot in Qingdao, China**

Qingdao runs one of the 15 pilot LTC programs in China. About 19% of its city population was aged 60 and over in 2010. To explore fiscally sustainable approaches to meet the demands for comprehensive care by its disabled elderly population, Qingdao has been implementing a unique insurance program in the past decade.

### *Comprehensive Care Insurance for Disabled Elders*

In China, almost all medical services are provided in a hospital setting.<sup>3</sup> There have traditionally been very limited mechanisms to provide medical services in nursing homes, communities, and homes.

The initiative through the CCIDE program hopes to effectively bring medical services into community-level clinics and support the disabled elderly in their own homes, as well as saving resources in major hospitals. In early 2000, Qingdao's health care system started to extend its service from major hospitals to communities and even homes. As a result, they accumulated both the labor force and pricing mechanisms for an independent program - CCIDE. Qingdao's CCIDE was designed to be separated from the existing medical insurance system, addressing the most paramount needs of disabled elders, with provision of affordable professional medical care outside major hospitals. Eligibility is determined by medical needs and disability status, assessed and certified by medical professionals and insurance companies.<sup>4</sup>

Since 2006, the Qingdao government has implemented policies that subsidize medical care for the disabled population in nursing homes and their own homes. The practice has helped to nurture the workforce for such services at market price. In June 2012,<sup>5</sup> the government issued "Guidelines for Establishing a Long-Term Care Medical Insurance System" (Qingdao Doc. No 91), and this was elaborated in further documentation released at the end of 2014 (Lu et al., 2017). The CCIDE currently covers all members who join an employee medical insurance or urban/rural resident medical insurance program. Members experiencing functional disability due to aging, disease, or disability can qualify for institutional, hospital, or home care. Individuals with Employee Medical Insurance face a co-payment of 10%; while others face a co-pay of between 20% and 40%. Qingdao CCIDE's eligibility criteria are based on disease records and limitations in ADLS (see ANNEX 1). There are 10 ADLs, with an overall

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<sup>3</sup> Some cities in China, for example Shanghai, do have an extensive program within their medical insurance service, but for most areas in China, this is not available.

<sup>4</sup> In 2015, the CCIDE invited tenders from insurance companies to manage the CCIDE funds. Two companies are now in charge: PPIC Health for employee medical insurance members and China Life Qingdao for other rural and urban residents. All evaluation processes will involve insurance personnel as "third party independent certification".

<sup>5</sup> Ministry of Human Resources and Social Security website, Document No 80 (2016), issued on June 27 2016, available at [http://www.mohrss.gov.cn/SYRlzyshbzb/shehuibaozhanga/zcwj/201607/t20160705\\_242951.html](http://www.mohrss.gov.cn/SYRlzyshbzb/shehuibaozhanga/zcwj/201607/t20160705_242951.html), accessed on July 8<sup>th</sup> 2016, and translated by authors.

score ranging from zero to 100; lower scores indicate higher disability. Questions are in line with the Barthel ADLs (Wade and Collin, 1988). Most beneficiaries have an ADL score of less than 55. Health status and medical treatment requirements are also taken into account in determining eligibility.

### Payment and pricing of the CCIDE since 2012

The Qingdao CCIDE defined unit price standards by type of services. Before 2015, for those who qualified for nursing home care or services at home, the daily service price was RMB60 per day per person, which provided at least one hour of comprehensive care to clients. For high intensive care, the price ranged from RMB 170 to RMB 200 per bed per day. Higher grade (i.e., tertiary) hospitals are usually overcrowded in China; this initiative was directed at local community hospitals, where service charges are lower and more beds are vacant, as well as nursing homes which have medical qualifications.

Since 2015, the new policy has expanded the types of services covered by the CCIDE. In addition to hospital, nursing home, and home care, another type of care – mobile clinic care – has been added to meet the medical needs of disabled elders in remote rural areas. The price structure was revised to RMB 170 per day for intensive care in hospitals or qualified institutions, RMB 65 per day for nursing home, RMB 50 per day for home care, and RM B800-RMB 1,600 per year for a mobile clinic.<sup>6</sup>

Local officials believe that after years of practice, this fee structure is sufficient to operate at market level. The main service providers are public hospitals and qualified private companies with medical resources (including clinics and nursing homes). The CCIDE signs a contract with service providers, based on the numbers of recipients and quantity/level of services proved by the CCIDE.

## **3. Data and Methods**

### Data

The data used in this study are obtained from government administrative records and consist of records from 23,828 individuals between July 2012 and April 2014. Observations are taken from all system beneficiaries with full coverage from five counties in the city (26% of the city's registered population). Age, ADL limitations at entry, types of disease, and days in each type of care system are given for each individual. During the study period, a total of 4,454 persons exited the system.

Each service recipient was recorded with the date admitted and the date of exit. The service contract is signed for one whole year, and is renewed for another year if the person is still alive and eligible. If the person dies or exits for other reasons, the exact exit date is

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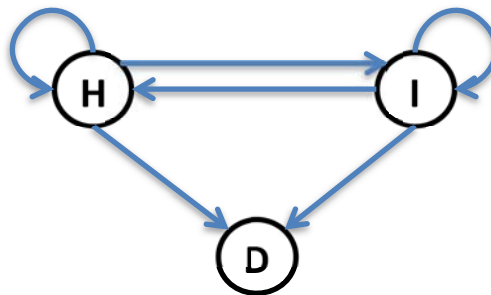
<sup>6</sup> This further utilized the clinic resources in rural areas.

recorded. If he or she transfers from home service to institutional or other types of care, the service starts under a new contract, but with the same ID.

### Methodological Approach

We estimate an age-dependent three-state Markov process, as represented in Figure 1. The state “H” represents home care, “I” institutional care, and “D” refers to exit. In most cases, exit occurs because of death, but in terms of the cost to the system, non-death exit has the same impact.

Figure 1. Three-State Markov Transition Process



The states H and I are transient states while D is the absorbing state. In the Qingdao CCIDE program, each individual is initially accepted with a particular contract specifying either home care or institutional care. Whenever the care type changes, the old contract is terminated and a new contract is issued. Such a process is best modelled by a discrete-time model, in contrast to a continuous-time one (e.g., Fong et al., 2015). The transition interval is measured in months.

We used a discrete-time, inhomogeneous Markov process as follows, separately for women and men. In each month, the transition probabilities among these three states are denoted as Probit models,

$$P_t(s_j|s_i) = \Phi(X_t'\beta_t), \quad s_j, s_i \in \{H, I, D\}$$

In the above equations,  $P_t(s_j|s_i)$  is the transitional probability from state  $s_i$  to state  $s_j$  at age  $t$ . The  $\Phi(X_t'\beta_t)$  is the Cumulative Distribution Function (CDF) of the standard normal distribution<sup>7</sup>, and  $X_t$  is a quartic polynomial of age  $t$ .

Using administrative data from the Qingdao CCIDE program, we estimated age-specific monthly Markov transition probabilities (from H to H/I/D and from I to H/I/D), separately for men and women. Based on these estimates, we simulated the event histories at each age between 60 and 100 to compute the average supporting duration in each type of care and the associated cumulative costs for women and men. For each age between 60 and

<sup>7</sup> We also modelled the logit distribution, but results were not significantly different.

100, we simulated 50,000 men and 50,000 women separately starting from home care or institution care; the initial condition of each simulated man and woman at each age is randomly sampled 50,000 times (with replacement) from the data. Thus the distribution of those characteristics is the same as those in Table 1 (including the proportion of recipients in each care type, i.e., 10% in institution and 90% in home care).

For each simulated individual at each survival month, we calculate the expense associated with the current state. For non-institutional care, we calculate different levels of expenses according to the number of service days per week. We then simulate the state for the next month (home care, institution care, or death) according to the gender-specific, age-dependent multi-state transition probabilities derived above. We apply the prices specified after 2015: RMB 170 for institutional care and RMB 65 for home care

This simulation procedure is repeated for each month until death is reached. After simulating the whole life-cycle for each individual, we aggregate the total costs as well as total months of stay for each individual.<sup>8</sup> Finally, weighted by the distribution of initial states derived from the data, we calculate the unconditional average cost per person for each age as well as the average supporting duration, allowing for different number of services received per week.

#### 4. Results

The essential characteristics of our sample data are summarized in Table 1 by three age groups: 60-74, 75-84, and 85 and above. The average ADL score is recorded when the recipient was assessed for administration by the application form (Annex 1).

Females account for less than half the 60-74 age group, but about two thirds of those aged 85 and above. Disability level increases with age, although the increase is not very dramatic. About 90% received home or nursing home care, while the remaining 10% received high and special care from institutions.

Table 1. General Statistics of Qingdao CCIDE data

	Age 60-74	Age 75-84	Age 85+	Total
Sample size	3719	9240	9378	22337
Females	49%	62%	69%	63%
BARTHEL-score <sup>9</sup>	28.6	27.8	24.6	26.6
Home care	91%	90%	89%	90%
Institution care	9%	10%	11%	10%

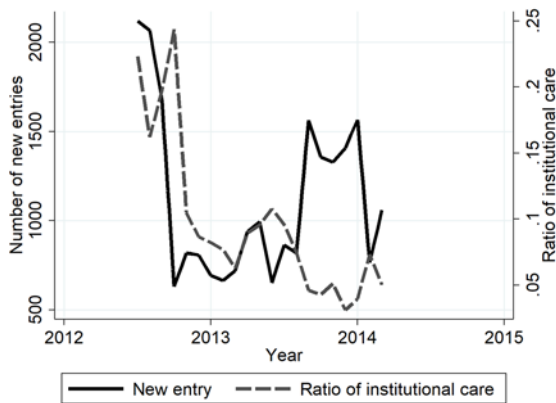
<sup>8</sup> For simplicity, we use RMB 60 for home care price and RMB 170 for institutional care, regardless of the co-payments.

<sup>9</sup> ADL score is from the assessment result in Annex 1.

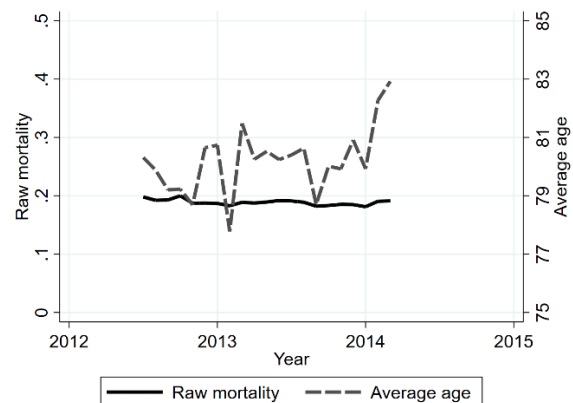
Figure 2 describes, for each month, the total number of new entrants to the system, the percentage of institutional care of the current members, the raw mortality rate, and the average age of current members recorded in the system during the sample period.

Figure 2. New entrants to the system, percentage in institutional care, mortality rate, and average age in the system from July 2012 to March 2014

(a) New entrants and institutional care rate



(b) Mortality and average age



The entry pattern, due to the new policy implementation, showed some turbulence in the data period. Figure 2(a) shows the number of recipients entering the system each month and the proportion in institutional CCIDE. The percentage of recipients of institutional care was about 20% at the beginning, dropping to about 5% in later months. Though the total number of new entrants is not smooth over time, mortality seems to be stable at around 18-19%.

The non-smooth pattern partly reflects the stage of the policy: in July-August 2012, when the program was first launched, there were a large number of entrants, after which it stabilized for about a year. When the program expanded from the initial three districts to five districts,<sup>10</sup> the number increased again during that expansion period. The raw mortality in 2(b) was about 1% higher than average, which probably reflects the severe level of the first eligible group, while BARTHEL scores were lower than the average.<sup>11</sup> We also tested the representativeness of samples by using Kaplan-Meier survival estimates for recipients from July-Sept 2012 and July-Dec 2012 respectively, and they presented almost the same survivor pattern.

<sup>10</sup> Qingdao has 10 districts for jurisdictional purposes. The CCIDE is promoted gradually from one to the other. Up to April 2014, five districts of the 10 had introduced CCIDE.

<sup>11</sup> The recipients of the first two months had an average BARTHEL score of 24, compared to an average of 26.6 in the total sample employed.



Figures 3 and 4 present the probability estimates of transitions, including death, for females and males at each age, using simulation to estimate average mortality and transition probabilities between states.

Figure 3. Annual mortality rates for males and females by age for home care and institutional care (CCIDE) members respectively

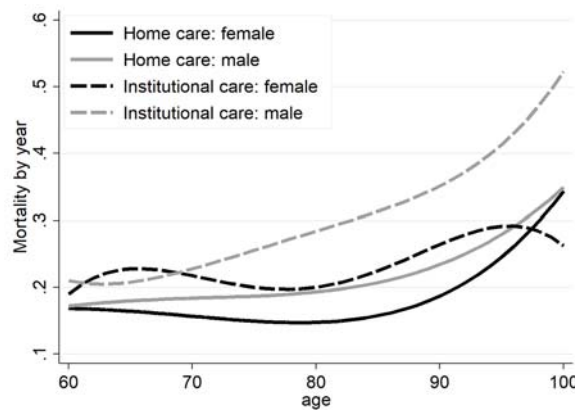
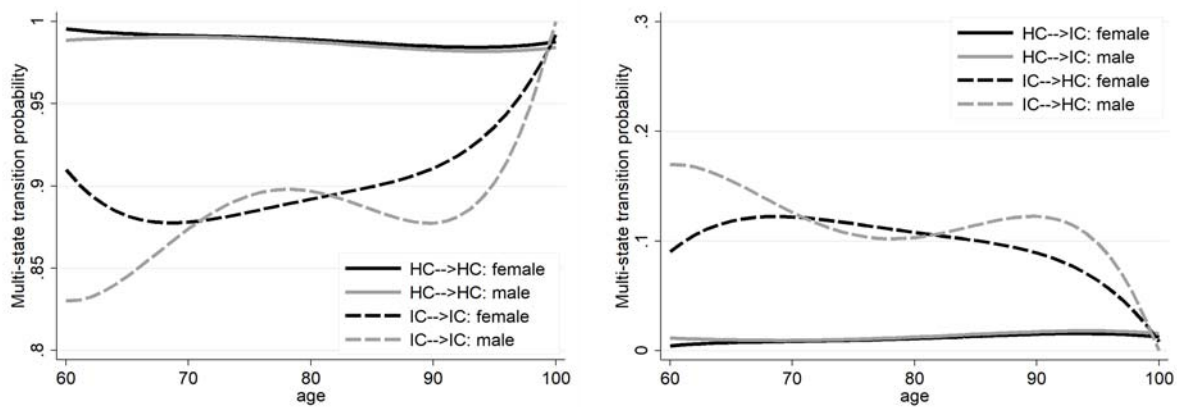


Figure 4. Annual multi-state transition rates for males and females by age for home care and institutional care (CCDE) members respectively

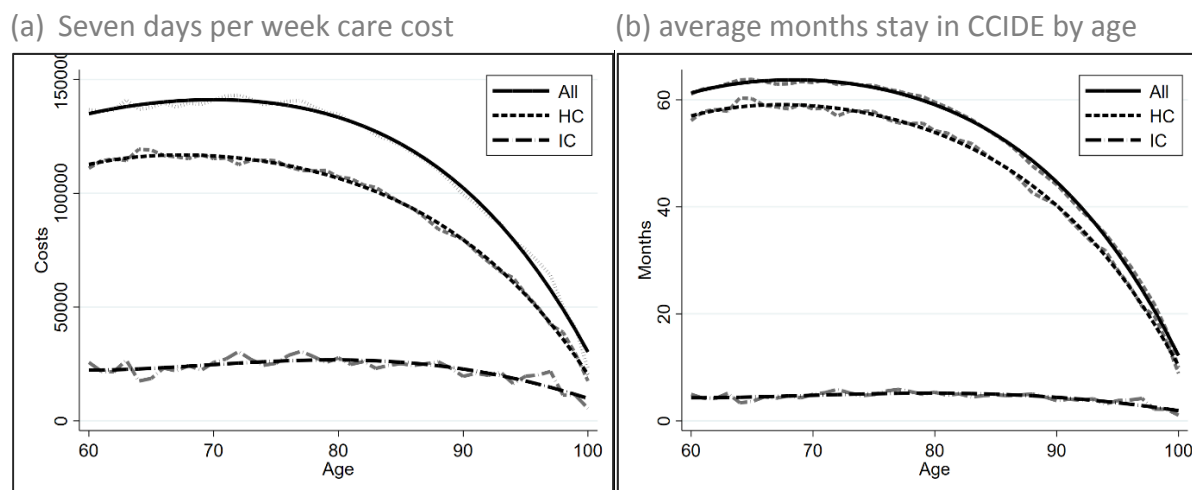


The annual probability of transferring from home care to institutional care is higher for females, while males in general have higher probabilities of transferring from institutional to home care. The probability of transferring from institutional to home care is about 10 times higher than that from home to institutional care. The probability of transferring from home to institutional care increases with age, and from institutional to home care decreases with age (except before the age of 67 for females, where the probability increases with age). Male mortality increases with age after the age of 70 and seems much higher in institutions after the age of 70, but female mortality shows little correlation with age except for home care from the late 80s. Males in home care show a higher mortality rate than females in each age

bracket. However, the institutional female mortality rate is higher than the male rate until about the age of 67, after which it shows a much lower rate.

The simulation using the Markov model can be used to estimate the total cost of Qingdao’s CCIDE, and thus provide the basis for deriving the cost-covering premium of the CCIDE plan. Figure 5 reports the average support duration at each age, and the total cost as well as institutional care and home care separately based on 7 days per week services.

Figure 5. Average cost per recipient in Qingdao’s CCIDE program based on seven days per week (a), and the average supporting duration at each age (b).



The simulation indicates that the mortality of the recipients in the CCIDE is stable from the age of 60 until the late 70s and increases with age at about the age of 80. Mortality increases with age and cost declines with age due to the shorter support periods for older people.<sup>12</sup> At age 60, the institutional care average supporting duration is about half year; this represents one fifth of the total aggregated cost. Institutional care duration does not vary much with age, indicating an end-of-life type of care. Table 2 reports the average supporting duration in the system of different age groups, for both institutional and home care beneficiaries.

Table 2. Average months of duration support by age group and associated cost assuming daily service

	Age 60-74	Age 75-84	Age 85+	Age 60 +
Total Months Stay	63	59	44	53
Total Months Stay(male)	58	51	38	48
Total Months Stay(female)	68	64	47	57
Average cost (RMB), 7 days	139,018	131,715	101,034	120,117
Average cost(male) RMB 7 days	129,457	113,375	85,533	107,455
Average cost(female) RMB 7 days	149,027	143,085	107,927	127,646

<sup>12</sup>Unfortunately, the data do not contain the cost of dying, which is non-negligible, so we do not include it in the CCIDE cost analysis. Local officials informed us that most institutional recipients died when in institutional care.

Currently, the average support duration period in the CCIDE program is 53 months, with an overall estimated cost of RMB 120,117 per head, assuming daily service. The actual frequency of service is about twice a week, which reduces the cost to about RMB 40,000 per recipient.

We conduct three experiments, which we think are practically feasible, to see how costs change in different policy scenario. In the first experiment, we assume the system only admit individuals with ADL scores lower than 45 (exclusive). This additional qualification restriction reduces the home care stay by one month but increases the institution care by only one-and-a-half day, resulting a saving of RMB 1,695 or 1% in the total costs. In the second experiment, we assume the government halves the capacity of the institution care to cover 5% of the admitted elders. In this second experiment, the stay in the home care increases by 1.9 months but the stay in the institution care decreases by 1.4 months. As a result, the total cost is reduced by RMB 3,435 or 3% of the total costs. In the third experiment, we assume the government doubles the capacity of the institution care to cover 20% of the admitted elders. Consequentially, the stay in the home care reduces by 3.8 months but the stay in the institution care increases by 2.8 months. This change results additional RMB 6,870 or about 6% of the total costs.”

## **5. Conclusion and Discussion**

Qingdao’s experiment in CCIDE offers an example of exploring cost-effective and sustainable social policies for a developing country. The policy initiative offers full coverage of comprehensive care for a population of 2.6 million (one third of the regional population) at a modest cost of 0.07% of regional 2014 GDP. If this initiative is expanded to the entire country, the cost would reach about RMB 45 billion. Compared with other LTC cost projections by Zhu and Jia (2009) and Ma et al. (2012), who estimated costs at about RMB 179 and RMB 397 billion in 2015 respectively, this is relatively affordable, while addressing the most paramount need of frail elders.

A key contribution of this study is to provide the first estimate of comprehensive care insurance costs for China based on the experience of an ongoing policy initiative rather than on theoretical assumptions. We applied a discrete-time Markov model instead of the Robinson model where a stochastic model was necessary without exact state transfer timing. Estimated length of recipient in the system ranges from 44-63 months depending on entry ages. With an average BARTHEL score of 26.6, the CCIDE estimates a cost range of RMB 40-120,000 per recipient. The estimation of average duration with transitional probability can give policy makers a guideline for a funding mechanism. Sensitivity analysis around home care-institutional care ratios are reported, and the results suggest that within limits, some flexibility is affordable.

Currently, China is implementing many local policies for LTC, but mainly in developed and rich urban areas. If the Qingdao initiative can be altered to include social care, and be expanded to national level, LTC would no longer be a fragmented and segmented practice and, most importantly, the poor regions would start to care for their frail elders with affordable costs.

Without a separate CCIDE program, Qingdao elders with Employee Medical Insurance members would be motivated to enter “social hospitalization” to receive the same support, as was the case in Japan in the early 1990s. The establishment of CCIDE has not only had a positive financial impact on the basic health system but has also made services for disabled elders more efficient.

The estimation of individual based long-term care cost and support duration in the Qingdao context has implications for national expansion. By translating the service cost as a ratio of local average wage or other parameters, it is possible to project the cost of replicating such a policy in other regions in China. This analysis is the first of its kind for China; it allows regional policy makers to estimate the budget of LTC insurance based on local service prices. The exercise will allow policy makers to adjust their beneficiary structure if necessary, for example, changing the ratio of each care type. It is not, however, a study of projected demand; rather, it focuses on estimating costs for a given population in current circumstances.

More importantly, this paper provides a tool how to estimate a long-term care social insurance cost based on individual data. The methodology used applies to all LTC practices under different eligibility scenarios and service type ratios.

One of the limitations of this study is the short observation period (20 months). Another limitation is that the data do not include the actual medical expenditure by the same recipients in the Basic Medical Insurance system. It is thus difficult to estimate with precision the overall effect on health expenditure by comparing hospital bed price with the institutional day care price. In addition, the CCIDE in this paper does not include social care expenditures for home care recipients. The Qingdao government has just expanded its CCIDE and subsidizes some social care<sup>13</sup>. An LTC insurance system seems to be in place.

In future decades, as population health evolves, transition probabilities may vary, and the kind of cost exercise undertaken here will require updating. See, for example, Smith et al (2014). But it is important that a methodology is established for undertaking such estimations, so that costs may be efficiently estimated in other populations with different socioeconomic and health characteristics.

LTC policy in China is in its infancy. As with many other policy formation processes in China, the central government has encouraged local governments to pilot their own programs;

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<sup>13</sup> Source from newspaper link: [http://news.dailyqd.com/2018-03/29/content\\_424245.htm](http://news.dailyqd.com/2018-03/29/content_424245.htm), translated by authors. The monthly subsidy ranges from RMB 660-1500 per head depending on disability levels.

this then provides guidance on which design to pursue more widely. But the local experience is always reported in the form of regulations along with some statistics of service prices and eligibility criteria. Actual costs are not typically available. The analysis of the Qingdao CCIDE program is especially valuable in providing useful insights into the cost mechanism at individual level. Further, we link eligibility criteria of the LTC system to cost, an exercise not previously carried out to our knowledge, and draw some policy implications.

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ANNEX 1. Qingdao CCIDE Assessment Table

Time : YY MM DD Application Signature :					
Name		ID		Occupation	Employee <input type="checkbox"/> Retiree <input type="checkbox"/>
Disease Description					
Items	Standards	Score	Assessment		
			Initial	Recheck	
1、 Eating	Can't do	0			
	Need Help	5			
	Can do	10			
2、 Bathing	Can't do	0			
	Can do	5			
3、 Grooming	Can't Do	0			
	Can do	5			
4、 Clothing	Can't do	0			
	Need help	5			
	Can do	10			
5、 Bowel	Can't control	0			
	Sometimes out of control ( once a week )	5			
	Can control	10			
6、 Urine	Can't control or do	0			
	Sometimes ( <1 /24hrs ; >once a week )	5			
	Can control	10			
7、 Toilet	Can't do	0			
	Need help	5			
	Can do	10			
8 、 From Bed to chair	Can't do	0			
	Need 2 people to help	5			
	Need 1 person to help	10			
	Can do	15			
9、 Walking	Can't walk	0			
	Can handle wheelchair	5			
	Need 1 helper	10			
	Can do ( with tools )	15			
10、 Walking stairs	Can't do	0			

	Need help	5		
	Can do	10		
Total		100		
SS check	Agree <input type="checkbox"/> No <input type="checkbox"/>	Check time		Signature