Estimating healthy life expectancy: A province-by-province study for China

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Australia-China Population Ageing Research Hub
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Australia-China Population Ageing Research Hub

- Website: **http://www.cepar.edu.au/research/australia-china-population-ageing-research-hub**
- Based in the ARC Centre of Excellence in Population Ageing Research (CEPAR) at UNSW Sydney; funded by UNSW Sydney
- Research areas focusing on China:
  1. Aging trends
  2. Long-term care services and insurance
  3. Mature labor force participation
  4. Retirement incomes, financial products and housing
- Team:
  - Director: Prof John Piggott
  - Scientific Director: Prof Hanming Fang (University of Pennsylvania)
  - 4 full-time research fellows, 3 PhD students

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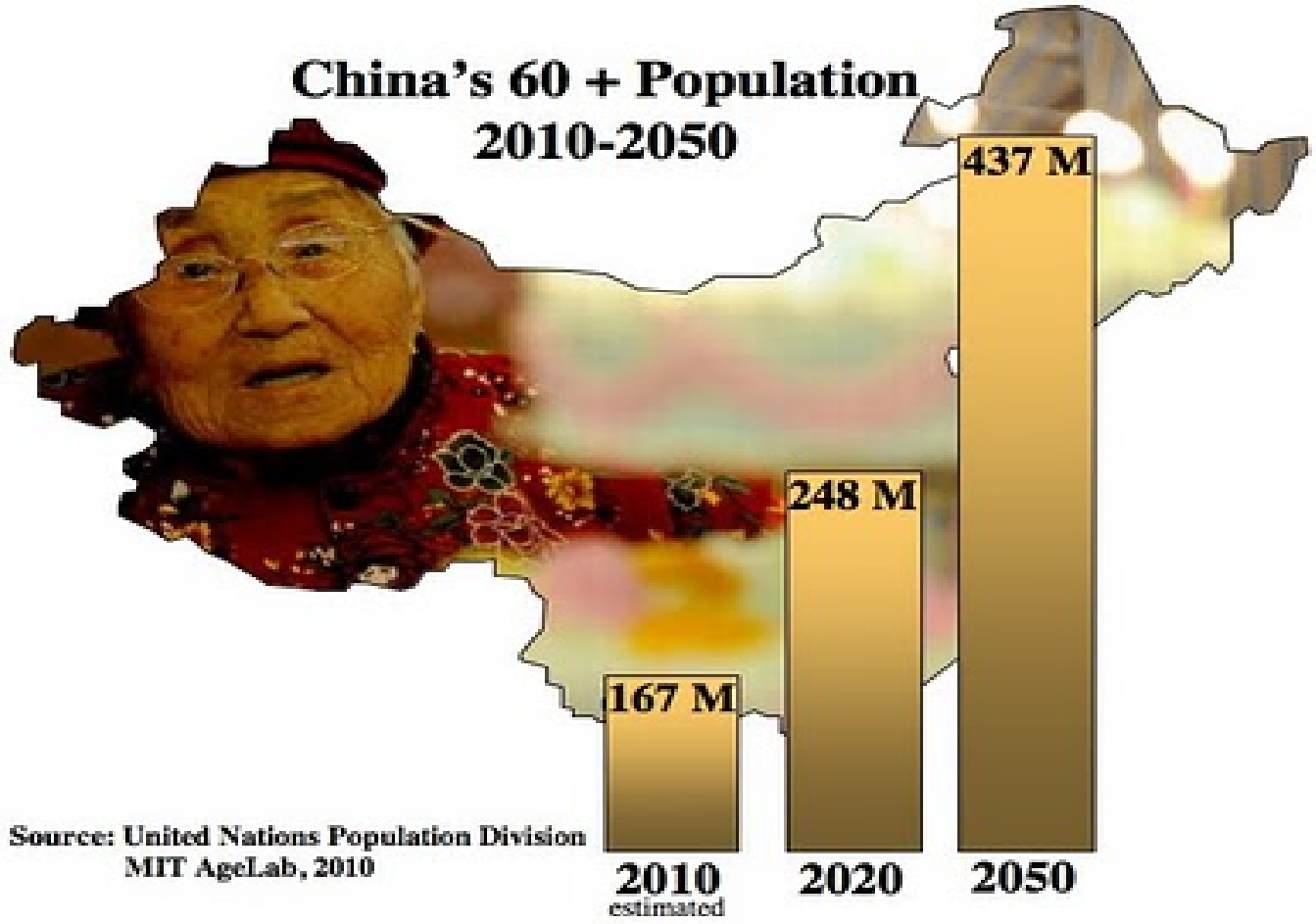
Background

- Long story short: China is getting "old".



Background

URL: http://www.thefiscaltimes.com/Columns/2016/04/01/China-Turns-Face-Its-Aging-Population

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URL: http://www.china-mike.com/chinese-culture/society/china-population-growth-crisis/

What is Healthy Life Expectancy (HLE)?

- Introduced by Sanders in 1964: an important and popular measure to monitor population health – a measure that combines information of mortality and morbidity.
- It captures the quality as well as the quantity of life.
- HLE can be measured in different ways: Disability Free Life Expectancy, Chronic Disease Free Life Expectancy, Active Life Expectancy, Good Perceived Healthy Life Expectancy.
- We use health-adjusted life expectancy (**HALE**) defined and published by the World Health Organization (WHO) as the measure of HLE.

Health-Adjusted Life Expectancy

- In 2000, WHO published the first report on average health situation for 191 countries using HALE as a summary measure.
- HALE: measures the expected years of life living in full health, taking into account severity-weighted disability prevalence estimated in the **Global Burden of Disease** (GBD) Study.
- Sullivan method is used to compute HALE. Information required includes age-specific mortality rates and prevalence rates which are often obtained by cross-sectional surveys.

Global Burden of Disease Study

- Originally commissioned by the World Bank in early 1990s, now institutionalized at World Health Organization.
- The most comprehensive world-wide observational epidemiological study to date:
  - data collected by more than 1,800 researchers in more than 120 countries;
  - capture premature death and disability from more than 300 diseases and injuries;
  - cover 188 countries, by age and sex, from 1990 to the present.
  - allow comparisons over time, across age groups, and among populations.

Need for Province-by-Province Studies on HLE for China

1. Disparity in health situation across China
   - A large degree of heterogeneity in population health across provincial-level regions
   - Variations mirror the differences in regional economic developments.
1. Challenge of data availability
   - Very few studies have focused on the disparity in subregional HLEs.
   - Existing studies mainly focus on HLE at older ages such as age 60 (see for example Liu *et al.*, 2010).
   - Sullivan method: requires detailed information on morbidity which is often not publicly available at province level.

Solution: Let's Borrow Some Data!

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- HLE and LE are driven by certain socio-economic factors.
- We can learn from other countries' experience with different social/economic/demographic features.
- Information on socio-economic variables such as GDP per capita and health expenditure are easier to obtain (For example World Bank and the Organization for Economic Co-operation and Development (OECD)).

Predictive Regression Modeling

Define $y = \text{logit}(\text{HLE}/\text{LE})$, we propose a multiple regression model as follows:

$$y_{it} = \beta_0 + \sum_{k=1}^{K} \sum_{j=1}^{J} \beta_{j,k} x_{it,j}^{k} + \epsilon_{it}, \tag{1}$$

where $i \in [1, N]$ represents country/region and $t \in [1, T]$ represents time.

- $\beta_{j,k}$ is the coefficient of the jth variable of order k.
- K is the highest polynomial order to be considered.
- J represents the number of explanatory variables in the model.
- ϵ_{it} denotes the error term.

Note that the model selection process described in the following section can set some of these coefficients to zero.

Predictive Regression Modeling

The six explanatory variables included in the model are:

- GDP: gross domestic product per capita
- Health: public health expenditure as a percentage of GDP
- Education: public education expenditure as a percentage of GDP
- Hospital bed: number of hospital beds per 1000 people
- Physician: number of physicians per 1000 people
- $D_{EastAsia}$: East-Asia dummy variable

Predictive Regression Modeling

We obtain estimates of coefficients by minimizing the following sum of squared residuals:

$$\sum_{i=1}^{N}\sum_{t=1}^{T}(y_{it} - \beta_0 - \sum_{k=1}^{K}\sum_{j=1}^{J}\beta_{j,k}x_{it,j}^{k})^2 \tag{2}$$

We identify the optimal model using the following selection process:
(1) Start with $K = 1$, compare all possible model specifications and select the model with the lowest BIC value.
(2) Use the Ramsey Regression Equation Specification Error Test (RESET) to test for misspecification of the selected model. If the model is mis-specified, we move on to step (3).
(3) We repeat steps (1) and (2) for the next higher polynomial order until the Ramsey RESET test is passed.

Data

- Estimation: data from the GBD Study for LE and HLE at birth for 139 countries in the years 1990, 2005 and 2013. Social-economic variables from two main sources: World Bank and the OECD.
- Validation:
  1. data from the GBD Study for LE and HLE at birth for 128 countries in 2010.
  2. data for LE and HLE in Taiwan for the years 2005, 2010 and 2013.
- Prediction: HLE for Chinese provinces in 2015 using data from the National Bureau of Statistics of China.

Model Selection

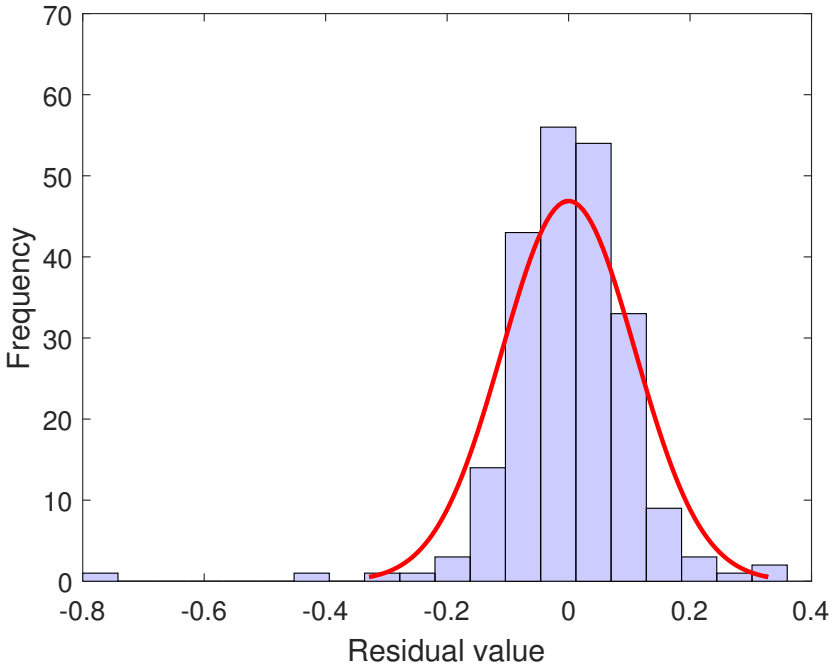
Table: Ramsey RESET test results

K	No. of parameters	BIC	RESET test p-value	RESET test outcome
		Male		
1	5	-307.54	0.0034	Fail
2	7	-315.12	0.1715	Pass
		Female		
1	5	-451.55	0.0104	Fail
2	6	-479.09	0.0752	Pass

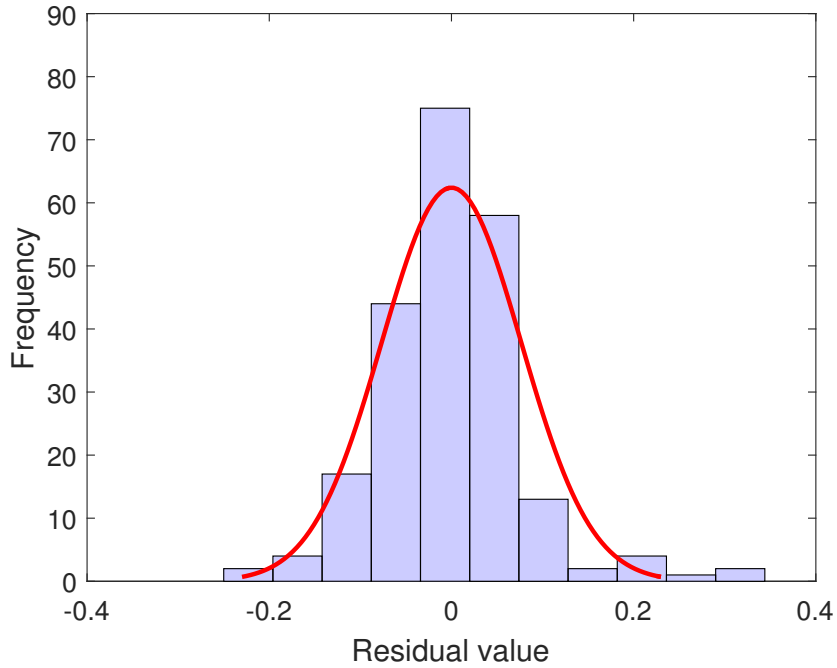
Estimation Results

Dependent variable:	**Logit (HLE/LE)**	
	Male	Female
Intercept	1.853**	1.795**
	(0.025)	(0.012)
GDP	-0.002**	-0.006**
	(0.001)	(0.001)
$GDP^2 (\times 10^2)$		0.005**
		(0.001)
Health	-0.013*	
	(0.006)	
Education	0.018**	
	(0.005)	
Hospital bed	0.042*	0.030**
	(0.006)	(0.004)
Hospital bed^2	-0.002**	-0.002**
	(0.000)	(0.000)
East Asia	0.111**	0.134**
	(0.032)	(0.021)
F-stat	16.623**	30.894**
R^2	0.984	0.994
Sample size	222	222

Residual Plots



(a) Males



(b) Females

Model Validation

Table: Prediction performance test results for HLE in 128 countries in 2010

	In-sample countries	Out-of-sample countries	Total
	Male		
Inside published CI	110	13	123
Outside of published CI	3	2	5
% Inside CI	97%	87%	96%
	Female		
	111	15	126
Outside of published CI	2	0	2
% Inside CI	98%	100%	98%

Model Validation

Table: Prediction performance test results for HLE in Taiwan

	Male		Female	
Year	**Predicted HLE**	**Published HLE**	**Predicted HLE**	**Published HLE**
2005	66.51	66.68 (64.37–68.71)	70.87	70.41 (67.46–73.07)
2010	67.73	67.20 (65.20–68.90)	71.83	72.00 (69.80–73.80)
2013	68.14	68.11 (65.59–70.23)	72.15	71.66 (68.51–74.46)

HLE Prediction for Chinese Provinces

Table: Predicted male HLE in 2015: top 3 provinces and last 3 provinces.

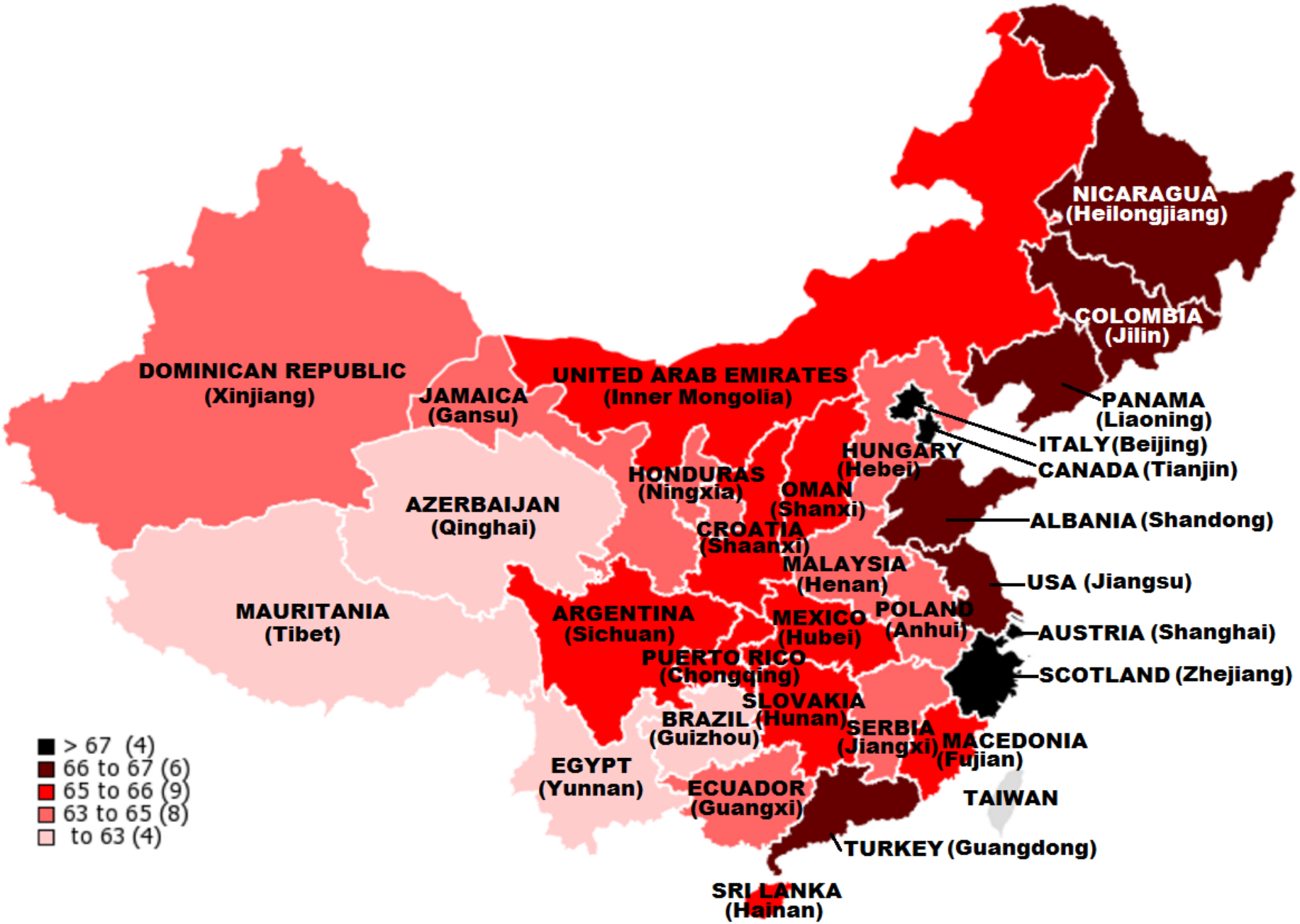
Rank	Province	LE	Predicted HLE	Prediction Interval	Years in disability
1	Beijing	78.97	70.53	(68.54–72.52)	8.45
2	Tianjin	78.20	69.63	(67.65–71.61)	8.58
3	Shanghai	77.92	69.54	(67.57–71.52)	8.38
⋮	⋮	⋮	⋮	⋮	⋮
29	Qinghai	68.77	61.79	(59.94–63.65)	6.98
30	Tibet	67.14	61.00	(59.08–62.93)	6.14
31	Yunnan	67.37	60.44	(58.60–62.27)	6.94

HLE Prediction for Chinese Provinces

Table: Predicted female HLE in 2015: top 3 provinces and last 3 provinces.

Rank	Province	LE	Predicted HLE	Prediction Interval	Years in disability
1	Beijing	84.21	73.78	(72.33–75.22)	10.43
2	Shanghai	83.54	73.20	(71.76–74.64)	10.34
3	Hainan	82.29	72.41	(70.98–73.84)	9.88
⋮	⋮	⋮	⋮	⋮	⋮
29	Yunnan	75.11	66.27	(64.91–67.62)	8.85
30	Qinghai	74.17	65.43	(64.08–66.79)	8.73
31	Tibet	71.94	63.37	(62.05–64.70)	8.57

If China's provinces were countries... Male HLE



If China's provinces were countries... Female HLE

Discussion and conclusions

- Our paper provides the most recent estimates of HLE at birth for China's provincial-level administrative units in 2015.
- Our results show that HLE varies by more than 10 years across Chinese provinces: the estimated male HLE in Beijing is 70.53 years—as good as European developed countries such as Italy, while the number in Yunnan is only 60.44 years which is comparable to African developing countries such as Egypt.
- As the model of HLE developed in our paper does not depend the prevalence rate of morbidity, the model can also be applied to estimate HLE in years where morbidity information is not available.
- Furthermore, as the methods to forecast life expectancy and macro-level social-economic variables are widely available, the model has potential to predict future HLE and thus to project long-term care demands.

Discussion and conclusions

Practical implications of our study:

1. Our results can inform the design of public policies in China.
   - **Current pension eligibility age:** 60 for males and 50–55 for females.
   - **Government:** plan to increase the eligibility age to 65 for both gender.
   - **However,** there are 12 provinces with a male HLE of under 65 years.
2. Our study can contribute to the development of private-market retirement financial products.
   - **Assess** the differences in regional demand for health care and long-term care services.
   - **Price** private health insurance, private long-term care insurance and home equity release products such as reverse mortgages.

End of Presentation

Thank you!

Any questions, comments or suggestions?

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