Evolution of the Value of Longevity in China

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Abstract

Life expectancy gain is an important component of welfare improvement aside from GDP per capita. This paper explores the value of mortality decline and its welfare effects in China's context. We exploit valuation formulae in the *Global Health 2035* report to compute the change in the value of a statistical life for a representative Chinese spanning the decades between 1952 and 2012. We unveil the fact that a substantial longevity improvement compensates the dismal economic performance to a large extent during the pre-reform era. Provincial analysis highlights the role of the value of longevity in mitigating interregional welfare disparity: inland residents, compared to their costal compatriots, generally enjoy a larger increase in the value of mortality decline, notwithstanding a lower increase in secular income across 1981-2010.

Keywords: longevity; mortality; value of life; China

JEL Classification: I18; J17; O53

1 Introduction

GDP per capita is often used as an overall measure for cross-country or interregional welfare comparison, but it fails to incorporate many factors. Beyond well-known defects of excluding non-market goods and home production, the difference in longevity, the variation in health status, and the cost of pollution are also not taken into account (e.g., Rosen, 1988; Usher, 1973). For all these three omissions in GDP accounting, life expectancy is considered a more comprehensive indicator for living standard (Murphy and Topel, 2003; Nordhaus, 2003). The

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welfare of a country whose citizens have long and healthy lives unambiguously outperforms another with the same GDP per capita but whose citizens suffer harrowing illness and die sooner (Bloom et al., 2004).

Life expectancy is largely dependent on population health status. People value health because it is a general form of human capital. Health investment, especially medical expenditure, determines the evolution of health stock (Grossman, 1972). Prior studies have well documented the positive effects of health on labor productivity and hence economic growth (e.g., Weil, 2007). Health is also a special type of consumption good in that it does not run into diminishing marginal utility so as to make both historical and future increases in health spending desirable (Hall and Jones, 2007).

The monetary measure of health status has been a long-standing topic in health economics. The most important measure is the Value of a Statistical Life (VSL), *i.e.* the tradeoff between wealth and mortality. It indicates the amount of money an individual is willing to pay (usually in terms of hedonic wage) for a very small change in the probability of death over a defined period. Usher (1973) first calculated country-specific value of change in life expectancy, and utilized that value for the economic analysis of national income accounting. The calibrated demand functions for the quantity and quality of life show that the optimal health and longevity are increasing in endowed wealth (Ehrlich and Chuma, 1990). Thus the VSL is closely related with income level. A country's total VSL is estimated to be 100-200 times GDP per capita, with values in richer countries more likely to approach the high end of the range (Bloom et al., 2004). Since GDP in the U.S. had grown sixfold during the 20th century, the value of mortality reduction is enormous. The accumulative value of gains in life expectancy across the 20th century for a representative American is over 1.2 million US dollars (Murphy and Topel, 2006). The current marginal increase in longevity is more valuable than the large increase during the first half of the twentieth century (Costa and Kahn, 2004). Moreover, the value of mortality reduction in the first half of the 20th century is somewhat larger than the value of increase in GDP, whereas it is smaller in the second half of the century (Nordhaus, 2003). Yet prior empirical studies dispute on the numeric estimation of the VSL. The lifelong VSL estimate for a representative U.S. citizen ranges from two to nine million dollars (e.g., Ashenfelter, 2006; Bellavance et al., 2009; Doucouliagos et al., 2012; Viscusi and Aldy, 2003).

Life expectancy has been rising significantly throughout the world and over the postwar period. Longevity matters in the analysis of world welfare inequality. Cross-country comparison finds that global inequality has been decreasing when the value of mortality decline is incorporated, although income disparity is rapidly increasing in terms of GDP per capita alone (Becker et al., 2005).

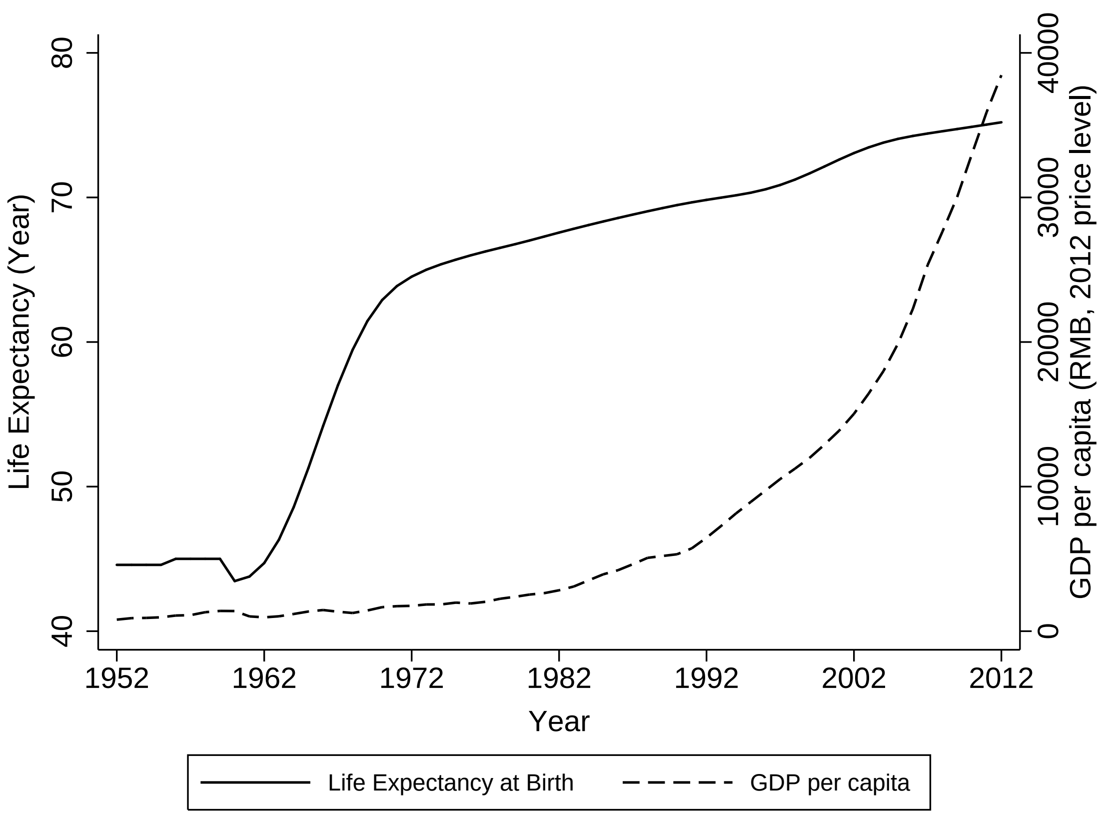
Compared to a cross-country longevity analysis, a more convincing test would be a country that has a shared ethnicity and government. China is a fitting natural test case because it is demographically and politically unified. Over 90% of Chinese are Han ethnicity, and the same sovereign has ruled over China for more than six decades, which controls for many confounding variables. More importantly, an in-depth analysis of the value of longevity for the Chinese, who constitute over one fifth of the world's population, is crucial to understanding the role of health human capital in the economics of inequality for many other low and middle income economies.

This paper, to the best of our knowledge, constitutes the first attempt to shed light on the value of health and its welfare implication for China over six decades. Our time series analysis illustrates that sustained life expectancy increase largely compensates the dismal economic performance during the pre-reform era. The subsequent cross-sectional study unveils the convergence of longevity and its effect on narrowing regional welfare disparity.

The rest of this paper is organized as follows. Section 2 briefly introduces China's institutional context in health care delivery. Section 3 describes our methodology for VSL calculation. Section 4 presents and interprets our results. Section 5 offers concluding remarks.

2 Institutional Background

Figure 1: China's life expectancy at birth and GDP per capita, 1952-2012



Notes: Life expectancy at birth comes from *World Population Prospects: The 2012 Revision* for 1952-1959, and *World Development Indicators* for 1960-2012. GDP per capita comes from *New China in 65 Years*. Nominal GDP per capita is adjusted to the price level of 2012 by annual GDP deflator.

Figure 1 shows that China's life expectancy at birth increased from 45 to 65 years across the decades between 1950 and 1980. Upon the recovery from the 1959-1961 Great Famine, China's life expectancy grew at a speed of approximately one year per annum. It is one of the most sustained and rapid growths ever documented in human history (e.g., Babiarz et al., 2015; Banister and Hill, 2004). What is remarkable is the sharp contrast that China's economy in terms of GDP per capita remains stagnant during these three decades. It was not until the 1980s when China ended political activism and started market-oriented reform that China's economy began to take off.

Prior literature has studied the underlying reasons for China's dramatic increase in life expectancy. First, China established a comprehensive system of grassroots primary health care clinics (Prescott and Jamison, 1985). Large numbers of "barefoot doctors" who received little medical training offered basic health service in the countryside. Second, a large-scale Patriot Hygiene Campaign (henceforth, PHC) was embarked upon nationwide in the 1950s.[1] Imbued with political enthusiasm, the PHC featured sanitation infrastructure construction, human excrement reutilization, children vaccination, reproductive health programs, and pest eradication (Jamison et al., 1984). The PHC substantially reduced the incidences of infectious diseases, such as malaria, cholera, smallpox, tuberculosis, and schistosomiasis that had been historically pandemic. Third, China established a basic but cover-all health system, though segmented and medically limited (Eggleston et al., 2008). Urban residents were under employer-provided health insurance as a part of their work-related benefits. Peasants participated in the Rural Cooperative Medical Schemes at village level for limited but free basic care. Fourth, primary and secondary school enrolment rates rose substantially during the 1950s (Babiarz et al., 2015). The increase in educational attainment reduces mortality through behavior mechanism (Cutler et al., 2006).

3 Methods

We aim to explore the evolution of the value of health in China and how it differs across regions. There are two challenges in the direct monetary assessment of health status. First, survey data on health status are available only for more recent years. Nationwide household surveys in China, such as China Health and Nutrition Survey and China Health and Retirement Longitudinal Survey, provide extensive data over the recent years, but do not provide data stretching back to the 1950s. Second, different health indicators complicate their comparability. Self-reported health measures are subject to region-specific response effects resulting from linguistic and cultural differences. Objective health indicators, such as BMI and ADL, are defined from different perspectives, thereby rendering it difficult to measure the comprehensive health status for cross-year or interregional comparison.

Since mortality and morbidity are highly correlated with each other, we employ Milligan and Wise (2015)'s approach which uses age-specific mortality rate to proxy the overall health

[1] Babiarz et al. (2015) assembled China's public health archives, and created a comprehensive dataset for the PHC.

status for a representative citizen at that age. Retrospective data on mortality rates in China are available back in the 1950s, and hence allow the construction of data series that are comparable across age cohorts, regions, and years.

We make use of methods in Jamison et al. (2013)'s *Global Health 2035* report to calculate the change in the value of mortality decline. In order to assess the value of a changing survival curve resulting from a change in life expectancy, we need to place a value on the changes in age-specific mortality.

Empirical research in the VSL literature (e.g., Hammitt and Robinson, 2011) provides an assessment of the value of reducing mortality by 10^{-4} (or one Standardized Mortality Unit, SMU) for people of middle age. The value of a SMU (VSMU) for a 35-year-old is estimated at 1.4% of average annual income. That estimate is used to project values of SMU for other age cohorts. Empirical evidences (e.g., Aldy and Viscusi, 2007) find that deaths at older ages relative to middle age (*i.e.* with fewer life-years to lose) tend to be discounted relative to younger deaths. In particular, the 10^{-4} increased mortality risk costs a 35-year-old person 1.6 days of life expectancy, but costs an 85-year-old person only about four hours.[2]

Our approach on how to assign values to the mortality change of one SMU at different ages rests on the assumption that the VSMU as a function of age is directly proportional to the years of life lost at that age, relative to the reference age of 35 for which we have empirical estimates of the VSMU. The choice of age 35 as a reference is somewhat arbitrary, but if we substitute other middle ages, the results would be essentially the same. Therefore, the VSMU for any age a is formulated as

$$VSMU(a) = \frac{e(a)}{e(35)} VSMU(35) \tag{1}$$

We take from Hammitt and Robinson (2011)'s estimate for $VSMU(35)$

$$VSMU(35) = 180 \times GDP\ per\ capita \times 10^{-4} \tag{2}$$

where *1.8%×* *GDP per capita* is the VSL. There is much discussion concerning how the ratio of VSL to income might vary with income, but the assumption of constancy is both reasonable and simple. The number 180 is not quantitatively important since we also tried different numbers to substitute for 180 in the VSL calculation. These sensitive analysis results are unaffected for cross-year and cross-sectional comparison. The region and year specific value of changes in age-specific survival depends on the age distribution of its population at that time.

[2] Aldy and Viscusi (2008) find that the VSL follows an inverse U-shaped relationship with age. This finding however exploits birth-year cohort effect and age-dependent fatal risk that lack supporting research in China's context. Our study, for simplicity, rests on the assumption of aforementioned three studies that VSL follows a monotonously declining relationship with age. This approach does not affect the VSL-age relationship for senior cohorts. Even for younger cohorts whose VSLs are increasing in age, the slope of VSL-age curve is relatively flat according to Aldy and Viscusi (2008)'s result, and thus does not pose significant threats to our calculation for younger cohorts.

The annual per capita value of an increase in life expectancy from year t_i to t_j is then

$$V(t_i, t_j, y) = \int_0^\infty n(a) VSMU(a) \triangle SMU(t_i, t_j) da \tag{3}$$

where y is the GDP per capita, and $n(a)$ is the density of population distribution at age a. Substituting equations (1) and (2) into equation (3), we obtain

$$V(t_i, t_j, y) = 0.018y \int_0^\infty n(a) \triangle SMU(t_i, t_j) \frac{e(a)}{e(35)} da \tag{4}$$

Equation (4) is the key equation for measuring changes in the value of mortality decline across time.

4 Results and Interpretations

4.1 Data Description

The underlying data for this study are drawn from several sources. Age-specific mortality rates come from the online database of *World Population Prospects: The 2012 Revision*.[3] Life expectancy at birth comes from *World Population Prospects: The 2012 Revision* for 1952-1959, and *World Development Indicators*[4] for 1960-2012. Nominal GDP per capita series come from *New China in 65 Years*.[5] They are officially released by China's National Bureau of Statistics. To validate the cross-year comparison, we compute annual GDP per capita deflator with the constant-price GDP growth rates, and then adjust the nominal GDP per capita series to the price level of 2012. Total health expenditure as a percentage of GDP series come from *China Statistical Yearbook*.[6] As only post-1978 health expenditures are available, we backward project the pre-1978 series using an exponential fit.

Provincial GDP per capita data are extracted in province-year panel format from *China Socioeconomic Development Statistical Database*.[7] We also adjust the raw data to comparable series by year-on-year constant-price growth rates.[8] Provincial age-specific mortality and life expectancy data are available only in census years. We compile *Almanac of China's*

[3]These data are compiled by Population Division of Department of Economic and Social Affairs of United Nations, and are available at http://esa.un.org/unpd/wpp/.

[4]These data are compiled by the World Bank, and are available at http://data.worldbank.org/data-catalog/world-development-indicators/.

[5]The data appendix is digitalized at http://www.stats.gov.cn/ztjc/ztsj/201502/t20150212_682681.html.

[6]These data are digitalized at http://www.stats.gov.cn/tjsj/ndsj/.

[7]These data are provided by the CNKI Knowledge Network Platform, and accessible through subscription at http://tongji.cnki.net/kns55/Dig/dig.aspx.

[8]This approach rests on an implicit assumption that all provinces have the same price level in 1981. This assumption is reasonable because back in 1981, the legacy of central-planned economy still prevailed in China. Factor and commodity prices are under rigid government regulations.

Population 1989[9] and *Tabulations on the 2010 Population Census of the People's Republic of China*[10] for the 1981 and 2010 provincial data respectively.[11] Provincial health expenditure in 2010 comes from *China Health and Family Planning Statistical Yearbook 2013*. We estimate provincial health expenditure in 1981 by the share of national health spending in China's total GDP (3.27%) in the same year. Therefore, the provincial value of longevity change reflects the accumulative sum of the value of health gain across 1981-2010, a three-decade interval roughly starting from China's market-oriented reform.

4.2 Time Series Analysis

We first compile the reduction of mortality rates (SMU) over five-year intervals (t_i to t_j). The five-year intervals help to smooth annual exogenous fluctuations. China's striking decrease in mortality rates during the years 1962-1967 is a miracle in the context of economic recession and social upheaval. The death rate drops for infants, children under five, and the elderly are particularly large compared to other age cohorts. Babiarz et al. (2015) find that education gain and public health campaign jointly gave rise to this longevity transition.

The calculation of changes in the value of mortality decline requires approximates for $SMU(t_i, t_j)$ and $e(a)/e(35)$. We compute $VSMU$ for 17 age brackets across 12 consecutive five-year intervals: 1952-1957, 1957-1962, and so on up to 2007-2012. We then use equation (4) to provide estimates of the value of mortality decline from 1952 to 2012. Health expenditure series prior to 1978 were backward-projected from an exponential fit based on the 1978-2012 data.

Table 1 shows our results of the value of mortality decline and its relevant variables spanning the decades between 1950 and 2010. The value of mortality decline in Column (4) shows a sharp reversal across the great famine years, from a trough of -126 during 1957-1962 to a local maximum of 2162 during 1962-1967. We also report the ratio of value of mortality decline relative to GDP per capita in Column (7) to investigate the relative importance of health in welfare across time. As our calculations add a value associated with mortality decline to GDP change, we follow Jamison et al. (2013)'s approach of redefining income by subtracting per head health expenditure from GDP per capita (Column (6)).[12] The ratio of value of mortality decline relative to GDP per capita in the pre-1978 era was considerably larger than that in the post-1978 era when China's GDP per capita took off. For example, the ratio is as large as 5.72 during 1962-1967, but declines to 0.11 during 2002-2007. In other words, health gains dominated secular income increase before 1978. Our finding ties in with Nordhaus (2003) for the centurylong evolution of full income in the United States: the value

[9] These data are downloadable through subscription at http://tongji.cnki.net/kns55/Navi/YearBook.aspx?id=N2005120137&floor=1.

[10] These data are digitalized at http://www.stats.gov.cn/tjsj/pcsj/rkpc/6rp/left.htm.

[11] Our analysis does not include Tibet whose age-specific mortality data are missing in 1981. Anyway, the proportion of residents in Tibet makes up less than 0.1% of China's total population across 1982-2010.

[12] In Jamison et al. (2013), the change in full income is the change in GDP without health expenditure per capita plus the value of mortality decline per head.

of mortality decline constitutes over half of the full income growth during the first half of the 20th century, but less than half during the second semicentury.

Table 1: Value of Mortality Decline in China, 1952-2012

Quinquennial	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1952-1957	311	6.79%	0.42	-8.58	-0.21%	303	-0.03
1957-1962	-152	-2.90%	-0.29	-126.46	-2.28%	-150	0.84
1962-1967	389	7.06%	12.30	2161.97	45.11%	378	5.72
1967-1972	406	5.41%	7.51	646.94	9.60%	392	1.65
1972-1977	281	3.01%	1.74	344.56	3.93%	268	1.28
1977-1982	796	6.82%	1.31	279.64	2.75%	761	0.37
1982-1987	1804	10.36%	1.24	338.56	2.39%	1752	0.19
1987-1992	1833	6.89%	1.02	486.94	2.10%	1715	0.28
1992-1997	4060	10.24%	1.03	551.21	1.70%	3897	0.14
1997-2002	4507	7.39%	2.21	1360.74	2.59%	4210	0.32
2002-2007	10297	11.00%	1.35	1045.06	1.39%	9918	0.11
2007-2012	13128	8.71%	0.78	1937.51	1.53%	12169	0.16

Notes: Column (1)-change in GDP per capita (RMB, 2012 price level); Column (2)-average annual growth rate of GDP per capita; Column (3)-change in life expectancy (years); Column (4)-per capita value of mortality decline (RMB, 2012 price level); Column (5)-value of mortality decline as a percentage of base year GDP per capita; Column (6)-change in GDP per capita excluding health expenditure (RMB, 2012 price level); Column (7)-the ratio of the value of mortality decline relative to change in GDP per capita excluding health expenditure.

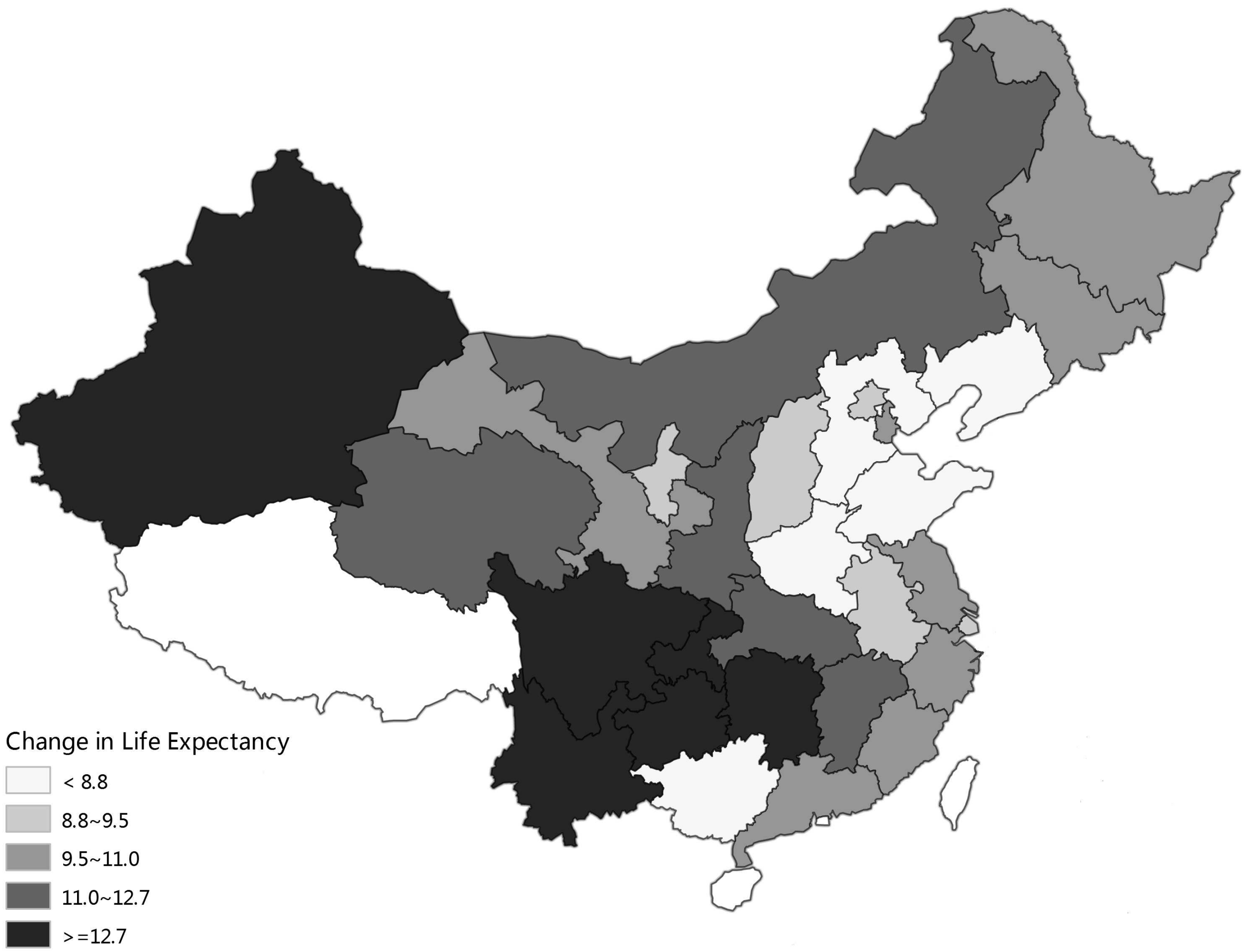
4.3 Cross-Sectional Analysis

The region-specific pattern in China's longevity transition is especially important to study, given China's huge population as a whole, and heterogeneous development levels across provinces. China has made remarkable economic achievement since the market-oriented reform starting in the late 1970s. Most of the increase in life expectancy after 1978 arose from the dramatic improvement in living standards and advances in health care. However, provincial secular incomes have diverged substantially over the past three decades. Coastal provinces such as Guangdong and Jiangsu have taken advantage of their geography, and therefore grown much more rapidly than inland provinces such as Gansu and Guizhou. For example, the GDP per capita of Jiangsu was 67% higher than that of Gansu in 1981, but grew to 2.27 times higher in 2010.

Figure 2 plots the provincial change in life expectancy at birth across 1981-2010 in a color map. Life expectancy gain ranges from 5.7 years in Hebei to 17.3 years in Xinjiang. Moreover, the regional evolution of life expectancy gain shows an opposite pattern as GDP per capita: inland provinces generally have larger life span gains than coastal provinces.

We use a similar approach to compute provincial value of longevity change and present the results in Table 2. The ratio of value of mortality decline to secular income increase varies from 0.11 in Hebei to 0.58 in Xinjiang.[13] This finding ties in with Becker et al. (2005)'s cross-country research in which global welfare inequality is declining, largely due to a convergent trend of cross-country life expectancies.

Figure 2: Provincial Lifespan Increase across 1981-2010



Notes: Provincial life expectancies at birth come from *Almanac of China's Population 1989* for 1981 and *Tabulations on the 2010 Population Census of the People's Republic of China* for 2010. Hong Kong, Macau, Taiwan, and Tibet are not painted due to missing data.

[13]Hainan was upgraded from a prefecture within Guangdong to a province in 1988. Thus we assume that Hainan has the same demographic structure and age-specific mortality rates as Guangdong in 1981. We also apply a similar treatment for Chongqing which separated from Sichuan in 1998.

Table 2: Provincial Value of Mortality Decline across 1981-2010

Province	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Anhui	19727	10.48%	8.8	2722.1	8.1%	18547	0.15
Beijing	66700	8.38%	9.5	10816.4	5.2%	62671	0.17
Chongqing	26149	10.70%	14.1	5854.9	14.0%	24689	0.24
Fujian	38340	11.54%	10.0	5830.7	11.9%	37111	0.16
Gansu	14945	9.47%	10.0	2642.0	7.8%	13828	0.19
Guangdong	43086	12.05%	7.5	5358.1	11.2%	41672	0.13
Guangxi	18617	9.14%	8.0	3081.4	6.6%	17581	0.18
Guizhou	12095	9.19%	13.5	2214.4	7.5%	11190	0.20
Hainan	22619	10.82%	9.5	3060.6	8.7%	21116	0.14
Hebei	27024	10.36%	5.7	2873.7	6.0%	25810	0.11
Heilongjiang	24444	8.37%	10.4	4346.5	5.7%	22948	0.19
Henan	23016	10.28%	7.9	2947.2	7.1%	21934	0.13
Hubei	26210	10.14%	12.6	5570.2	11.3%	25074	0.22
Hunan	22913	9.44%	12.7	5542.3	10.6%	21833	0.25
Inner Mongolia	45572	11.99%	11.2	6179.0	12.0%	43858	0.14
Jiangsu	50884	12.04%	9.5	7054.2	12.4%	49376	0.14
Jiangxi	19733	9.52%	11.0	4290.6	9.7%	18787	0.23
Jilin	29731	10.24%	10.1	4151.8	7.7%	28136	0.15
Liaoning	39526	9.78%	7.3	4398.5	5.4%	37845	0.12
Ningxia	24338	8.50%	9.2	5669.8	7.8%	22934	0.25
Qinghai	21685	8.24%	12.3	6032.8	8.6%	20187	0.30
Shaanxi	25794	10.99%	12.4	4836.2	12.6%	24253	0.20
Shandong	39400	11.60%	7.8	4450.2	9.0%	37963	0.12
Shanghai	69813	8.99%	9.1	9786.1	5.4%	66332	0.15
Shanxi	24349	9.42%	9.1	3947.2	7.0%	23088	0.17
Sichuan	19915	10.20%	13.1	4396.4	12.0%	18726	0.23
Tianjin	67992	9.68%	10.1	8305.4	5.7%	65342	0.13
Xinjiang	22738	8.59%	17.3	12407.6	18.6%	21327	0.58
Yunnan	14449	8.97%	13.1	5185.7	13.7%	13380	0.39
Zhejiang	49649	11.75%	9.8	7358.6	12.3%	47584	0.15

Notes: Column (1)-change in GDP per capita (RMB, 2012 price level); Column (2)-average annual growth rate of GDP per capita; Column (3)-change in life expectancy (years); Column (4)-per capita value of mortality decline (RMB, 2012 price level); Column (5)-value of mortality decline as a percentage of base year GDP per capita; Column (6)-change in GDP per capita excluding health expenditure (RMB, 2012 price level); Column (7)-the ratio of the value of mortality decline relative to change in GDP per capita excluding health expenditure.

Although residents in coastal provinces may have better living standard and health care facility due to their higher income, their gains in longevity and its monetary value turn out to be smaller than their inland compatriots. In this sense, health mitigates interregional welfare inequality in China. The underlying reasons for this pattern are twofold. First, the return to longevity from investing in health gradually declines with age. Simply put, the increase from a life expectancy of 60 to 70 is much easier than that from 70 to 80 (Hall and Jones, 2007). Second, economic prosperity can have opposing effects on population health despite its positive effects through better nutrition and medical care. For example, economic boom coincides with pollution, calorie-rich diets, and reduction in physical activity, all of which increase the risk of chronic disease, thereby becoming counterproductive to longevity gain (Ruhm, 2003).

5 Concluding Remarks

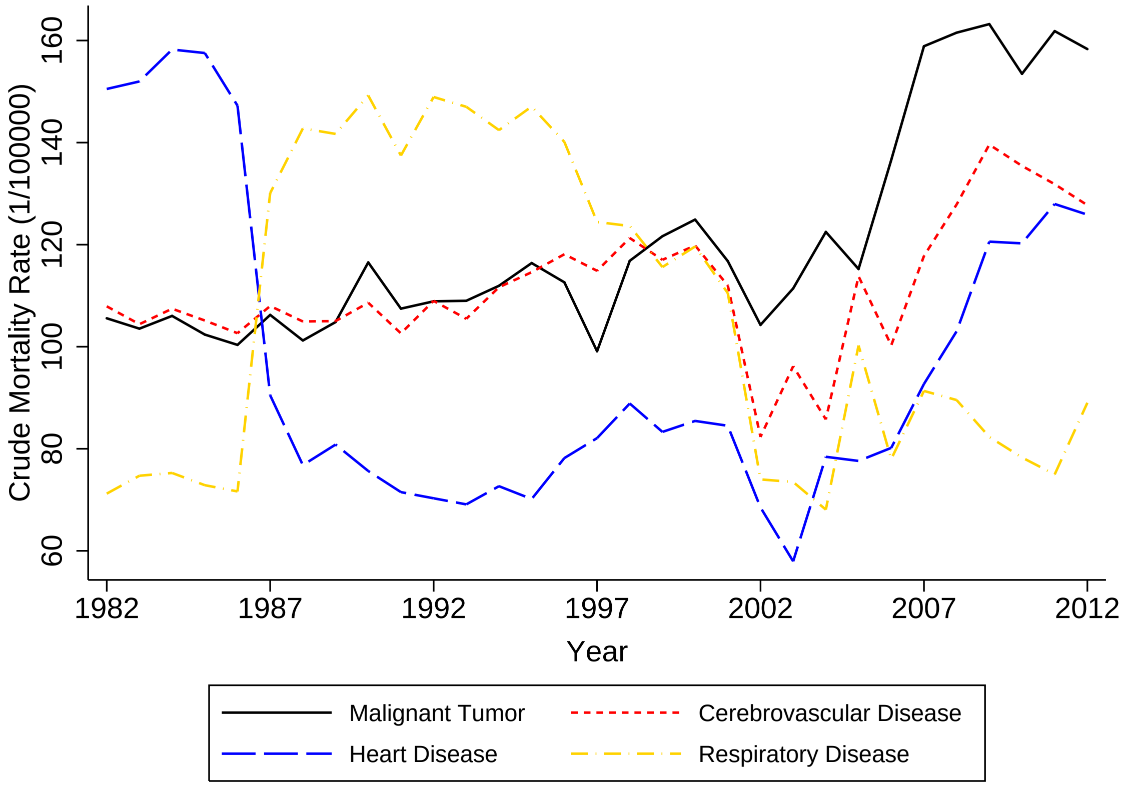
This paper studies the value of health gain in China's context, both in time series and cross-section. We present some salient findings. The six decades from 1952 to 2012, especially the 1970s, witnessed significant reduction in mortality rates across age cohorts, regions, and years. Our nationwide time series analysis unravels the pattern that unprecedented mortality rate reduction more or less compensates for the disappointing economic performance in the pre-reform era. Our provincial evidence further implies that underdeveloped inland regions enjoy larger health gains across the most recent three decades when China's economy takes off. In other words, the value of longevity gain is conducive to mitigate interregional welfare inequality.

Note that our estimates and discussions capture the effect of mortality decline in China across 1952-2012. There are two important caveats to the future extrapolation of our results. First, new challenges loom in China's demographic and epidemiological transition. Increased pollution and unhealthy life styles have brought about the prevalence of vast morbid population suffering from non-communicable diseases. Figure 3 shows the rising trends of mortality rates of four types of non-communicable diseases that are replacing infectious ones as the leading causes of fatality.[14] Second, medical costs are rapidly increasing, especially in such non-communicable diseases (Huang et al., 2015). The progress in medical technologies and the inadequacy of health providers are two major drivers of the rising medical burden. To address such new challenges, China's government launched a major health care reform in 2009. The reform was marked by large-scale health spending and fundamental health system revamp to achieve universally affordable and equitable health care coverage. China's epidemiological transition resembles those of high-income nations; however, there is still much to be done as China's current health spending (% of GDP) is less than one third of the U.S. level in 2013.

The argument of this paper is likely applicable to many other countries that have experi-

[14]In recent years, the aforementioned four on-communicable diseases accounted for over 75% deaths in China.

Figure 3: Crude mortality rates of major diseases in China, 1982-2010



Notes: Crude mortality rates (deaths per 100,000 people) come from *Earth Policy Institute* (`http://www.earth-policy.org/data_center/C26`) for 1982-2009, and annual *China Statistical Yearbook* for 2009-2012. Raw data are dichotomously categorized for urban and rural residents. We compute the weighted average series representative of all Chinese citizens using annual urban-rural population ratio in *China Statistical Yearbook*.

enced significant historical mortality reductions as well. A couple of countries in South Asia and Sub-Saharan Africa improved their medical care delivery so as to control the prevalence of malaria and AIDS. Investigations of such countries, as well as general equilibrium analyses of longevity transition in the global context, are interesting areas for future work.

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