Three papers on development economics

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Abstract

This thesis comprises two papers investigating the economic impacts of demographic transition *(DT)* and one examining its gender aspects in a developing economies context. The first paper, contained in Chapter 2, examines the effect of DT on income growth and the sectoral inequality in China between 1988 and 2013. Based on the Oaxaca-Blinder decomposition, we find that the DT process made a negative contribution to national, urban and rural income growth over the period 1988-2013. The negative contribution of DT variables was driven by the changes in the returns to DT variables, notably rise in the negative returns to household size and the falling positive returns to adult composition in the household. In terms of the contribution of DT process to sectoral-inequality, we find that DT variables made a significant positive contribution to the urban-rural income gap both in 1988 and 2013, and their contribution increased substantially over time. This increase was almost entirely due to the rise in the structure component of DT variables. Thus, over the 25-year period, the urban-rural income gap in China have moved from being primarily a matter of sectoral differences in demographic characteristics to becoming a matter of sectoral differences in the rates of return to those characteristics.

Chapter 3 further estimates the contribution of DT on aggregate inequality in China. Decomposing a set of distribution measures over a period of rapid economic growth in China between 1988 and 2013, we find the DT process contributes substantially to the increase in income inequality over the period. Both changes in endowments and returns contribute to the positive contribution of DT variables, while their relative importance differs depending on the distribution statistics used. The composition component explains 20%-53% of the total DT effect, and its positive contribution is mostly realized through decline in work participation of the young and increase in adult education attainment. The structure component accounts for 47%-80% of the total DT effect, and is realized through change in returns to child dependency (household size controlling for age composition of adults), adult employment as well as high school education of the old.

Chapter 4 investigate the DT process in the developing world from a gender perspective. We construct long-run estimates of total missing women (including missing girls at birth and excess female deaths) in China and India over seven decades from 1950 to 2020. Our estimates yield the following key findings: (1) Number of missing women in India has been higher than that in China throughout the 70-year period; (2) Over time, missing girls at birth grew faster in China than India but China has made more rapid process in reducing excess female deaths; (3) Since the 1980s, there has been a rapid rise in the share of female birth deficits in both countries while the composition of excess female deaths in both countries has shifted from younger to older age groups; (4) The estimated trends of missing girls are consistent with the introduction and spread of sex-determination (ultrasound) technology in China and India, the timing and pace of fertility decline associated with DT in both countries, and the introduction, relaxation and discontinuation of the One Child Policy in China. (5) In relation to excess female deaths, the observed time patterns are consistent with excess mortality of women during the Great Famine of 1958-61 and the more universalistic improvement in social indicators in China relative to India.

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Declaration

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature: …… …………

Print Name: ………………….

Date: ………………………

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Chapter 1: Introduction and overview

This thesis consists of three self-contained papers on the demographic transition process in developing countries. The first two papers, contained in Chapter 2 and Chapter 3, study the impact of demographic transition, hereafter DT, on growth and inequality using a micro dataset covering a long period spanning 25 years in China. The third paper, in the final chapter, analyses the DT process from a gender perspective, in which we construct long-run estimates of missing women for the two most populous countries in the world - China and India.

We now provide a brief overview of the three papers.

Chapter 2 evaluates the effect of demographic changes on growth in China using a micro dataset spanning the period 1988-2013. China makes a good case to document the DT-growth relationship as it has experienced rapid economic growth and profound demographic changes since the late 1970s. For instance, during the 25-year period we study, GDP per capita income (at constant 2010 US$) went up from 694 in 1988 to 5711 in 2013 while the fertility rate decreased from 2.6 to 1.6 (births per woman). Meanwhile, life expectancy increased from 69.0 to 75.3 years over the same period (World Bank 2019).

We differ from existing empirical studies investigating the DT-growth relationship in the following ways. First, while existing studies mostly use cross-country or country-level time-series data, we use a household level data on incomes and DT characteristics to investigate the effect of DT on growth in living standards (as measured by per capita incomes). Second, instead of focusing on the growth effect of a single DT variable, such as change in the dependency ratio or the proportion of working-age population, we estimate how a "broader" DT process, including change in age composition, household size as well as education and employment DT characteristics contribute to change in household income in China from 1988 to 2013. This is important as DT affects growth not only through age composition, but also through inherent age-specific factors, such as human capital and employment attributes. For instance, the World Bank (2016) has pointed out that aging, which is a distinctive feature of the DT process in the 21st century, "cuts across all dimensions of people's lives and public policy" (p.2). We also aim to separate the effects of changes in the distribution of DT characteristics (composition effect) from that of changes in returns to those characteristics (structure effect), which has obvious policy significance (Van de Walle and Gunewardena 2001, Borooah 2005, Kijima 2006).

In chapter 2 we also investigate how the growth effect of DT varies across the urban and rural sectors as well as the urban-rural disparity. One distinguishing feature of China's economy is its urban-rural divide, which stems from the 1950s when the Chinese government emphasized the development of capital-intensive heavy industry in the urban sector by extracting agricultural resources, and implemented the *hukou* system as a way to control the resources moving away from the agricultural sector (Yang and Fang 2000, Kanbur and Zhang 2005). Using the standard Oaxaca-Blinder decomposition, our results call into question the demographic dividend hypothesis for China. The demographic dividend hypothesis depicts that the increasing share of working age population resulting from decline in mortality and fertility tends to stimulate economic growth. Our results, however, suggest that the DT process made a negative contribution to national, as well as urban and rural, income growth in China from 1988 to 2013. We find a positive contribution of changes in levels of the DT characteristic to income growth, which is consistent with the demographic dividend hypothesis. However, these positive contributions are overwhelmed by changes in returns to DT variables, in particular, those related to household size and composition.

Regarding the urban-rural divide, we find that DT variables have made a substantial positive contribution to the urban-rural income gap in China, and that their contribution has increased dramatically over time. This increase is driven by the rapid increase in returns to DT variables, reflecting an increasing sectoral difference in the rate of returns to those characteristics.

In light of the important role of DT in the widening urban-rural income gap found in Chapter 2, in Chapter 3 we hone in on the relationship between DT and aggregate inequality. The DT-inequality relationship remains inconclusive in the existing literature, and empirical studies estimating this relationship in China have mainly focused on inequality within pre-defined groups, such as inequality within young and old cohorts and inequality within urban and rural areas. We differ from those studies firstly by focusing on aggregate income inequality at the national level in China. In addition, similar to the approach in Chapter 2, we consider a wider conception of the DT process that is not limited to just the changing age composition of the population. Moreover, using a methodology developed by Firpo, Fortin and Lumieux (2007, 2018) which generalizes the standard Oaxaca-Blinder decomposition, we decompose a set of distributional measures into a composition effect and structure effect, which has never been analysed in studies documenting the DT-inequality relationship in China.

Our results suggest that the overall DT process has made a substantial positive contribution to the increase in national inequality in China over the period 1988-2013. Both changes in endowments and returns contribute to the inequality widening effect of DT variables, while their relative importance differs depending on the distribution statistics used. The composition component explains 20%-53% of the total DT effect, and its positive contribution is mostly realized through decline in work participation of the young and increase in adult education attainment. The structure component accounts for 47%-80% of the total DT effect, and is realized through change in returns to child dependency (household size controlling for age composition of adults), adult employment as well as high school education of the old.

In Chapter 4, we move to analyse the DT process from a gender perspective. We construct flow estimates of missing women in China and India over seven decades.[1] While China and India are the two most populous countries in the world, they also account for most of the missing women in the world (Das Gupta 2005, World Bank 2012, Bongaarts and Guilmoto 2015, Guilmoto et al. 2018). Our study provides long-run estimates of total missing women (including missing girls at birth and excess female deaths) for these two countries, which is the longest period for such estimates available in the literature. The 70-year period covered in our study also helps form a historical time file of missing women in these two countries from 1950 to 2020. We find that over the 70-year period, on average 1.3 million women are missing in China and 2 million are missing in India. India's missing women has been higher than China throughout the seven decades; however, China exhibits more rapid increase in missing girls at birth, while India has had slower progress in reducing excess female deaths.

We also offer a complete age profile of missing women for both countries over the 70-year period, which sheds light on the changing significance of gender inequalities at birth, during infancy and childhood as well as in reproduction years and at higher age groups. Our results suggest that since the 1980s, there has been a rapid rise in the share of female birth deficits in both countries. Correspondingly, the share of excess female deaths has been shrinking over time. Moreover, in relation to the age composition of excess female deaths, there has been a shift from younger to older age groups in both China and India.

[1] See chapter 4 for the discussion of flow estimates of missing women.

The long period covered in our analysis for China and India is marked by a transition period which encompasses several episodic events and secular changes in the two countries. We link the observed patterns of missing women to the economic, social, technological and policy development over the 70-year period, which provides insights into their underlying role in generating the historical trends on missing women in the China and India. We find that the estimated trends of missing girls at birth are consistent with the introduction and spread of sex-determination (ultrasound) technology in China and India, the timing and pace of fertility decline associated with demographic transition in both countries, and the introduction, relaxation and discontinuation of the One Child Policy in China. For excess female deaths, the observed time patterns are consistent with excess mortality of women during the Great Famine of 1958-61 in China and the more universalistic improvement in social indicators in China relative to India.

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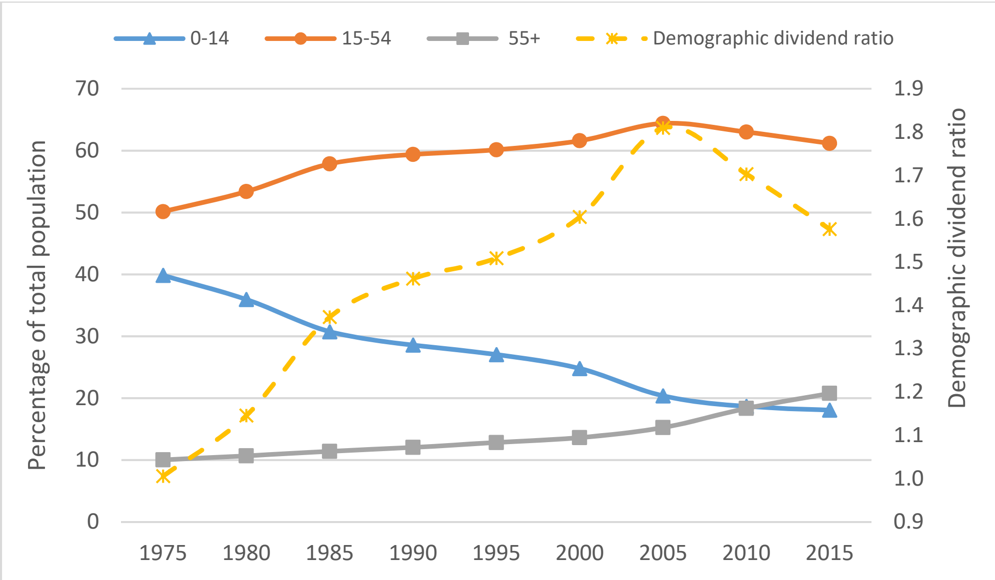
Chapter 2: Demographic transition, income growth and the urban-rural income gap: China 1988 – 2013

2.1 Introduction

The potential effect of population growth on economic development has been long debated and attracted much attention. For instance, the well-known demographic dividend hypothesis posits that a decline in fertility and mortality will lead to a rising share of working-age population that can be productivity-enhancing, though eventually the decreasing birth rate and increasing life expectancy will result in an expanding aged population that will put an end to the demographic dividend (Bloom and Williamson 1998). While there has been much interest in the relationship between demographic transition (DT) and growth, existing empirical studies focus exclusively on the growth effects of changes in the dependency ratio or the proportion of working-age population. However, the DT process could affect growth not only through changing age-composition of the population, but also through age-specific factors such as changes in human capital or employment attributes of different age-groups. (Bloom et al. 2003, Kelly and Schmidt 2005, Zhang et al. 2015). Consequently, the evidence on whether, and how, DT influences economic growth in the existing empirical literature is still inconclusive, and there exists a knowledge gap. This is especially true for developing countries which have been experiencing a rapid aging process at relatively low-income levels with underdeveloped financial and social welfare systems (UN 2015, World Bank 2016). In this chapter, we examine the effect of DT on household income growth using China as a case study. We estimate how age composition, as well as age-specific variations in education and employment, have affected income growth over a generation-long period from 1988 to 2013.

While the choice of the time period from 1988 to 2013 is determined by the availability of comparable household survey data (discussed later), this period for China is marked by a profound demographic transition accompanied by very rapid economic growth. The explosion of economic growth over this period is well known. China's GDP per capita grew at 8.8% per annum during this 25-year period – the highest sustained growth rate observed anywhere in the world (World Bank 2019). At the same time, China's fertility rate fell from 2.7 in 1985-90 to 1.6 in 2010-15 while the life expectancy rate rose rapidly from 68.9 years to 75.1 years over the same period, resulting in a dramatic change in the age composition of the population. For instance, the share of children in the total population fell from 31% in 1985 to 18% by 2015, while the share of the elderly (55+ years) rose from 11% to 21% (Figure 2.1). Thus, the demographic dividend ratio (defined as the ratio of population aged 15-54 years to sum of population in age groups 0-14 and 55 and above) rose from 1.4 to 1.6 over this period after reaching a peak of 1.8 in 2005. This combination of rapid economic growth and major demographic shifts makes China a good candidate for studying the relationship between demographic transition and income growth.

Figure 2.1 Demographic transition in China, 1975-2015



Note: Demographic dividend ratio refers to the ratio of population aged 15-54 years to sum of population in age groups 0-14 and 55 and above.
Source: United Nations (2019).

It is also well known that China has a large urban-rural divide, reflecting historically urban-biased policies such as restrictions on rural-to-urban migration via the household registration system (*hukou* system) which besides restricting labor mobility also limited rural households' access to education and welfare programs in urban areas (Cheng and Selden 1994, Chan and Zhang 1999). At the same time as the Chinese government has been implementing a set of pro-rural policies in order to boost rural household incomes,[2] the urban-rural income gap has been widening. Similarly, the *hukou* reforms do not appear to have had a significant effect on improving rural households' access to social welfare programs and public services (Cai 2011, Li, Sato and Sicular 2013a).[3] In this context, we may, therefore, also expect differential growth effects of DT across urban and rural areas. Understanding how DT affects inter-sectoral

[2] Since the mid-2000s, the government has gradually eliminated rural taxation, exempted tuition fees for rural areas and imposed direct agricultural subsidies. Meanwhile, the division between the urban and rural *hukou* has been gradually replaced by a unified *hukou* system, which was expanded nationwide in 2016.
[3] Li, Sato and Sicular (2013a) point out that one important factor underlying faster growth in urban incomes is the urban non-employment income component, which is closely related to policies and programs favouring the urban sector.

differences is important for public policy responses to the widening urban-rural gap. In addition, since the urban-rural gap is an important component of overall national inequality (Yang 1999, Kanbur and Zhang 2005, Ravallion and Chen 2009), it will also shed light on the DT-inequality relationship that remains inconclusive in the existing literature.

Therefore, in this chapter, we start with investigating how DT affects income growth at the national level, proceed to examine whether the effects vary for the urban and rural sectors and then draw out the implications of DT for the urban-rural income gap. In contrast to existing studies which mostly use cross-country or country-level time series data to estimate the effect of DT on growth, we use a micro dataset spanning the period 1988-2013 that allows us to investigate this relationship using household-level data on incomes and demographic characteristics. Using Oaxaca-Blinder decomposition techniques, we also distinguish between so-called "composition effects" and "structure effects", i.e., the effects of changes (differences) in the demographic characteristics and the effects of changes (differences) in returns to those characteristics respectively. Distinguishing between these effects has obvious policy significance (Van de Walle and Gunewardena 2001, Borooah 2005, Kijima 2006).

The other important distinguishing feature of our study is that our scope of DT variables is not limited to changes in age-composition alone, but also includes changes in household size and the education and employment profiles of different age-groups. The latter are seen to be an intrinsic part of the demographic transition process. For instance, the World Bank (2016) has pointed out that in East Asia and the Pacific, while the population is getting old, those currently aged 60 and above are much more productive and better educated than those aged 60 and above in previous generations. Evidence suggests that an increase in human capital can mitigate part of the negative effects of aging on productivity.

Our analysis addresses the following questions: What is the overall contribution of DT-related variables to growth in living standards (as measured by per capita incomes) nationally? What are the relative contributions of the composition and structure effects? What are the relative contributions of age-composition and other DT variables? How do those effects vary across the urban and rural sectors, and how much do they contribute to the urban-rural divide in living standards?

Our key finding on the growth contribution of the DT process calls into question the demographic dividend hypothesis for China. We find that the DT variables jointly made a negative contribution to national, urban and rural income growth over the period 1988-2013.

The negative contribution was driven by the changes in the returns to DT variables, in particular those related to household size and composition, even as the contribution of changes in the levels of DT variables were positive, consistent with the notion of a demographic dividend. Our other key finding relates to the important contribution of demographic transition to sectoral income inequality. We find that DT variables made a significant positive contribution to the urban-rural income gap both in 1988 and 2013, but their contribution increased substantially over time. This increase was almost entirely due to an increase in the structure component of DT variables, reflecting changes in the returns to these variables between 1988 and 2013. Over the 25-year period, China appears to have moved from the urban-rural income gap being primarily a matter of sectoral differences in demographic characteristics to becoming a matter of sectoral differences in the rates of return to those characteristics. We also discuss how the two sets of findings on income growth and sectoral inequality are complementary to each other and reflect underlying processes related to the opening up of massive rural-to-urban migration opportunities over this period.

2.2 Data

We use data from the China Household Income Project (CHIP), which is a repeated cross-section survey, administered with assistance from the National Bureau of Statistics (NBS). The survey benefited from NBS input in many stages of the data collection process (Gustafsson, Li and Sato 2014). There are five waves of CHIP; the first wave was conducted in 1988 with subsequent waves in 1995, 2002, 2007 and 2013. For the purpose of this analysis, we use the first and the last waves from CHIP, for the years 1988 and 2013. The two waves, being 25 years apart, offer a long time span suitable for studying the DT-growth relationship.

Each wave of CHIP includes an urban and a rural survey; the samples for which were drawn as sub-samples of the rural and urban household surveys conducted by the NBS. For the CHIP rounds from 1988 to 2007, the sampled provinces were selected from four regions (east, central, western and large municipalities with provincial status), and the surveys were administered separately in urban and rural areas. The urban samples include urban residents, while the rural samples include rural residents, short-term migrants and long-term unstable migrants.[4] In the 1988 wave, CHIP did not contain data on long-term stable migrants (Song, Sicular and Yue

[4] Short-term migrants are those who have been away from their rural household for ≤6 months; Long-term unstable migrants are those who have been away from their household for >6 months, but maintain close economic ties with their original household.

2013).[5] Reflecting the importance of rural-urban migration, a migrant sample was added to each wave of the CHIP survey from 2002 onwards which included long-term stable migrants. In CHIP 2013, the sampled provinces were selected using a sample frame that integrated urban and rural households, and they were drawn from three regions (east, central and west). However, complicating matters for CHIP 2013, long-term unstable migrants who up to that point had been counted as members of rural households ceased to be captured in the rural sample (Li et al. 2017).[6] Compared to long-term stable migrants, the other two types of migrants (short term and long-term unstable migrants) account for a relatively larger proportion, and the first four waves of CHIP count these two types as part of the rural sample. Thus, to maximize consistency with the earlier rounds, for the 2013 wave we add the migrant sample to the rural sample. This means that effectively migrants are included in the rural samples for both 1988 and 2013.

For our analysis, we use the urban and rural samples from CHIP 1988 to create a national sample for 1988, and we use the urban, rural and migrant samples from CHIP 2013 to create a national sample for 2013. Since the CHIP samples are not proportional to their population, we use the provincial population in each region to adjust the sampling weights so that they reflect the provincial populations in the main regions in China. For the 2013 wave, Li et al. (2017) provide the provincial urban, rural and migrant population data to compute the sampling weights for CHIP 2013. Song, Sicular and Yue (2013) provide the provincial urban, rural and long-term stable migrants data from information in the 2000 census and 2005 mini-census to calculate the weights for the 2002 and 2007 round. Unfortunately, information on the number of long-term stable migrants for 1988 are not available; hence, we first calculate the proportion of long-term stable migrants in each province for 1988, based on data for 2002 and 2007, assuming linear growth of long-term stable migrants across years. Then, using the total population data for each province from the 1990 population census, we calculate the provincial urban, rural and long-term stable migrant population in 1988.[7]

A key variable of interest is per capita household income. For the 1988 wave, we calculate household income closely following the definitions of household income in Griffin and Zhao

[5] Long-term stable migrants are defined as those who have been away from their household for >6 months and do not have close economic ties with the household.
[6] For more details on CHIP, see Griffin and Zhao (1993), Gustafsson Li and Sicular (2008), Li, Sato and Sicular (2013b) and Li et al (2017).
[7] More specifically, the weight of a household in province i in j-th region for urban (rural) areas is equal to:

$$\text{weight}_{ij} = \frac{urban\ (\ rural\ )\ population\ of\ province\ i}{urban\ (rural)\ sample\ size\ of\ province\ i} \times \frac{urban\ (rural)\ population\ of\ region\ j}{urban\ (rural)\ sample\ size\ of\ region\ j}$$

(2010) which provide guidelines for constructing urban and rural household income for the CHIP 1988 round.[8] For the 2013 wave, household income is defined as the sum of wage income, net business income, net property income and net transfer income, while paying particular attention to making it comparable with the 1988 wave. Table 2.A1 in the Appendix summarizes the income components contained in the CHIP dataset that we use to calculate total household income.

We use the spatial price deflators constructed by Brandt and Holz (2006) to adjust for cost of living (COL) differences in urban and rural areas and over time, specifying urban Beijing as the base province and 2013 as the base year. Brandt and Holz (2006) estimate the cost of living differences for urban and rural areas at the provincial level from 1985 to 2004. We use the price deflators provided in Brandt and Holz (2006) for the 1988 round, and then use provincial urban and rural CPIs in later years to get the COL adjustments for 2013.[9]

2.3 Methodology

2.3.1 The income model

We model national, urban and rural log per capita household incomes as functions of the size of the household, the age composition of its members, their education level and work status while also controlling for region and industry fixed effects. We start by estimating the following (log) household income per capita equations for the 1988 and 2013 urban, rural and national samples respectively:

$$lny_{ijt} = X_{ijt}'\beta_{jt} + \varepsilon_{ijt} \qquad (1)$$

Where lny_{ijt} is log household income per capita for household i of sample j at time t; j denotes the urban, rural or national sample; and t denotes years 1988 and 2013; and X_{ijt} is the set of explanatory variables for household i in sample j at time t as described below.

[8] In order to ensure consistency across the various survey rounds, we adjust the income definition for the 1988 round based on Griffin and Zhao (2010). Firstly, we exclude the rental value of owner-occupied housing and subsidies on urban housing as the 2013 data do not allow for the calculation of these two extra components. Secondly, for the urban area in 1988, net income in-kind is not included in total income.

[9] For the four large municipalities, Beijing, Shanghai, Tianjing and Chongqing (separated from Sichuan since 1997), no official rural CPIs are available. Only official municipal and urban CPIs are published, which have the same value. Brandt and Holz (2006) use the official urban CPIs as rural CPIs for these four municipalities. We also follow the same approach to update the COL deflators after 2004. We use the rural COL index for migrants in 2013 as we count them as part of the rural sample.

Amongst the explanatory variables we include: household size, proportion of household members aged >=55, proportion of household members aged 16-54[10], proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education.[11]

In addition, the regressions also allow for region and industry fixed effects. The estimations with the national sample distinguish six regions: urban central, urban west, urban east, rural central, rural west and rural east; for estimates with the urban and rural samples, we distinguish three regions: east, central and west.[12] Industry fixed effects distinguish primary, secondary and tertiary sectors of work (with no household member reported to be working as the omitted category). The industry for the household is identified as the most common sector in which household members work.

2.3.2 Identification of the demographic variables

We take the view that the notion of demographic transition ought not be limited to just the changing age composition of the population but should also include a consideration of how the work and age profiles of the young and the old are changing. Our set of DT variables will, thus, consist of the age composition, household size as well as education and working characteristics of household members discussed in section 2.3.1. This set of DT variables will be our primary variables of interest in tracking the effects of demographic transition on income growth and urban-rural inequality in China over this period. This is consistent with a wider conception of demographic transition than has been presumed in the literature.

For a given year, we would first expect that, households with a smaller size, a higher proportion of adults (conditional on adult employment and education) have a higher income. The parameters for the age composition variables and household size ought to be interpreted together. Note that the omitted age composition category relates to children up to 15 years. Thus, the included age composition variables (the proportions of adult cohorts aged 16-54 and

[10] The proportion of children below 16 is the omitted group.

[11] Children below 16 and household members who are still students are categorized as neither working, nor having a high-school education.

[12] Eastern provinces (municipalities): Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan; Central provinces (municipalities): Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan;
Western provinces (municipalities): Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia. Urban east is the omitted group.

55+) together with household size pick up the effects of the child dependency ratios on per capita incomes. For instance, for any given year, the positive parameters for the age composition variables and the negative parameters for household size in Eq (1) are indicative of the negative effects of additional dependent children on household per capita incomes (conditional on adult employment and education). Secondly, we would expect households with a higher proportion of high-school education and work participation among the adults tend to have a higher income in a given year.

2.3.3 The Oaxaca-Blinder decomposition

We then use the Oaxaca-Blinder decomposition methodology to identify the contribution of age composition, household size as well as education and working characteristics of household members to income growth and the urban-rural gap in China (Oaxaca 1973 and Blinder 1973). We perform two Oaxaca-Blinder decompositions: one with respect to the change in income per capita between 1988 and 2013 for the national, urban and rural samples; and the other with respect to the urban-rural income gap for each of 1988 and 2013. One well-known issue with the Oaxaca-Blinder decomposition is that the decomposition results are not invariant to the choice of the reference group. In order to address this issue, we take the average of the two decompositions which use different group parameters as the reference. For instance, to decompose the change in log income per capita between 1988 and 2013, we can write the income change between 1988 and 2013 for sample j as:

$$ln\bar{y}_{j,2013} - ln\bar{y}_{j,1988} = \frac{1}{2}\left(\hat{\beta}_{j,2013} + \hat{\beta}_{j,1988}\right)\left(\bar{X}_{j,2013} - \bar{X}_{j,1988}\right)' + \frac{1}{2}(\bar{X}'_{j,1988} + \bar{X}'_{j,2013})' \cdot \left(\hat{\beta}_{j,2013} - \hat{\beta}_{j,1988}\right) \quad (2)$$

Similarly, the decomposition of the urban-rural gap in year t will be:

$$ln\bar{y}_{urban,t} - ln\bar{y}_{rural,t} = \frac{1}{2}\left(\hat{\beta}_{urban,t} + \hat{\beta}_{rural,t}\right)\left(\bar{X}_{urban,t} - \bar{X}_{rural,t}\right)' + \frac{1}{2}(\bar{X}'_{urban,t} + \bar{X}'_{rural,t})' \cdot \left(\hat{\beta}_{urban,t} - \hat{\beta}_{rural,t}\right) \quad (3)$$

Where the first term of equations (2) and (3) is the composition effect, reflecting the effect of changes (differences) in the distribution of the covariates. The second term is the structure effect, reflecting the effect of changes (differences) in the returns to the covariates. $\hat{\beta}_{j,t}$ are the estimated coefficients for sample j at time t from equation (1).

2.4 Growth, demographic transition and the urban-rural income gap in China: descriptive statistics

Table 2.1 shows the national, urban and rural mean per capita incomes as well as the ratio of urban to rural mean per capita income. We report the statistics both with, and without, adjustment for the COL differences and the population weighting for urban and rural samples. Between 1988 and 2013, there was a phenomenal increase in per capita incomes in each of the national, as well as urban and rural samples. Over the period, the annual growth rate of real mean per capita income was 7.1% per annum within the urban sector, 6.1% within the rural sector and 7.9% in aggregate. Due to increasing urbanization of the Chinese population over this period, there is a shrink in the scale of a rural sector with a relatively lower growth while the scale of a urban sector with a faster growth is larger, resulting a higher overall growth rate than both the rural and urban sector. However, the urban-rural income gap has been increasing over time. In 1988, real per capita income in urban China was around 1.6 times that in rural China, and this difference increased to 2 by 2013. Table 2.1 also shows that our adjustment for the COL difference and population weighting reduce the urban-rural gap in both 1988 and 2013, and it also reduces the increase in the urban-rural income ratio over this period.

Table 2.1 Household income per capita: National, Urban, Rural and the Urban-Rural per capita income gap, China

	1988		**2013**		**Total change (percentage change per year)**	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
National	1091	4155	18801	27647	17710	23492
					12.1	7.9
Urban	1489	6384	30760	35081	29271	28697
					12.9	7.1
Rural	739	4014	11744	17788	11005	13774
					11.7	6.1
Urban-Rural income ratio	2.0	1.6	2.6	2.0	0.6	0.4

Note: unadjusted refers to nominal per capita incomes with unweighted samples, while "adjusted' refers to real per capita incomes with sampling weights adjusted for spatial and temporal cost of living differences as discussed in the text. Real per capita incomes are expressed in RMB/person/year at 2013 Beijing prices.
Source: authors' calculation from CHIP data.

Table 2.2 and Table 2.3 present descriptive statistics for the DT variables that we use in this chapter. Table 2.2 shows the proportion of the old and young as well as the education and employment profile of each for China at the national level. Our data indicate that China has experienced a rapid aging process coupled with significant change in the education and employment profile of the old and young. Over the 25 years, the fraction of those aged 16-54 remained stable at around 61%; while, the proportion of those aged 55 and above increased substantially from 10.7% to 24%, suggesting a rapid aging process. During 1988-2013, the elderly and the young were both become more educated, with the proportion of the old with a high school education rising by 8.2 percentage points and that of the young going up by 26.9 percentage points.

Table 2.2 Descriptive statistics for DT variables in China: national-level

	1988	**2013**	**Total change**
Household size	5.4	3.8	-1.6
Age composition (%):			
% members 55+	10.7	24.0	13.3
% members 16-54:	60.7	60.8	0.0
Employment (%):			
% members 55+ who are working	14.4	16.2	1.8
% members 16-54 who are working	88.3	69.2	-19.2
Education (%):			
% members 55+ with >= high school	0.9	9.1	8.2
% members 16-54 with >=high school	11.5	38.3	26.9

One notable feature of Table 2.2 is that there was a substantial decline in work participation of the 16-54 cohort, while work participation of the elderly in fact increased a little. These estimates from the CHIP data are consistent with the International Labor Organization (ILO) estimates, according to which between 1990 and 2013, the labor force participation rate for all age groups in China went down from around 79% to 59% while the labor participation rate for those aged 65+ increased by 1.6%. Thus, a particular feature of DT in China is that the share of the elderly in the population has been rising considerably faster than the share of the elderly in the work force.

Table 2.3 reports the descriptive statistics for urban and rural areas in 1988 and 2013, as well changes in urban-rural differences over time. There are significant differences between urban and rural areas for almost all DT variables in both 1988 and 2013. Relative to households in rural areas, urban households are smaller in size, have a higher proportion of adult members and have a larger fraction of their adult members with high school education, but lower work participation rates amongst the 16-54 as well as 55+ cohorts.

Table 2.3 Descriptive statistics for DT variables in Urban, Rural China and the Urban-Rural gap

	1988			2013			2013-1988		
	Urban	Rural	Δ	Urban	Rural	Δ	Urban	Rural	Δ
Household size	3.8	5.5	-1.7	3.4	4.2	-0.8	-0.4	-1.3	0.9
Age composition (%):									
% members 55+	13.7	10.5	3.2	25.0	22.8	2.2	11.2	12.2	-1.0^
% members 16-54	64.6	60.5	4.1	60.9	60.5	0.4^	-3.7	0.1	-3.8
Employment (%):									
% members 55+ who are working	7.8	14.8	-7.0	9.2	25.5	-16.3	1.4	10.7	-9.3
% members 16-54 who are working	83.1	88.7	-5.5	67.6	71.2	-3.6	-15.5	-17.5	2.0
Education (%):									
% members 55+ with >= high school	5.9	0.6	5.3	13.3	3.5	9.9	7.4	2.9	4.5
% members 16-54 with >=high school	42.9	9.6	33.3	53.6	18.1	35.5	10.7	8.5	2.2

Note: Δ denotes the difference between urban and rural values. All differences are statistically significant at the 5% level or better, except for those marked with ^.

As for changes over time, similar to the national level, both urban and rural China have experienced a demographic transition in which the population is getting older and better educated, with changing work participation of the elderly and the young. However, as the last three columns of Table 2.3 show, while the direction of change for nearly all DT variables has been the same in both urban and rural areas, the magnitude of change has been different, with a narrowing of the urban-rural gap for some DT variables and widening for others. Thus, for instance, while household size decreased in both urban and rural areas, the rural decline was larger leading to a narrowing of the urban-rural gap. Urban-rural differences in the proportion of adult household members and in the work participation rate of 16-54 year old members also narrowed between 1988 and 2013. However, there was a widening of differences related to the work participation of the elderly, with an 11 percentage point increase in rural areas relative to a 1.4 percentage point increase in urban areas. Also notably, there was a widening of the urban-rural education gap, with larger increments in the proportion of adult members with at least high school education in urban areas than in rural areas.

These shifting patterns of changes in key demographic transition variables over time have potentially important implications for income growth at the national and sectoral levels as well as for urban-rural income gaps that we will explore below.

2.5 Estimated regression models

Table 2.4 reports our estimates of the log per capita income model (eq 1). Our estimated coefficients on the DT variables are mostly significant and have expected signs. For both 1988 and 2013, our regression results show the following: (1) Controlling for the education and working profile, higher proportion of adults is associated with higher household income per capita. (2) Larger households tend to have lower real per capita income. (3) Greater work participation of adults increases per capita income. (4) More high-school education, among the young and the old, is associated with higher household income per capita.

Table 2.4 also shows that the coefficients exhibit considerable variation over time as well as between urban and rural areas. At the national level, there is a large increase in returns to high-school education for both the young and the old as indicated by the increase in the associated parameters; the latter doubling and the former increasing more than three times between 1988 and 2013. Controlling for education, there is also a large increase in the returns to employment for the 16-54 cohort, with its parameter increasing more than three times over this period. However, there is a decline in the returns to employment for the elderly (55+), conditional on education. This seems counter-intuitive at face value, but could reflect the supply-side dampening effect on earnings of the elderly associated with the massive growth in their work participation over this period.

Across urban and rural areas, the returns to employment and education are generally higher in urban areas for both the young and the elderly and in both years, the only exception being the returns to education for the young (16-54 years) that seem similar across the two sectors. There is also an indication that the urban-rural gap in the returns to education has increased over time. This is especially true for the returns to high-school education for the young.

Table 2.4 Regression estimates of real per capita incomes, 1988 and 2013

	National	Urban	Rural
	1988		
Proportion of members 55+	0.2991***	0.7410***	0.2545***
	(0.0441)	(0.0340)	(0.0480)
Proportion of members 16-54	0.5538***	0.7481***	0.5528***
	(0.0331)	(0.0292)	(0.0346)
Household size	-0.0466***	-0.1167***	-0.0450***
	(0.0038)	(0.0049)	(0.0039)
Proportion of members 55+ who are working	0.0422*	0.0886***	0.0531**
	(0.0220)	(0.0201)	(0.0232)
Proportion of members 16-54 who are working	0.0573*	0.2229***	0.0554
	(0.0330)	(0.0222)	(0.0356)
Proportion of members 55+ with >= high school	0.1503**	0.1260***	0.0974
	(0.0662)	(0.0235)	(0.1043)
Proportion of members 16-54 with >= high school	0.0900***	0.0608***	0.0907***
	(0.0256)	(0.0112)	(0.0307)
R-square	0.1360	0.2930	0.0899
N	18975	8914	10061
	2013		
	National	Urban	Rural
Proportion of members 55+	0.2591***	0.5189***	-0.0802
	(0.0456)	(0.0706)	(0.0550)
Proportion of members 16-54	0.2854***	0.4255***	0.1265***
	(0.0403)	(0.0627)	(0.0476)
Household size	-0.1977***	-0.2051***	-0.1994***
	(0.0063)	(0.0111)	(0.0068)
Proportion of members 55+ who are working	-0.0597***	-0.0326	-0.0136
	(0.0209)	(0.0410)	(0.0238)
Proportion of members 16-54 who are working	0.1990***	0.2775***	0.1080***
	(0.0211)	(0.0349)	(0.0246)
Proportion of members 55+ with >= high school	0.2984***	0.3006***	0.0114
	(0.0286)	(0.0333)	(0.0599)
Proportion of members 16-54 with >= high school	0.3403***	0.3575***	0.3548***
	(0.0197)	(0.0268)	(0.0278)
R-square	0.4130	0.2700	0.2439
N	16823	6243	10580

Note: The regressions also controlled for region dummies, household industry dummies and dummy variables for missing values. All coefficients and standard errors are scaled up by 100. *** p<0.01, ** p<0.05, * p<0.1.

As is notes in Section 2.3.2, the included age composition variables together with household size reflect the effects of the child dependency ratios on per capita incomes. Table 2.4 shows that having additional dependent children has a negative effect on household per capita incomes (conditional on adult employment and education). These effects are bigger (in absolute terms) for urban than rural areas.

Over time, the negative income effects of household size have increased in absolute terms, while the positive effects of having a larger proportion of adults in the household conditional on their employment and education levels have lessened. Taken together, these changes suggest that between 1988 and 2013 there was an increase in the negative income effects associated with child dependency and there was a fall in the returns to having more adults in the household without an increase in the proportion who are working or have high-school education. The changes in the returns to this set of variables seems to be larger in rural than in urban areas.

2.6 Decomposition results

The above discussion points to a complex interplay of several forces at work across sectors and over time. To trace the implications of these forces for income growth and the urban-rural income gap, we deploy the decomposition methods discussed earlier in section 2.3. In particular, we decompose per capita income growth and change in the urban-rural per capita income gap between 1988 and 2013 into components related to changes in distribution of explanatory variables (composition effect) and change in returns to those variables (structure effect). In each of the decompositions, our particular focus is on the contribution of the variables related to demographic transition. We, thus, first report summary decomposition results linked to the total contribution of all DT variables, and then report the detailed decomposition results relating to the individual contributions of age composition and other variables. For all cases, we present both the absolute size of the contributions of covariates and their proportional contribution to overall income growth or urban-rural income gaps.

2.6.1 Demographic transition and growth – summary results

Table 2.5 presents summary decomposition results for changes in log per capita incomes at the national level as well as for the urban and rural sectors. Consistent with the numbers reported in Table 2.1, the top row of the Table shows that urban income growth has been faster than rural growth. The national income growth is faster still because of the shift in population to the faster growing urban sector. The rest of the Table shows the contribution of different factors to this income growth.

Table 2.5 Decomposition of growth in per capita incomes in China between 1988 and 2013: National, Urban and Rural summary results

	National		Urban		Rural	
Total change in log per capita income	1.7767***		1.5665***		1.3763***	
	(0.0076)		(0.0092)		(0.0097)	
	Contribution to total change					
	Value	%	Value	%	Value	%
Composition effect:						
DT variables	0.2914***	16.4	0.1317***	8.4	0.1763***	12.8
	(0.0066)		(0.0055)		(0.0063)	
Other	0.3234***	18.2	-0.0142	-0.9	0.1420***	10.3
	(0.0098)		(0.0113)		(0.0098)	
Total	0.6148***	34.6	0.1175***	7.5	0.3184***	23.1
	(0.0105)		(0.0122)		(0.0116)	
Structure effect:						
DT variables	-0.7002***	-39.4	-0.3823***	-24.4	-1.0028***	-72.9
	(0.0486)		(0.0658)		(0.0655)	
Other	1.8621***	104.8	1.8313***	116.9	2.0607***	149.7
	(0.0499)		(0.0679)		(0.0674)	
Total	1.1619***	65.4	1.4490***	92.5	1.0579***	76.9
	(0.0117)		(0.0140)		(0.0141)	
Total effect:						
DT variables	-0.4088	-23.0	-0.2506	-16.0	-0.8265	-60.1
Other	2.1855	123.0	1.8171	116.0	2.2027	160.0
Total	1.7767	100.0	1.5665	100.0	1.3762	100.0

Note: DT variables include: proportion of household members aged >=55, proportion of household members aged 16-54, household size, proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education. Other includes the region and industry fixed effects and dummy variables for missing values and a constant term. *** p<0.01, ** p<0.05, * p<0.1.

The first key result in Table 2.5 is that between 1988 and 2013 the DT process has negatively contributed to income growth for China as a whole (bottom panel of the Table). Expressed in percentage terms, if the total growth in national per capita income is scaled to 100 points, the contribution of the DT variables jointly amounted to -23 points; correspondingly, the total contribution of all other variables was 123 points. The contribution of DT variables was even more negative for rural income growth at -60 points relative to -16 points for urban income growth.

Recall that our specification of other non-DT variables is fairly parsimonious; they only include region and industry fixed effects besides a constant term. Thus, the dominant contribution of these variables to income growth nationally as well as in both rural and urban areas points to the role of rapid structural transformation of output and employment in the economy (with a large scale shift from agriculture to non-agricultural sectors) as well as its regionally diversified pattern with a concentration of growth in the coastal provinces in the East.

How did the DT variables make a negative contribute to income growth? The summary decomposition results in Table 2.5, as well as the detailed decompositions presented in the following section, shed further light on this question.

In this regard, a second key result in Table 2.5 is that the negative contribution of DT variables is realized entirely though the structure component. As seen in the Table, the total negative contribution of -23% of DT variables is made up of a -39% contribution of the structure effect and a positive 16% contribution of the composition effect associated with these variables. Similarly, the structure and composition components contributed -24% and 8% respectively towards the overall -16% contribution of DT variables to urban income growth, while they contributed -73% and 13% respectively to rural income growth.

These results indicate that changes in the composition of DT variables between 1988 and 2013, as shown above in Tables 2.2 (at the national level) and 2.3 (for urban and rural sectors), in fact contributed positively to per capita income growth. Recall that significant compositional changes in DT variables over this period related to the fall in average household size, the rise in the proportion of 55+, the fall in work participation of the 16-54 cohort, and the rise in high school education for the adult population (both 16-54 and 55+ cohorts). Our results, thus, indicate that these compositional changes jointly had a positive effect on income growth.

The negative contributions of DT variables, on the other hand, came from the changes in the returns to these variables. As discussed above in section 2.5 (Table 2.4), the significant changes in returns to DT variables between 1998 and 2013 have included the following: an increase in the returns to high-school education for both the young (16-54 years) and the old (55+ years), an increase in the returns to employment for the 16-54 cohort but a fall in the returns to employment for the 55+ cohort, a rise in the negative returns to household size and a fall in the positive returns to a higher proportion of adults in the household holding the proportion employed and with high school education constant. Thus, while the first two of these changes, relating to increasing returns to education of adults and employment for the young contributed positively to income growth, the remaining changes in returns had negative effects on income growth. Our summary results on the overall negative contribution of the structure component of DT variables, thus, indicate that the negative effects of changes in returns outweighed the positive effects. Not only that, the negative structure effects also outweighed the positive growth effect of compositional changes in DT variables.

These patterns generally hold for both urban and rural income growth, though they are more accentuated for the latter reflecting in the rural sector relatively smaller changes in returns to factors contributing positively to income growth and larger changes in returns to factors contributing negatively to income growth. These summary patterns become clearer when we look at the detailed decomposition results which also help us quantify the relative contribution of different factors.

2.6.2 Demographic transition and growth – detailed results

Table 2.6 presents the detailed decomposition results on the contributions of individual DT variables to the composition and structure effects.

Consistent with the foregoing discussion, we find that the fall in household size accounts for most of the positive contribution of DT variables through the composition effect: 11% out of 16% at the national level, 11% out of 13% in rural areas and 4% out of 8% in urban areas. In urban areas, the rise in the proportion of 55+ also contributed to the positive composition effect. By comparison, the rise in the proportion of adults with high-school education made a relatively smaller positive contribution to the composition effect of DT variables (of about 4% combined for 16-54 and 55+ cohorts at the national level), while the fall in work participation of the 16-54 cohort made a small negative contribution.

Table 2.6 Decomposition of growth in per capita incomes in China National between 1988 and 2013: National, Urban and Rural China– Detailed results

	Contribution to change in log per capita income					
	National		Urban		Rural	
	Value	%	Value	%	Value	%
Composition effect:						
Proportion of members 55+	0.0371***	2.1	0.0708***	4.5	0.0106**	0.8
	(0.0034)		(0.0047)		(0.0043)	
Proportion of members 16-54	0.0002	0.0	-0.0217***	-1.4	0.0002	0.0
	(0.0012)		(0.0030)		(0.0012)	
Household size	0.1988***	11.2	0.0578***	3.7	0.1544***	11.2
	(0.0044)		(0.0033)		(0.0048)	
Proportion of members 55+ who are working	-0.0002	0.0	0.0005	0.0	0.0021	0.2
	(0.0002)		(0.0003)		(0.0016)	
Proportion of members 16-54 who are working	-0.0228***	-1.3	-0.0258***	-1.6	-0.0134***	-1.0
	(0.0026)		(0.0023)		(0.0032)	
Proportion of members 55+ with >= high school	0.0186***	1.0	0.0173***	1.1	0.0016	0.1
	(0.0024)		(0.0016)		(0.0015)	
Proportion of members 16-54 with >= high school	0.0598***	3.4	0.0329***	2.1	0.0207***	1.5
	(0.0034)		(0.0023)		(0.0019)	
Total composition effect of DT variables	***0.2914****	***16.4***	***0.1317****	***8.4***	***0.1763****	*12.8*
	(0.0066)		***(0.0055)***		***(0.0063)***	
Structure effect:						
Proportion of members 55+	-0.0070	-0.4	-0.0430***	-2.7	-0.0557***	-4.0
	(0.0087)		(0.0120)		(0.0116)	
Proportion of members 16-54	-0.1630***	-9.2	-0.2025***	-12.9	-0.2580***	-18.7
	(0.0244)		(0.0347)		(0.0331)	
Household size	-0.6921***	-39.0	-0.3176***	-20.3	-0.7508***	-54.6
	(0.0220)		(0.0276)		(0.0299)	
Proportion of members 55+ who are working	-0.0152***	-0.9	-0.0098***	-0.6	-0.0132**	-1.0
	(0.0034)		(0.0029)		(0.0058)	
Proportion of members 16-54 who are working	0.1087***	6.1	0.0390	2.5	0.0411	3.0
	(0.0219)		(0.0239)		(0.0304)	
Proportion of members 55+ with >= high school	0.0073***	0.4	0.0162***	1.0	-0.0017	-0.1
	(0.0028)		(0.0030)		(0.0020)	
Proportion of members 16-54 with >= high school	0.0611***	3.4	0.1355***	8.6	0.0355***	2.6
	(0.0059)		(0.0106)		(0.0050)	
Total Structure effect of DT variables	***-0.7002****	***-39.4***	***-0.3823****	***-24.4***	***-1.0028****	***-72.9***
	(0.0486)		***(0.0658)***		***(0.0655)***	
Total effect:						
Age composition variables	*-0.6260*	*-35.2*	*-0.4562*	*-29.1*	*-0.8992*	*-65.3*
Education and employment DT variables	0.2172	12.2	0.2057	13.1	0.0727	5.3
Total DT variables	***-0.4088***	***-23.0***	***-0.2505***	***-16.0***	***-0.8265***	***-60.1***

Note: Age composition variables include proportion of members 55+, proportion of members 16-54 and household size. Total DT variables include age composition variables, education and employment DT variables. *** p<0.01, ** p<0.05, * p<0.1.

As noted in the summary results, the negative contribution of DT variables to income growth came through their structure effect, i.e. through changes in their rates of return. The detailed decompositions show that changes in the returns to age composition and household size account for all of this negative contribution, while increased returns to employment and education for the 16-54 cohort make a positive contribution to income growth. The latter contribution is about 10% of total per capita income growth nationally, 11% to urban income growth and somewhat lower at about 6% of rural income growth. However, this is completely outweighed by the negative structure effect of the three variables related to household composition, whose joint contribution was -49% to national income growth, -77% to rural income growth and -36% to urban income growth. As is seen in Table 2.4, the negative contribution of the structure effect related to household composition variables consists a rise in the negative income effects associated with household size and the decrease in the returns to having more adults in the household (holding the proportion who are working or have high-school education constant), reflecting an increasing opportunity cost of additional child between 1988 and 2013.

Overall, through composition and structure effects taken together (bottom panel of Table 2.6), the age composition variables, including household size, made a negative contribution to per capita income growth: -35% of national income growth, -29% of urban income growth and -65% of rural income growth. These negative effects are mediated through changes in the returns to these variables: an increasing negative income effect of household size and decreasing positive income effects of the proportion of adults in the household (holding their employment and education status constant). In contrast, the overall contribution of education and employment related DT variable to per capita income growth was positive: 12% of national income growth, 13% of urban income growth and 5% of rural income growth. This positive contribution was mediated through the improved rates of return to employment and education for the young (16-54 years) and, to a lesser extent, through an increased proportion of the young who have at least high school education.

2.6.3 Demographic transition and the urban-rural gap – summary results

Differences across the urban and rural sectors in the above discussion on income growth have already hinted at the potential implications of demographic transition for urban-rural disparities in per capita incomes. We now directly focus on these by applying the decomposition methods to urban-rural income gaps.

Table 2.7 presents the summary decomposition results for the urban-rural per capita income gap for each of the two years, 1988 and 2013. The top panel of Table 2.7 shows the gap between urban and rural per capita income widened over this period; mean log ratio of urban-to-rural per capita income ratio went up from 0.572 to 0.762.

Table 2.7 Decomposition of the Urban-Rural per capita income gap in 1988 and 2013 – summary results

	1988		2013	
Total difference between urban and rural log per capita income	0.5719***		0.7621***	
	(0.0072)		(0.0112)	
	Contribution to total change			
	Value	%	Value	%
Composition effect:				
DT variables	0.1910***	33.4	0.3101***	40.7
	(0.0071)		(0.0088)	
Other	0.1429***	25.0	0.1080***	14.2
	(0.0168)		(0.0084)	
Total	0.3339***	58.4	0.4181***	54.9
	(0.0177)		(0.0111)	
Structure effect:				
DT variables	-0.0165	-2.9	0.4404***	57.8
	(0.0511)		(0.0786)	
Other	0.2544***	44.5	-0.0963	-12.6
	(0.0534)		(0.0794)	
Total	0.2379***	41.6	0.3440***	45.1
	(0.0188)		(0.0138)	
Total effect:				
DT variables	0.1745	30.5	0.7505	98.5
Other	0.3973	69.5	0.0117	1.5
Total	0.5718	100.0	0.7622	100.0

Note: DT variables include: proportion of household members aged >=55, proportion of household members aged 16-54, household size, proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education. Other includes the region and industry fixed effects and dummy variables for missing values and a constant term. *** p<0.01, ** p<0.05, * p<0.1.

The key results of the decomposition in Table 2.7 underline the importance of demographic transition related variables to the growing urban-rural income gap in China. In 1988, the DT variables jointly accounted for about 30% of the urban-rural income disparity, while in 2013 they accounted for virtually all of it.

Beginning with the contributions to the urban-rural income gap in each of the years 1988 and 2013, Table 2.7 shows that for 1988 while the DT variables explain 30.5% of the income gap between the urban and rural areas, this is made up of a contribution of 33.4% due to the composition effect of DT variables and a small negative contribution of -2.9% due to the structure effect of these variables. Thus, the entire contribution of DT variables to the urban-rural income gap is attributable to the sectoral differences in these demographic characteristics, not to the sectoral difference in the returns to those characteristics.

For the year 2013, it is striking that the DT variables explain nearly all of the urban-rural income gap. Of the total 98.5% contribution of DT variables to the sectoral income gap, 40.7% is realized through the composition effect and 57.8% through the structure effect.

Over time, therefore, our results indicate a substantial increase in the contribution of DT variables to the urban-rural income gap. This increase is almost entirely due to an increase in the structure component of DT variables, thus, on account of the changes in the returns to these variables between 1988 and 2013. These results point to the critical role of widening sectoral differentials in rates of returns to the widening urban-rural income inequality in China over the 25-year period. Over the 25-year period, China appears to have moved from a situation where the urban-rural income gap was primarily a matter of sectoral differences in demographic characteristics to one where it is more a matter of sectoral differences in the rates of return to those characteristics.

2.6.4 Demographic transition and the urban-rural gap – detailed results

The detailed decomposition results in Table 2.8 shed further light on how the increasingly adverse contribution of demographic transition variables to urban-rural income disparity has been realized.

The bottom panel of Table 2.8 shows that the contribution of education and employment related variables increased from 25% of the urban-rural income gap in 1988 to 36% of the urban-rural income gap in 2013. This increase came about mainly through the increase in the composition effect related to the proportion of 16-54 cohort with at least high school education. This reflects the widening urban-rural education gap for this cohort during 1988-2013 (see Table 2.3).

More strikingly, the total contribution of the age composition variables (including household size) increased from 6% to 62% of the urban-rural income gap between 1988 and 2013. Note that combined contribution of these variables through the composition effect in fact declined from 32% to 22% of the urban-rural income gap, reflecting some convergence between rural and urban household composition over this period.

Table 2.8 Decomposition of Urban-Rural per capita income gap in 1988 and 2013 – Detailed results

	Contribution to difference in log per capita income			
	1988		2013	
	Value	%	Value	%
Composition effect:				
Proportion of members 55+	0.0160***	2.8	0.0049***	0.6
	(0.0018)		(0.0014)	
Proportion of members 16-54	0.0269***	4.7	0.0010	0.1
	(0.0022)		(0.0014)	
Household size	0.1393***	24.4	0.1657***	21.7
	(0.0044)		(0.0055)	
Proportion of members 55+ who are working	-0.0051***	-0.9	0.0037	0.5
	(0.0010)		(0.0030)	
Proportion of members 16-54 who are working	-0.0133***	-2.3	-0.0068***	-0.9
	(0.0018)		(0.0013)	
Proportion of members 55+ with >= high school	0.0052**	0.9	0.0153***	2.0
	(0.0021)		(0.0026)	
Proportion of members 16-54 with >= high school	0.0220***	3.8	0.1262***	16.6
	(0.0044)		(0.0059)	
Total composition effect of DT variables	***0.1910******	***33.4***	***0.3101******	***40.7***
	(0.0071)		***(0.0088)***	
Structure effect:				
Proportion of members 55+	0.0591***	10.3	0.1431***	18.8
	(0.0067)		(0.0180)	
Proportion of members 16-54	0.1222***	21.4	0.1816***	23.8
	(0.0250)		(0.0405)	
Household size	-0.3319***	-58.0	-0.0216	-2.8
	(0.0217)		(0.0330)	
Proportion of members 55+ who are working	0.0038	0.7	-0.0033	-0.4
	(0.0029)		(0.0063)	
Proportion of members 16-54 who are working	0.1364***	23.9	0.1154***	15.1
	(0.0295)		(0.0249)	
Proportion of members 55+ with >= high school	0.0008	0.1	0.0242***	3.2
	(0.0026)		(0.0043)	
Proportion of members 16-54 with >= high school	-0.0070	-1.2	0.0010	0.1
	(0.0071)		(0.0112)	
Total Structure effect of DT variables	***-0.0165***	***-2.9***	***0.4404******	***57.8***
	(0.0511)		***(0.0786)***	
Total effect:				
Age composition variables	***0.0315***	***5.5***	***0.4746***	***62.3***
Education & employment	***0.1430***	***25.0***	***0.2757***	***36.2***
Total DT variables	***0.1745***	***30.5***	***0.7503***	***98.5***

Note: Age composition variables include proportion of members 55+, proportion of members 16-54 and household size. Total DT variables include age composition variables, education and employment DT variables. *** p<0.01, ** p<0.05, * p<0.1.

Instead, the increase in the total contribution of household composition variables came about entirely through the increase in the structure effect related to these variables; their combined contribution (through the structure effect) increased from -26% of the urban-rural income gap in 1988 to about 40% of the gap in 2013. The biggest change was in the structure effect related to household size, whose contribution changed from -58% to -3%. This big change reflects the changes in the rates of return to household size across urban and rural areas. As seen in the regression results in Table 2.4, in 1988 household size had a much larger negative marginal effect on per capita income in urban than in rural areas. By 2013, the negative marginal effects of household size increased in absolute terms in both urban and rural areas, but the increase was much larger in rural areas, such that by 2013 the negative marginal effects of household size were similar across urban and rural areas.

What may explain the increasingly negative marginal effects of household size in rural areas? Note that the marginal effects of household size can be interpreted as the opportunity cost of additional children in the household. A likely explanation for an increasing opportunity cost of children in rural areas lies in the massive growth in migration opportunities for young adults from rural to urban areas over this period. Recall that migrant workers are included in the rural samples in the CHIP data. Hence, it is plausible that increasing migration opportunities for young adults in rural areas are reflected in the increasing opportunity (or income) cost of children in the rural sample. This is also consistent with the increasing positive contribution of the structure effect related to the proportion of adults in the household to the widening urban-rural income gap over this period.

In sum, therefore, these results point to the key role of DT variables in the widening of the urban-rural disparity in per capita incomes over the 25-year period. Some of the widening effect occurred through the increasing urban-rural gap in the education endowments of the young working age population. But most of it occurred through the changing sectoral returns to household composition. Our results show that holding household composition constant across urban and rural sectors, China went from a situation in 1988 of a much lower rural penalty to household size, contributing to a large reduction of the urban-rural income disparity, to a situation in 2013 of similar penalties to household size in rural and urban areas, thereby eliminating this important source of reduction of urban-rural income disparity.

2.7 Discussion and conclusion

Our analysis has investigated the contribution of the demographic transition process to income growth and the urban-rural income gap in China over a transformative period of both rapid economic growth and major demographic changes. China's One Child Policy (initiated in 1979 and discontinued only in 2016) undoubtedly contributed to hastening the decline in fertility and demographic transition in China. However, the consequences of demographic transition for growth and inequality have remained a matter of debate for China (and beyond). While there are no clear predictions for inequality, in relation to economic growth, the leading contender is the demographic dividend hypothesis that posits positive effects on growth of a rising share of the working-age population and a falling dependency ratio.

However, our results call into question the demographic dividend hypothesis for China. A key finding of our analysis for 1988-2013 is that demographic transition variables contributed negatively to per capita income growth nationally as well as within the rural and urban sectors over this period. But this was the result of some changes that were consistent with the demographic dividend hypothesis and others that were not. In particular, our analysis indicates that if there were no changes in the rates of return to DT variables, the changes in the levels of these variables – such as falling household size, increasing proportion of adults in the household and increasing educational endowments of the adult population – themselves contributed positively to income growth, consistent with the idea of a demographic dividend. Some changes in the rates of return – such as increasing returns to employment for the young and to high school education for all adults – also contributed positively to income growth consistent with the demographic dividend hypothesis. However, these positive growth contributions were overwhelmed by other changes in the rates of return to DT variables, notably the rise in the negative return to household size and the falling positive return to the proportion of adults in the household. Thus, our findings are consistent with the notion of a demographic dividend only if we hold the rates of return to demographic variables constant.

It is difficult to argue that our finding of the negative growth contribution of DT variables reflects the closing of the demographic dividend for China. There are certainly signs of such closing towards the end of our period with a plateauing and some decline in the proportion of the working age population post 2005. However, for most of the 25-year period we study, China is still well within the increasing demographic potential stage. Thus, we interpret our results on the overall negative contribution of DT variables to income growth as indicating that while China did experience rapid economic growth over this period, the sources of growth are to be found elsewhere, not in the ongoing demographic transition.

Over the same period, urban economic growth was faster than rural economic growth, such that despite significant rural-to-urban migration, there was a considerable increase in the urban-rural gap in per capita incomes. Our key finding in this regard is that the DT variables contributed heavily to the widening of the sectoral income gap. In particular, while the DT variables contributed to the sectoral income gap in both 1988 and 2013, their contribution was much higher by 2013. This increase was propelled by changes in the rates of return to household composition variables, in particular the large increase (in absolute terms) in the negative marginal return to household size in rural areas, bringing them on par with urban areas. We interpret this as reflecting the rapidly rising opportunity cost of children in rural areas with the opening up of significant migration opportunities for young rural adults during this period.

Insofar as these changes in the rates of return to household composition variables in rural areas are also reflected in similar changes at the national level, they also shed light on the overall negative contribution of DT variables on income growth. The two elements of analysis for the contribution of demographic transition to income growth and sectoral inequality are thus complementary.

One limitation is our analysis is that we fail to control for the potential endogeneity issues, therefore, our analysis cannot provide possible causality, but the contribution of the DT variables to the income growth and urban-rural income gap. Moreover, urban-rural inequality is only one component of overall income inequality at the national level which is also known to have increased over this period of rapid growth. A fuller investigation of how demographic transition may have contributed to national-level income inequality is the subject of the next chapter.

Appendix

Table2.1 A1 Income components for CHIP 1988 and 2013

	Urban	Rural
1988	(1) Cash income of the working members;	(1)Income from wages pensions and other compensations received by individual members of the household;
	(2) Income of the retired members;	(2) Household income from township, village, collective and other types of enterprise;
	(3) Income from non-working members;	(3) Cash income from farming and industrial and subsidiary activities;
	(4) Income from private/individuals;	(4) Gross value of self-consumption of farm products;
	(5) Income from property;	(5) Income from property;
	(6) Miscellaneous income (including private transfer and special income);	(6) Net transfer from/to collective and state entities;
	(7) Subsidies less taxes (except housing subsidy).	(7) Miscellaneous income (including private transfer);
2013	(1) Wage income;	(1) Wage income;
	(2) Net business income;	(2) Net business income;
	(3) Net property income;	(3) Net property income ;
	(4) Net transfer income.	(4) Net transfer income.

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Chapter 3: Aging, demographic transition and inequality during a period of rapid growth: China 1988-2013

3.1 Introduction

In the 21st century, the demographic transition, hereafter DT, across the world is represented as a profound population aging process, in which the population of all countries is getting older due to the decline in fertility and increase in longevity (UN 2019). However, the pattern, and pace, of this process vary substantially across different developed groups of the world (Attanasio et al. 2006, World Bank 2016). According to the United Nations (UN), although developed countries have the highest proportion of older people, the rate at which their population is aging has slowed down. At the same time, the rate of aging in developing countries is occurring much faster than what occurred in developed countries in the past. It is projected by the UN that from 2015 to 2030, the number of older people in the developing world will grow by 71%, compared to an increase of 60% between 2000 and 2015 (UN 2015). Rapid aging of the population poses several challenges for developing economies. Most notably, an increase in the proportion of the elderly raises concerns about savings, labour supply and greater demand for welfare spending on health care and old-age security. The magnitude of such policy challenges of aging depends, inter alia, on how aging affects income inequality. Specifically, the severity of these challenges will be considerably greater if aging also induces greater income inequality. This is especially true for many developing economies that are already grappling with rising income inequality. In this chapter, we thus examine the effect of DT on inequality in the context of China, which represents a starkest example of a developing economy with a rapid DT process, coupled with rising income inequality.

China's "One Child Policy" since the end of 1970s, and large investment in female education before that, led to a dramatic reduction in fertility (from 3.9 in 1975 to 1.6 in 2015), while life expectancy rate rose rapidly from 63.9 years to 75.9 years over the same period (World Bank 2019). As a result, compared to what occurred in developed countries, China has been experiencing a much more rapid DT process shifting from a young to an old population. For example, it took China only 36 years for the proportion of the population aged 60 and above to increase from 7% to 14%, which is around one third of the time taken in France (115 years), around half the time taken in Australia (73 years) and the US (69 years) (UN 2015). The UN predicts that by 2030, China will be one of the few upper-income-countries that has become as aged as today's high-income countries. At the same time, it is well-known that China's high economic growth has also been accompanied by rising income inequality (Kanbur and Zhang 1999, Benjamin, Brandt and Giles 2005, Kanbur and Zhang 2005, Sicular et al. 2007), which has become an important political and policy concern for the Chinese government.[13]

While change in age profile of the population (e.g rising proportion of the elderly in the population) comprises an important component of the DT process, as discussed in Chapter 2, we take the view that the DT process also includes the changing profile of different age groups, i.e., the changing characteristics of the old relative to the young; of which, characteristics related to education and employment are the most important. Therefore, in this chapter, we examine the DT-inequality relationship by inquiring into the implication of an overall DT process that takes a wider set of demographic characteristics of household members into account, which is ignored in existing literature documented the relationship between DT and inequality.

We also improve on the methodological approach adopted in existing studies investigating the effect of DT on income inequality in China. As summarized in Table 3.A1, the methods employed in existing studies mainly fall into two strands, one are studies like Zhang and Xiang (2014) and Chen, Huang and Li (2018) that use the method developed by Deaton and Paxson (1994) to decompose the variance into a cohort effect and an age effect; The other are studies that use regression-based approaches; For instance, Dong, Tang and Wei (2018) provides several regression estimates for the Gini coefficient while Zhong (2011) and Wang et al. (2017) further use the decomposition method developed by Wan (2004) to decompose the Gini index into the contribution of each covariate included in the estimated regressions. In this study, we use a recentered influence function (RIF) regression-based decomposition method developed by Firpo, Fortin and Lemieux (2007, 2018) that generalizes the standard Oaxaca-Blinder decomposition to more general distribution statistics other than the mean, such as the Gini coefficient, the variance and the quantiles. The advantage of the RIF method over the Deaton and Paxson (1994) method is that it quantifies the contribution of each individual variable to change in aggregate inequality. Moreover, compared to the regression-based approach developed by Wan (2004), the RIF method allows to decompose change in distribution statistics into a composition effect (due to changes in the distribution of covariates or endowments) and a structure effect (due to changes in returns to endowments), and then further

[13] The Chinese government has, over the years, taken a number of measures to address income inequality, for instance, the campaign on “western development” introduced in 1999, the urban di bao (cash transfer) program also introduced in 1999 and the abolition of the agricultural tax and fee for compulsory education in rural areas starting in 2006.

divide these two effects into the contribution of each covariate, which has never been analysed in studies documenting the DT-inequality relationship in China.

In addition, we also improve on existing studies in the following ways. (1) The period that we consider, 1988 to 2013, is the longest period considered in the existing literature. This is important because DT is inherently a long-term process; hence, it is clearly desirable to have data covering as longer period as possible with which to investigate the DT effect. (2) For robustness, we employ several distributional measures; in addition to the popular Gini index of income per capita, we also use variance of log income per capita and ratio (log difference) of the 80th to the 20th quantiles of income per capita. (3) Unlike most of the existing literature for China that uses the CPI to control for changes in price over time, but does not adjust for the spatial price differences at a given point in time, we adjust for both spatial and temporal differences in the cost of living (COL). (4) We improve on the precision of existing estimates for China by weighting the urban and rural samples and taking rural-urban migrants into account. [14]

Our main result suggests that between 1988 and 2013, the DT process, including changes in the age composition, household size as well as the education and employment profile of different age groups contribute substantially to the increase in income inequality in China over the period. Both changes in endowments and returns contribute to the total positive contribution of demographic change to widening inequality, while there are variations in their relative importance depending on the distribution statistics used.

The composition component explains 20%-53% of the total DT contribution, and is mostly realized through compositional changes in education and employment characteristics, specifically through decline in work participation of the young and increase in adult education attainment. The structure component accounts for 47%-80% of the total DT contribution, and is realized through both household size and composition as well as education and employment DT variables, in particular through change in returns to child dependency (household size controlling for age composition of adults), adult employment as well as high school education of the old. We find that the contribution of the structure component to total DT effect, particularly change in marginal returns to household size, has become much larger when comparing the disparities between the top and bottom end of the income distribution. We

[14] The importance of adjusting the spatial and temporal COL difference as well as population weighting are discussed in Section 3.2.

interpret this reflecting the underlying processes related to the opening up of migration opportunities similar to our earlier results on the DT-growth relationship in Chapter 2.

3.2 Data and descriptive statistics

In this Chapter, we use data from the 1988 and 2013 waves of China Household Income Project (CHIP)[15]. Our dependent variables consist of three inequality measures: (1) the Gini index of household income per capita, (2) the variance of log household income per capita, and (3) the difference between the 80th quantile and the 20th quantile of log household income per capita. Table 3.1 shows the descriptive statistics on these three measures of income inequality.

The statistics are presented both with and without adjustment for the COL difference and the population weighting for urban and rural samples. Table 3.1 first shows that the adjustment for COL and population weighting makes a difference. Allowing for spatial and temporal differences in COL and weighting reduces measured income inequality at the national level for both 1988 and 2013; it also reduces the measured change in inequality over time[16].

The descriptive statistics confirm some well-known facts about growth and inequality in China. Consistent with the earlier literature, the CHIP data show that real mean per capita income in China grew nearly seven times between 1988 and 2013, or at an annual average rate of growth of 7.9% per annum. The data also confirm that this rapid economic growth was accompanied by a substantial rise in inequality as reflected in the worsening of all three distributional statistics. The Gini index rose from 0.312 to 0.397, variance of log income from 0.377 to 0.646 and the log ratio of the 80th to the 20th quintile from 0.925 to 1.288.[17]

[15] See Chapter 2 for more detailed discussions about the CHIP data.

[16] Ravallion and Chen (2007) also show that after adjusting for spatial and temporal COL differences, both national inequality and changes in inequality in China between 1981 and 2001 are reduced.

[17] The distribution statistics that we calculate may differ from others in the literature for many reasons, such as different income definitions, different ways to adjust for spatial price differences and different sample populations (Gustafsson and Li 2002; Sicular et al. 2007; Gustafsson, Li and Sicular 2008; Zhong 2011; Luo et al., 2013).

Table 3.1 Descriptive statistics for dependent variables

	1988		2013		Total Change	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Household income per capita	1091	4155	18801	27647	17710	23492
Gini of per capita income	0.334	0.312	0.454	0.397	0.120	0.085
Variance of log income per capita	0.466	0.377	0.812	0.646	0.346	0.270
Q80 of log income per capita	7.341	8.634	10.237	10.589	2.896	1.955
Q20 of log income per capita	6.238	7.709	8.717	9.301	2.479	1.592
Q80-Q20	1.103	0.925	1.520	1.288	0.417	0.363

Note: unadjusted refers to nominal per capita incomes with unweighted samples, while "adjusted' refers to real per capita incomes with sampling weights adjusted for spatial and temporal cost of living differences as discussed in the text. Real per capita incomes are expressed in RMB/person/year at 2013 Beijing prices.
Source: author's calculation from CHIP data.

Our primary explanatory variables are a set of DT variables which include the following: household size, proportion of household members aged >=55, proportion of household members aged 16-54[18], proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education. The analysis also controls for region and industry fixed effects. We distinguish six regions: urban central, urban west, urban east, rural central, rural west and rural east. Industry fixed effects distinguish primary, secondary and tertiary sectors of work (with no household member reported to be working as the omitted category).[19]

In Table 3.2, we present the descriptive statistics for the DT covariates, which help us characterize the nature of DT in China over the 25-year period. The key change is from a less educated, but younger, population to a more educated, but older, population. More specifically, between 1988 and 2013, while average size of the household shrank from 5.4 to 3.8 persons, there was an increase in the proportion of those aged 55 and above and a decrease in those below 16, suggesting a rapid aging process in China. In 1988, around 11% of household members were aged 55 and above. By 2013, the fraction of the old cohort was over 20%. Simultaneously, the proportion of those aged 16-54 remained stable at about 61%. Our data also show that rapid aging in China was accompanied by a substantial decline in the work participation of the 16-54 group from 88% to 69%, which partly reflects the younger cohort continuing with education beyond age 16. During the same period, work participation of the elderly rose from 14% to 16%. The education attainment of both the old and young also

[18] The proportion of children below 16 is the omitted group.
[19] See Chapter 2 for more detailed discussion about the explanatory variables.

increased substantially during this period. The proportion of the elderly with high school education went up from less than 1% to around 10% and that of the 16-54 age group increased from 11% to 38%. These trends reflect the fact that with the expansion of education, the education attainment of both the old and young cohort has improved substantially, which may mitigate the negative aging effect on labour supply by enhancing employment opportunities for the old and the consequent increase in the productivity of the labour force (World Bank 2016).

Table 3.2 Descriptive statistics for independent variables

	1988	2013	Total change
Household size	5.4	3.8	-1.6
Total no. of household members who are working	3.0	2.0	-1.0
Age (%):			
% members 55+	10.7	24.0	13.3
% members 16-54:	60.7	60.8	0.0
Employment (%):			
% members 55+ who are working	14.4	16.2	1.8
% members 16-54 who are working:	88.3	69.2	-19.2
Education (%):			
% members 55+ with >= high school	0.9	9.1	8.2
% members 16-54 with >=high school :	11.5	38.3	26.9

Source: Author's calculation from CHIP data;

3.3 Methodology

We use the RIF regression-based methodology to model the three distribution statistics of household income (discussed above in Section 3.2) as functions of the size of the household, the age composition of its members, their education level and work status while also controlling for region and industry fixed effects. The RIF decomposition developed by Firpo, Fortin and Lemieux (2007, 2018) is a generalization of the traditional Oaxaca-Blinder decomposition (Oaxaca 1973 and Blinder 1973) to more general distribution statistics other than the mean and it allows us to compute the contribution of each covariate to changes in inequality between two years. The method is explained as below.

Let v be the distribution statistic of interest. The change in v between 1988 and 2013 ($\widehat{\Delta_O^v}$) can then be divided into:

$$\widehat{\Delta_O^v} = (v_C - v_{1988}) + (v_{2013} - v_C) = \widehat{\Delta_X^v} + \widehat{\Delta_S^v} \tag{1}$$

Where

v_C is the counterfactual distribution statistic that would have prevailed in 1988 with the distribution of observed and unobserved characteristics that existed in 2013.

$\widehat{\Delta_X^v}$ is the composition effect, reflecting the effect of differences in the distribution of the covariates between 1988 and 2013;

$\widehat{\Delta_S^v}$ is the structure effect, reflecting the effect of differences in returns to the covariates between 1988 and 2013;

The counterfactual distribution is constructed using a reweighting factor, which can be easily computed by estimating a probit model for the probability of belonging to year 2013 or 1988.[20] Based on this, the reweighting factor is then defined as:

$$\hat{\psi}(X) = \frac{\widehat{\Pr}\,[T = 2013|X]/\widehat{\Pr}\,(T = 2013)}{\widehat{\Pr}\,[T = 1988|X]/\widehat{\Pr}\,(T = 1988)} \tag{2}$$

where $\widehat{\Pr}\,[T = 2013|X]$ is the predicted probability of belonging to year 2013;

$\widehat{\Pr}\,[T = 1988|X]$ is the predicted probability of belonging to year 1988;

$\widehat{\Pr}\,(T = 2013)$ is the sample proportion in year 2013;

$\widehat{\Pr}\,(T = 1988)$ is the sample proportion in year 1988.

Using the reweighting factor in (2), we can reweight the sample from 1988 to create a counterfactual distribution which is the distribution of income that would have prevailed in 1988 with the distribution of observed and unobserved characteristics that existed in 2013.

$\widehat{\Delta_S^v}$ and $\widehat{\Delta_X^v}$ can be further decomposed into the contribution of each covariate. The first step is to estimate a RIF regression for the 1988, 2013 and counterfactual samples, respectively. The

[20] The dependent variable of the probit model is a dummy variable, where it equals to 0 for the year 1988 and 1 for the year 2013. We follow Firpo, Fortin and Lemieux (2007, 2018) in using a flexible and richer specification of the probit model with additional interaction terms to compute the reweighting factor. The interaction terms include interactions between household size and industry dummies, region dummies and the age composition of household members, as well as the interaction between industry and region dummies.

RIF regression, developed by Firpo, Fortin and Lemieux (2009), models the conditional expectation of the RIF of v as a linear function of the explanatory variables:

$$E[RIF(y, v(y)|X] = X\gamma \tag{3}$$

Where $v(y)$ is the distribution statistics of the dependent variable y, X is the vector of explanatory variables and γ gives the marginal effect of a change in X on $v(y)$.

Suppose that the estimated coefficients are $\hat{\gamma}_{1988}$ for the 1988 sample, $\hat{\gamma}_{2013}$ for the 2013 sample and $\hat{\gamma}_C$ for the counterfactual sample, then the composition effect $\widehat{\Delta_X^v}$ is written as:

$$\widehat{\Delta_X^v} = (\bar{X}_C - \bar{X}_{1988})' \cdot \hat{\gamma}_{1988} + \bar{X}_C' \cdot (\hat{\gamma}_C - \hat{\gamma}_{1988}) \tag{4}$$

$$= \widehat{\Delta_{X,p}^v} + \widehat{\Delta_{X,e}^v} \tag{5}$$

where $\Delta_{X,p}^v$ is the pure composition effect and $\widehat{\Delta_{X,e}^v}$ is the specification error which allows us to assess the importance of departures from the linearity assumption.

Similarly, the structure effect $\widehat{\Delta_S^v}$ is written as:

$$\widehat{\Delta_S^v} = \bar{X}_{2013}' \cdot (\hat{\gamma}_{2013} - \hat{\gamma}_C) + (\bar{X}_{2013} - \bar{X}_C)' \cdot \hat{\gamma}_C \tag{6}$$

$$= \widehat{\Delta_{S,p}^v} + \widehat{\Delta_{S,e}^v} \tag{7}$$

where $\Delta_{S,p}^v$ is the pure structure effect and $\widehat{\Delta_{S,e}^v}$ is the reweighting error which allows us to assess the quality of reweighting.

A well-known issue related to the estimated decomposition results from equation (4) and equation (6) is that they may not be invariant to the choice of the reference group. For example, in equation (4), the composition effect can be estimated with respect to $\hat{\gamma}_C$ (instead of $\hat{\gamma}_{1988}$) in the first term and $\bar{X}_{1988}$ (instead of $\bar{X}_C$) in the second term. In order to address this issue, we take the average of the two decompositions which use different groups' parameters as the reference. Therefore, equation (4) becomes:

$$\widehat{\Delta_X^v} = \frac{1}{2}(\hat{\gamma}_{1988} + \hat{\gamma}_C)(\bar{X}_C - \bar{X}_{1988})' + \frac{1}{2}(\bar{X}_C + \bar{X}_{1988})' \cdot (\hat{\gamma}_C - \hat{\gamma}_{1988}) \tag{8}$$

Where the first term is the pure composition effect $\widehat{\Delta_{X,p}^v}$ and the second term is the specification error $\widehat{\Delta_{X,e}^v}$. Similarly, equation (6) can be generalized to:

$$\widehat{\Delta_S^v} = \frac{1}{2}(\bar{X}_{2013} + \bar{X}_C)' \cdot (\hat{\gamma}_{2013} - \hat{\gamma}_C) + \frac{1}{2}(\hat{\gamma}_C + \hat{\gamma}_{2013}) \cdot (\bar{X}_{2013} - \bar{X}_C)' \quad (9)$$

Where the first term is the pure structure effect $\Delta_{S,p}^v$ and the second term is the reweighting error $\widehat{\Delta_{S,e}^v}$.

3.4 RIF regression models

Table 3.3 reports our estimated RIF regressions of the Gini index, the variance of log per capita income, the 20th quantile and the 80th quantile of log per capita income (eq 3). The estimated effects of DT variables on Gini in Table 3.3 are consistent with that on the variance while there are variations in their significance levels. The results also show that over time the returns to DT variables on per capita income vary considerably for households at the 20th and 80th quantiles, leading to a diverse effects of the DT variables on income inequality from 1988 to 2013.

For age composition variables (the proportion of the young and old), in 1988 the income effect is larger for the 80th quantile than the 20th quantile; thus a higher proportion of the young and old is associated with an increase in inequality. In 2013, compared to their rich counterparts, the positive returns to age composition variables on per capita income are higher, or almost the same, for poor households; hence the age composition variables have an equalizing effect.

For household size, in both 1988 and 2013, larger family size is associated with a lower income for both the lower and upper quantiles. However, in 1988, the negative income effect is larger for rich households; hence, household size has a significant inequality decreasing effect. In contrast, in 2013 the negative effect of household size on per capita income is more substantial for poor households; therefore, household size has a significant inequality widening effect.

As discussed in Chapter 2, the included age composition variables together with household size will capture the effect of child dependency ratios, conditioning on adult employment and education. In 1988, the positive parameters of age composition variables on inequality measures and the negative parameters of household size indicates negative effect of higher child dependency on inequality (conditional on adult employment and education). The regression results for the 20th and 80th quantile show that over the period (1988 to 2013), while the negative income effect of child dependency is increasing for both rich and poor households, the magnitude is larger for poor households. Consequently, there is a higher penalty of additional children on per capita income for poor households in 2013, thus higher child dependency is associated with higher inequality.

Table 3.3 RIF regression result for distribution statistics in 1988 and 2013

	1988			
	Gini of per capita income	Variance of log per capita income	Q20 of log per capita income	Q80 of log per capita income
Proportion members 55+	0.0517***	0.0399	0.2183***	0.3443***
	(0.0170)	(0.0508)	(0.0726)	(0.0536)
Proportion members 16-54	0.0393***	0.0765**	0.4787***	0.5666***
	(0.0118)	(0.0353)	(0.0534)	(0.0388)
Household size	-0.0074***	-0.0213***	-0.0380***	-0.0600***
	(0.0012)	(0.0037)	(0.0067)	(0.0045)
Proportion members 55+ who are working	-0.0035	-0.0244	0.0446	0.0339
	(0.0077)	(0.0230)	(0.0367)	(0.0269)
Proportion members 16-54 who are working	-0.0030	-0.1253***	0.0502	0.0396
	(0.0112)	(0.0336)	(0.0480)	(0.0358)
Proportion members 55+ with >= high school	0.0890***	0.1692**	-0.0177	0.3677***
	(0.0259)	(0.0773)	(0.0916)	(0.1013)
Proportion members 16-54 with >= high school	0.0191**	0.0287	0.0227	0.1671***
	(0.0096)	(0.0287)	(0.0393)	(0.0322)
R-square	0.0186	0.0079	0.0445	0.1429
N	18975	18975	18975	18975
	2013			
	Gini of per capita income	Variance of log per capita income	Q20 of log per capita income	Q80 of log per capita income
Proportion members 55+	-0.0792***	-0.0663	0.2626***	0.2084***
	(0.0215)	(0.0707)	(0.0789)	(0.0614)
Proportion members 16-54	-0.0224	0.0653	0.2661***	0.2790***
	(0.0191)	(0.0628)	(0.0682)	(0.0550)
Household size	0.0185***	0.0726***	-0.2330***	-0.1486***
	(0.0024)	(0.0079)	(0.0107)	(0.0062)
Proportion members 55+ who are working	0.0246**	0.0491	-0.1019***	-0.0488**
	(0.0099)	(0.0324)	(0.0393)	(0.0240)
Proportion members 16-54 who are working	-0.0261**	-0.0527	0.1835***	0.1504***
	(0.0103)	(0.0339)	(0.0374)	(0.0263)
Proportion members 55+ with >= high school	0.0874***	0.2771***	0.0997***	0.4819***
	(0.0120)	(0.0394)	(0.0387)	(0.0440)
Proportion members 16-54 with >= high school	-0.0237***	0.0292	0.3075***	0.3389***
	(0.0085)	(0.0281)	(0.0313)	(0.0257)
R-square	0.0410	0.0362	0.2638	0.1985
N	16823	16823	16823	16823

Note: The regressions also controlled for region dummies, household industry dummies and dummy variables for missing values. All coefficients and standard errors are scaled up by 100. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

For the education and employment characteristics, in 1988, our results suggest the following: (1) The estimated income effect of adult employment (conditional on their education) are higher for poor households than the rich, however, they are not statistically significant. We only find a significant negative effect of work participation of the young on the variance of log income; (2) For rich households, there are significant positive income effects of high school educations of the 16-54 and 55+ age group; for poor households, the estimated income effects of these variables are lower and not significant. Consequently, higher proportion of adults with high school education is associated with higher inequality.

In relation to the education and employment DT variables in 2013, we find that the effects of these characteristics differ between the young and elderly group. For instance, high proportion of the working participation of the 55+ age group is associated with a significant increase in the Gini index while that of the 16-54 age group tends to decrease inequality; Higher proportion of the old with high school education is associated with an increase in inequality while that of the young is associated with a decrease in inequality. In addition, in contrast to 1988, there are more variations in the income effect of these characteristics for the upper and lower quantiles. For instance, while for the 55+ age group, higher working participation and education both tend to increase inequality, the positive effect of working participation is through larger negative income effect for poor households than the rich while that of high school education is through higher income effect for the rich households than the poor.

Given the discussion above, in the following section we decompose changes in the inequality measures discussed above to investigate how the DT process contributes to the increase in inequality from 1988 to 2013. Moreover, we separate the contribution of age composition variables and household size from the education and employment DT variables. We also examine the relative contribution of the composition and structure effect in the DT-related characteristics.

3.5 Decomposition results

We discuss our decomposition results in two parts. We first present summary results for the contribution of all DT variables to income inequality in China. We then present results for the contribution of individual variables, which helps to isolate the contributions of the age composition including household size from that of the education and employment DT characteristics. In both cases, we distinguish between the composition and structure effects. We report both the absolute size of the contributions of the covariates and their proportional contribution to the net change in distributional statistics.[21]

3.5.1 Overall contribution of demographic transition to income inequality

Tables 3.4 and 3.5 summarize the decomposition results for the overall change in income inequality as well as the contribution of all DT variables to the composition and structure components of the change in inequality. The top panels of Table 3.4 and 3.5 show the actual change in distribution statistics between 1988 and 2013 as well as the change net of specification and reweighting errors associated with the RIF decomposition methodology. As the latter errors are relatively small, the net changes largely mirror the observed total rise in income inequality for all distribution statistics.

Beginning with the change in Gini and log variance, the main result of the decomposition analysis in Table 3.4 is that the DT process contribute substantially to the total rise in inequality between 1988 and 2013 (bottom panel of the table). Taken together, the DT variables account for over half of the rise in Gini and fully explain the increase in variance of log (per capita) income. For the change in Gini, 53% of the contribution of the DT variables is realized through the composition effect and 47% through the structure effect. In case of change in variance of log incomes, around four-fifths are realized through the structure effect and one-fifth through the composition effect.

[21] Net change = total change – approximation error, where the approximation error is the sum of the specification error and reweighting error from the RIF decomposition.

Table 3.4 Decomposition of change in Gini and variance of per capita income between 1988 and 2013 - Summary results

	Gini of per capita income		Variance of log per capita income	
Total change:	0.0848***		0.2698***	
	(0.0044)		(0.0148)	
Specification error & reweighting error:	0.0057		-0.0161	
Net change:	0.0791		0.2859	
	Contribution to net change			
	Value	%	Value	%
Composition effect:				
DT variables	0.0219	27.7	0.1281***	44.8
	(0.0144)		(0.0360)	
Other	-0.0390**	-49.3	-0.1376***	-48.1
	(0.0184)		(0.0425)	
Total	-0.0171	-21.6	-0.0095	-3.3
	(0.0200)		(0.0289)	
Structure effect:				
DT variables	0.0195	24.7	0.4671***	163.4
	(0.0615)		(0.1400)	
Other	0.0767	97.0	-0.1718	-60.1
	(0.0568)		(0.1347)	
Total	0.0962***	121.6	0.2953***	103.3
	(0.0116)		(0.0242)	
Total effect:				
DT variables	0.0414	52.3	0.5952	208.2
Other	0.0377	47.7	-0.3094	-108.2
Total	0.0791	100.0	0.2858	100.0

Note: DT variables include: proportion of household members aged >=55, proportion of household members aged 16-54, household size, proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education. "Other" includes region and industry fixed effects as well as dummy variables for missing values and a constant term. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.5 shows the decomposition results for the change in the 80-20 quantile log differential (or, equivalently, the change in the log ratio of the 80^{th} quantile to the 20^{th} quantile of per capita income[22]) as an alternate distribution statistic. Similar to the rise in inequality indicated by the other distributional statistics, there is a net increase of 0.492 in the 80-20 quantile log differential, which reflects a larger increase in log 80^{th} quantile (of 2.023) than the increase in the 20^{th} quantile (of 1.535). Net of approximation errors, incomes at the top rise significantly faster than incomes the bottom end of the distribution.

[22] Note that the quantile of log income is the same as the log of quantile of income.

Table 3.5 Decomposition of change in quantiles of per capita income between 1988 and 2013 - Summary results

	Q20 of log per capita income		Q80 of log per capita income		80-20	
Total change:	1.5917***		1.9550***		0.3633***	
	(0.0143)		(0.0115)		(0.0161)	
Specification error & reweighting error:	0.0569		-0.0716		-0.1285	
Net change:	1.5348		2.0266		0.4918	
	Contribution to net change					
	Value	%	Value	%	Value	%
Composition effect:						
DT variables	0.0785***	5.1	0.4278***	21.1	0.3493***	71.0
	(0.0286)		(0.1241)		(0.1062)	
Other	0.2217***	14.4	0.1874***	9.2	-0.0344	-7.0
	(0.0190)		(0.0374)		(0.0403)	
Total	0.3002***	19.6	0.6152***	30.4	0.3149***	64.1
	(0.0273)		(0.1029)		(0.0867)	
Structure effect:						
DT variables	-0.6539***	-42.6	0.2013	9.9	0.8551***	173.9
	(0.1666)		(0.1712)		(0.1918)	
Other	1.8884***	123.0	1.2102***	59.7	-0.6782***	-137.9
	(0.1217)		(0.1898)		(0.2088)	
Total	1.2345***	80.4	1.4114***	69.6	0.1769**	36.0
	(0.0855)		(0.0572)		(0.0880)	
Total effect:						
DT variables	-0.5754	-37.5	0.6291	31.0	1.2045	244.9
Other	2.1101	137.5	1.3976	69.0	-0.7125	-144.9
Total	1.5347	100.0	2.0267	100.0	0.4920	100.0

Note: DT variables include: proportion of household members aged >=55, proportion of household members aged 16-54, household size, proportion of members aged >=55 who are working, proportion of members aged 16-54 who are working, proportion of members aged >=55 with at least high school education, proportion of members aged 16-54 with at least high school education. "Other" includes region and industry fixed effects as well as dummy variables for missing values and a constant term. *** p<0.01, ** p<0.05, * p<0.1.

The results show that the net increase in the 80-20 quantile log differential is fully attributed to DT variables. The contribution of DT variables to the increase in inequality is realised both through composition and structure effects. Among which, 71% of the DT contribution is realized through structure effects and 29% through composition effects. This suggests when comparing relative income growth at the top and bottom end of the distribution, changes in returns to DT variables has been far more important than the changes in distribution of those variables.

As Table 3.5 shows the results for changes in the 80th and the 20th quantiles themselves, it also sheds more light on how the effects of DT have been playing out at the top and bottom ends of the distribution. Thus, for instance, we find that composition effects related to DT variables drive the rise in inequality by raising incomes at the 80th quantile much more than incomes at the 20th quantile. For the structure effects, change in returns to DT variables negatively contributes to the income growth for the lower end while it helps increase incomes at the high end and, thus, contributes substantially to the increase in the quantile differential.

Note that our other non-DT variables consists of regional and industry fixed effects as well as a constant term. In Table 3.4 and Table 3.5, the negative contribution of the composition component linked to those variables reflects that the rapid structural transformation in China, including a transit from an agricultural to non-agricultural sectors as well as the diverse pattern of economic development across different regions help reduce the inequality in China between 1988 and 2013. And the first two column of Table 3.5 further show that the negative contribution of this structural shift is realized through contributing more to the income growth for relatively poor households than their rich counterparts.

To sum up, for all our distribution statistics, our summary decomposition results show that the DT process play a large and significant role in the observed increase in national income inequality in China, contributing to over half of the rise in inequality. Changes in the distribution of characteristics and their returns both contribute to the DT contribution, though there is some variation in their relative significance depending upon the inequality measure used. For the variance of log incomes and 80-20 quantile differential, most (70-80%) of the DT effects on inequality are mediated through changes in returns to endowments, while for the Gini, a larger contribution (53% of the DT contribution) is mediated through the change in distribution of the underlying endowments.

3.5.2 Individual contribution of DT variables

Tables 3.6 to 3.8 present the detailed decomposition results for the contribution of individual DT variables that allowing us to further investigate the pattern of the summary results discussed in Section 3.5.1. Similar to Table 3.4 and 3.5, we report the absolute size of the contribution of each covariate as well as their proportional contribution to the total net change. In order to further investigate the relative importance of different DT variables, we also report the proportional contribution of each covariate to the total DT effect *(% DT).*

3.5.2a Individual DT contribution to Gini

Beginning with the detailed decomposition results for Gini, our results first suggest that changes in the distribution of endowments related to education and employment DT characteristics account for most of the positive total DT composition effect to increase in inequality. Together, these characteristics fully explain the composition effect related to DT variables (28.4% out of 27.7%) while age composition including household size has a marginal negative contribution (-0.8% out of 27.7%). As discussed in Section 3.4 that, the key compositional change in the DT process in China consists of a shift from a less educated but younger population to a more educated but older population coupled with a substantial decline in the work participation of the young. The first panel of Table 3.6 shows that the decline in the working participation of the 16-54 cohort, the rise in high school education of the adult population (16-54 and 55+ age group) account for most of the positive contribution of overall DT composition effect to increase in inequality (31.8% out of 27.7%).

Second, both age composition variables including household size as well as the education and employment characteristics contribute to the positive contribution of total DT structure effect to rise in Gini. For household composition and size, change in returns to age composition variables has a negative contribution (-6.7%) to increase in Gini, thus, the structure effect is entirely mediated through change in rate of returns to household size. For education and employment DT characteristics, the positive structure effect is realized through changes in returns to working participation of adults and high school education of the old (second panel of Table 3.6). Together, they contribute to 41% of the rise in Gini from 1988 to 2013. However, this positive contribution is partially mitigates by the negative contribution of change in returns to high school education of young, which accounts for -21.4% of the change in Gini.

Overall, the last panel of Table 3.6 shows that the age composition variables include household size explain 4.4% of the increase in Gini, and this is driven by changes in returns to household size (11.9% out of 4.4%). The education and employment DT characteristics account for 47.9% of the rise in Gini, among which more is realized through changes in composition of these characteristics. For changes in returns, the negative contribution of the structure effect related to high school education of the young has netted out much of the positive contribution of changes in returns to other education and employment DT variables.

Table 3.6. Decomposition of change in the Gini of per capita income between 1988 and 2013 – Detailed results

	Contribution to change in:		
	Gini of per capita income		
	Value	% (net change)	% (DT)
Composition effect:			
Proportion of members 55+	0.0059	7.5	14.3
	(0.0074)		
Proportion of members 16-54	0.0002	0.3	0.5
	(0.0013)		
Household size	-0.0068	-8.6	-16.4
	(0.0074)		
Proportion of members 55+ who are working	-0.0027	-3.4	-6.5
	(0.0020)		
Proportion of members 16-54 who are working	0.0115	14.5	27.8
	(0.0089)		
Proportion of members 55+ with >= high school	0.0088*	11.1	21.3
	(0.0049)		
Proportion of members 16-54 with >= high school	0.0049	6.2	11.8
	(0.0045)		
Total composition effect of DT variables	***0.0219***	***27.7***	***52.9***
	(0.0144)		
Structure effect:			
Proportion of members 55+	-0.0222	-28.1	-53.6
	(0.0191)		
Proportion of members 16-54	0.0169	21.4	40.8
	(0.0318)		
Household size	0.0094	11.9	22.7
	(0.0319)		
Proportion of members 55+ who are working	0.0131**	16.6	31.6
	(0.0062)		
Proportion of members 16-54 who are working	0.0079	10.0	19.1
	(0.0177)		
Proportion of members 55+ with >= high school	0.0114**	14.4	27.5
	(0.0055)		
Proportion of members 16-54 with >= high school	-0.0169	-21.4	-40.8
	(0.0138)		
Total Structure effect of DT variables	***0.0195***	***24.7***	***47.1***
	(0.0615)		
Total effect:			
Age composition variables	0.0035	4.4	8.5
Education & employment DT variables	0.0379	47.9	91.5
Total DT variables	***0.0414***	***52.3***	***100.0***

Note: Age composition variables include proportion of members 55+, proportion of members 16-54 and household size. Total DT variables include age composition variables, education and employment DT variables. *** p<0.01, ** p<0.05, * p<0.1.

3.5.2b Individual DT contribution to the 80-20 quantile log differential

While the discussion above investigates the detailed contributions of DT characteristics to income inequality for the overall income distribution, it raises the question of how these contributions vary for households across different points of the income distribution. In this section, we investigate the detailed decomposition results of the 20th and 80th quantile as well as the differences between them, thus shedding light on the role of individual DT covariate for households at the top and bottom end of the income distribution.

Table 3.7 presents the detailed decomposition results for the 80-20 quantile log differential. Overall, the results in Table 3.7 are consistent with the discussion above in Gini.

Table 3.7 Decomposition of change in quantiles of log per capita income between 1988 and 2013 – Detailed results

	Contribution to change in:								
	Q20 of log per capita income			Q80 of log per capita income			Difference between Q80 and Q20		
	Value	% (net change)	% (DT)	Value	% (net change)	% (DT)	Value	% (net change)	% (DT)
Composition effect:									
Proportion of members 55+	0.0592**	3.9	-10.3	0.0467	2.3	7.4	-0.0124	-2.5	-1.0
	(0.0234)			(0.0360)			(0.0307)		
Proportion of members 16-54	-0.0140	-0.9	2.4	-0.0178	-0.9	-2.8	-0.0038	-0.8	-0.3
	(0.0196)			(0.0257)			(0.0075)		
Household size	0.0325	2.1	-5.6	0.1565***	7.7	24.9	0.1240***	25.2	10.3
	(0.0218)			(0.0594)			(0.0429)		
Proportion of members 55+ who are working	0.0027	0.2	-0.5	-0.0010	0.0	-0.2	-0.0037	-0.8	-0.3
	(0.0036)			(0.0077)			(0.0087)		
Proportion of members 16-54 who are working	-0.0083	-0.5	1.4	0.1019**	5.0	16.2	0.1102**	22.4	9.1
	(0.0157)			(0.0502)			(0.0493)		
Proportion of members 55+ with >= high school	-0.0001	0.0	0.0	0.0396**	2.0	6.3	0.0397**	8.1	3.3
	(0.0097)			(0.0200)			(0.0202)		
Proportion of members 16-54 with >= high school	0.0066	0.4	-1.1	0.1019**	5.0	16.2	0.0953**	19.4	7.9
	(0.0061)			(0.0439)			(0.0430)		
Total composition effect of DT variables	***0.0785****	***5.1***	***-13.6***	***0.4278****	***21.1***	***68.0***	***0.3493****	***71.0***	***29.0***
	(0.0286)			***(0.1241)***			***(0.1062)***		
Structure effect:									
Proportion of members 55+	0.0091	0.6	-1.6	0.0600	3.0	9.5	0.0508	10.3	4.2
	(0.0383)			(0.0663)			(0.0697)		
Proportion of members 16-54	0.0153	1.0	-2.7	-0.0410	-2.0	-6.5	-0.0563	-11.4	-4.7
	(0.0607)			(0.0764)			(0.0904)		
Household size	-0.8708***	-56.7	151.3	-0.0426	-2.1	-6.8	0.8282***	168.4	68.8
	(0.0998)			(0.0795)			(0.1139)		
Proportion members of 55+ who are working	-0.0210**	-1.4	3.6	-0.0003	0.0	0.0	0.0207	4.2	1.7
	(0.0102)			(0.0209)			(0.0234)		
Proportion members of 16-54 who are working	0.1025***	6.7	-17.8	0.2967***	14.6	47.2	0.1943**	39.5	16.1
	(0.0302)			(0.0785)			(0.0814)		
Proportion members of 55+ with >= high school	0.0118**	0.8	-2.1	0.0593***	2.9	9.4	0.0475***	9.7	3.9
	(0.0059)			(0.0171)			(0.0175)		
Proportion members of 16-54 with >= high school	0.0992***	6.5	-17.2	-0.1308*	-6.5	-20.8	-0.2300***	-46.8	-19.1
	(0.0194)			(0.0778)			(0.0844)		
Total Structure effect of DT variables	***-0.6539****	***-42.6***	***113.6***	***0.2013***	***9.9***	***32.0***	***0.8551****	***173.9***	***71.0***
	(0.1666)			***(0.1712)***			***(0.1918)***		
Total effect:									
Age composition variables	-0.7686	-50.1	133.6	0.1619	8.0	25.7	0.9305	189.2	77.3
Education & employment DT variables	0.1932	12.6	-33.6	0.4673	23.1	74.3	0.274	55.7	22.8
Total DT variables	***-0.5754***	***-37.5***	***100.0***	***0.6292***	***31.0***	***100.0***	***1.2045***	***244.9***	***100.0***

Note: Age composition variables include proportion of members 55+, proportion of members 16-54 and household size. Total DT variables include age composition variables, education and employment DT variables. *** p<0.01, ** p<0.05, * p<0.1.

First, Table 3.7 shows that changes in the distribution of education and employment DT variables, more specifically, decline in the work participation of the young and increase in the proportion of adults with high school education account for much of the composition effect linker to DT variables (Panel 1 of Table 3.7). Taken together, they account for around 70% (50% out of 71%) of the total composition effect of DT variables.

Second, similar as Gini, the positive contribution of total DT structure effect to rise in the 80-20 quantile is realized through both household size and composition as well as education and employment DT variables. For age composition variables including household size, change in returns to age composition has a negligible contribution (-1.1%) to the overall increase in inequality, thus the structure effect of those characteristics is entirely realized through change in rate of returns to household size. The decomposition results for each of the 20th and 80th quantile further show that changes in returns to household size contribute to the rising inequality by a larger negative contribution to growth in per capita income for poor households (-56.7%) during 1988 and 2013 than the rich households (-2.1%).

In the case of education and employment characteristics, the positive contribution of structure effect is attributed to changes in returns to adult employment and high school education of the 55+ age group, together they contribute to 53.4% of the increase in the 80-20 log income differential over the period 1988-2013. Overall, changes in returns to these characteristics drive the increase in inequality by rising per capita income at the 80th quantile more than that at the 20th quantile.

Third, the second panel of Table 3.7 confirms the considerable negative contribution of change in returns to high school education of the 16-54 age group to rise in inequality found in Gini. In the case of quantile differential, it mitigates -46.8% of the rise in the 80-20 log income differential between 1988 and 2013. The structure component of the high school education of the young help reduce the widening inequality by rising incomes more for poor households than the rich households. As is shown in Table 3.3, while the returns to education of the young on per capita income has been increasing for households at both the 20th and 80th quantile of the income distribution, the magnitude is more substantial for poor households, leading to an equalizing effect of the structure component related to education attainment of the young.

In contrast to Gini, one feature in the result of 80-20 quantile is that the magnitude of the contribution of most DT characteristics is larger, reflecting a much more substantial disparity when we consider differences between households at the upper and lower ends of the income distribution. In particular, the positive contribution of the structure effect of DT variables is strikingly large. Table 3.7 shows that this is mostly attributed to change in returns to household size. We discuss above that the positive contribution of change in marginal returns to household size to rising inequality is through larger negative contribution to the income growth for poor households during 1988 and 2013 than their rich counterparts. As is noted in Section 3.4, while for both rich and poor households, larger household size is associated with a lower household income and this negative effect has been increasing over time (see Table 3.3), the increasing penalty for per capita income hurts low-income level households more than those with high income.

What could explain this faster increase in the negative effect of larger household size on per capita income for poor households over time? As suggested earlier, the marginal effect of household size could be interpreted as the opportunity cost of additional children in the household. Consistent with the evidence on rural-to-urban migration and the rapid decline in rural poverty, it is plausible that this opportunity cost of additional children in the household increased substantially over the 25-year period (from 1988 to 2013) in response to the massive migration opportunities for rural young adults opened up by China's rapid industrialization. These migration opportunities have been particularly important for the relative poor households. Hence, it may be expected that the rise in the opportunity cost of additional children is larger for poorer than the richer households.

The last panel of Table 3.7 show that taken together, over 77% of the total DT effect is attributed to age composition variables including household size and 23% attributed to the education and employment DT characteristics. The large contribution of the age composition and household size is mostly mediated through change in returns to household size, reflecting higher opportunity cost of additional children for poor household related to the underlying drastic increase in migration opportunities over the period 1988-2013. For the education and employment DT variables, the positive contribution are mediated through the composition component related to those characteristics; for the structure component, changes in returns to high school education of the young has netted out most of the positive contribution of other education and employment-related characteristics.

3.5.2c Individual DT contribution to the variance

We now present the detailed decomposition results for the change in variance in Table 3.8, the results further confirm the robustness of the findings discussed above.

i. Changes in endowments related to education and employment DT variables explain much of the composition component of DT variables. The first panel of Table 3.8 show that over three-fourths (33.7% out of 44.8%) of the total DT composition effect is mediated through education and employment characteristics.

Table 3.8 Decomposition of change in variance of log per capita income between 1988 and 2013 – Detailed results

	Contribution to change in:		
	Variance of log per capita income		
	Value	% (net change)	% (DT)
Composition effect:			
Proportion of members 55+	0.0003	0.1	0.1
	(0.0193)		
Proportion of members 16-54	-0.0003	-0.1	-0.1
	(0.0035)		
Household size	0.0319	11.2	5.4
	(0.0221)		
Proportion of members 55+ who are working	-0.0053	-1.9	-0.9
	(0.0050)		
Proportion of members 16-54 who are working	0.0642***	22.5	10.8
	(0.0239)		
Proportion of members 55+ with >= high school	0.0193*	6.8	3.2
	(0.0100)		
Proportion of members 16-54 with >= high school	0.0181*	6.3	3.0
	(0.0102)		
Total composition effect of DT variables	***0.1281****	***44.8***	***21.5***
	(0.0360)		
Structure effect:			
Proportion of members 55+	-0.0087	-3.0	-1.5
	(0.0496)		
Proportion of members 16-54	0.0730	25.5	12.3
	(0.0816)		
Household size	0.3466***	121.2	58.2
	(0.0782)		
Proportion of members 55+ who are working	0.0218	7.6	3.7
	(0.0164)		
Proportion of members 16-54 who are working	0.0357	12.5	6.0
	(0.0352)		
Proportion of members 55+ with >= high school	0.0334***	11.7	5.6
	(0.0114)		
Proportion of members 16-54 with >= high school	-0.0348	-12.2	-5.8
	(0.0273)		
Total Structure effect of DT variables	***0.4671****	***163.4***	***78.5***
	(0.1400)		
Total effect:			
Age composition variables	0.4427	154.8	74.4
Education & employment DT variables	0.1525	53.3	25.6
Total DT variables	***0.5952***	***208.2***	***100.0***

Note: Age composition variables include proportion of members 55+, proportion of members 16-54 and household size. Total DT variables include age composition variables, education and employment DT variables. *** p<0.01, ** p<0.05, * p<0.1.

ii. Changes in returns to employment of adults and education of the old have made positive contribution to increase in inequality. Taken together, 31.8% of the rise in variance during 1988 and 2013 are attributed to change in returns to those characteristics (Second panel of Table 3.8).

iii. The positive contribution of the education and employment characteristics in (ii) is partially mitigated by the negative contribution of change in returns to high school education of the young. Specifically, the structure effect of the young with high school education help mitigate 12.2% of the increase in the variance of log income per capita between 1988 and 2013.

iv. Age composition variables including household size have a positive contribution to increase in variance over time (Last panel of Table 3.8). This contribution is driven by changes in returns to these variables, among which change in returns to household size plays a dominant role. For instance, over 90% of the total contribution of age composition and household size is attributed to the structure component, of which over 80% is realized through change in rate of returns to household size.

Similar to its contribution to the 80-20 quantile differential, there is larger contribution of household size to increase in variance compared to that in Gini. Like the 80-20 quantile differential, the variance of log per capita income is also more sensitive to the extremes at the lower and upper end of the income distribution. This largely accounts for the larger contributions of DT characteristics relative to those for the Gini index.

3.6 Discussion and conclusion

In this chapter, we used a RIF regression-based decomposition method to decompose a set of inequality measures between 1988 and 2013 in China. While the contribution of DT to inequality in existing studies is still inconclusive, we improve on the literature documenting the DT-inequality relationship in several ways. First, we use a dataset covering a period spanning 25 years in China, which to the best of our knowledge, is the longest period considered in existing studies. Second, we place the contributions of age composition changes within an overall DT process which also enquires into the contributions of household size as well as the changing work and education profiles of different age groups. Third, we also isolate the effect of changes in the distribution of DT characteristics from changes in returns to those characteristics.

Our main result is that the overall DT process has made a substantial contribution to the increase in inequality in China during 1988 and 2013. It explains 52.3% of the increase in the Gini index and fully captures the rise in the variance and 80-20 quantile differential. Both changes in the endowments and changes in returns to the underlying DT characteristics contribute to the widening inequality over the 25-year period, while there are variations in their relative contribution depending on the distributional statistics used. For the variance of log incomes and 80-20 quantile differential, more (70-80%) of the DT contribution on inequality is mediated through changes in returns to endowments and 20-30% through changes in the distribution of the endowments. For the Gini index, a larger contribution (53% of the DT contribution) is mediated through the changes in the distribution of the underlying endowments and 47% through changes in returns to those characteristics.

For composition effect, we find that the compositional changes including the decline in working participation of the young, rise in the education attainment of adults play a dominant role. The positive contribution of the structure component are realized through changes in rate of returns to child dependency (household size conditional on age composition of adults), adult employment as well as high school education of the old. For change in marginal rate of returns to household size, the positive contribution to widening inequality is mediated through a larger negative contribution to income growth for the poor households over time. For changes in rate of returns to the adult employment and high school education of the old, the positive contributions to rise in inequality are though rising income for rich households more than the poor over time. Change in returns to high school education of the young has a considerable negative contribution to increase in equality. This equalizing effect is through rising income more for poor households than the rich.

We also find that there is a larger positive contribution of change in marginal returns to household size to rise in inequality when investigating income disparity between the upper and lower end of the income distribution. We interpret this as reflecting faster increase in opportunity cost of additional children for poor households due to the massive migration opportunities over the 25-year period.

A limitation in our analysis is that the decomposition analysis used in this chapter does not rigorously establish causal links, just as the Oaxaca-Blinder type of decomposition of wage inequality only provides suggestive evidence of the causal influence of discrimination. However, our main findings of the contribution of different variables associated with the DT process provide insights into the various pathways through which demographic transition has influenced the increase in inequality in China. This opens up awareness for further causal investigations of the role of these processes.

Appendix

Table 3.A1. Summary of empirical studies on aging and inequality in China

	Methodology	Period of analysis	Geographic coverage	Inequality measure	Demographic variable	Cost of living adjustment	Weight adjustment
Zhong (2011)	Decompose inequality into the relative contribution of each covariate, developed by Wan (2004); Decompose inequality into mean effect, distributional effect and income generation effect, developed by Wagstsff, Van Dooeslaer and Watanabe (2003).	1997-2006	Rural China, Urban China	Rural and Urban Gini, Rural and Urban Theil index	Ratio of household members in working age	Adjust for CPI	NO
Wang et al. (2017)	CGE with micro simulation; Decompose inequality into the relative contribution of each covariate, developed by Wan (2004)	2010-2030	National China	Gini	Average age within a household	Adjust for CPI	Yes
Zhang and Xiang (2014)	Decompose inequality into a cohort effect and age effect, developed by Deaton and Paxson (1994)	2003-2009	Urban China	Variance of log income within the young and old	Age of household head	NO	NO
Chen, Huang and Li (2018)	Decompose inequality into a cohort effect and age effect, developed by Deaton and Paxson (1994)	1989-2011	National China	Variance of log income within the young and old	Age of household head	Adjust for CPI	NO
Dong, Tang and Wei (2018)	Fixed-effects (FE), Random-effects (RE), Instrument Variable (IV), Generalized method of moments (GMM) estimates	1996-2011	National China	Provincial Gini	Children's dependence ratio and elderly dependency ratio	Adjust for CPI	/

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Chapter 4: Missing women in China and India over seven decades: an analysis of birth and mortality data from 1950 to 2020

4.1 Introduction

Sen (1990, 1992) pointed out that the ratio of women to men in many parts of the developing world in Asia and North Africa is uncharacteristically low relative to Europe and North America, suggesting that a substantial number of women are simply "missing" relative to "the numbers that could be expected if men and women received similar care in health, medicine and nutrition". A deficit of women seems evident even from the raw numbers on the overall sex ratio of the population. For instance, in 2015 the sex ratio of the population in Europe and Northern America[23] was 105.5 females per hundred males, while it was 94.7 in China and 92.3 in India (United Nations, 2019a). Following Sen's contribution, the magnitude and regional distribution of missing women and excess female mortality has attracted considerable attention. The existing literature has estimated that millions of women are missing in South Asia, West Asia, China and North Africa, amongst which China and India account for most of the deficit (Das Gupta 2005, World Bank 2012, Bongaarts and Guilmoto 2015, Guilmoto et al. 2018). For instance, Bongaarts and Guilmoto (2015) estimate that China and India together accounted for 84 percent of total missing women in the world in 2010. Thus, a focus on China and India is appropriate in this context. This paper contributes to the literature by constructing long-run estimates of missing women in China and India for a period spanning seventy years.

In particular, the contribution of the paper is three-fold. First, in contrast to most of the literature which provides estimates of missing women at one or only a few points in time, this paper constructs long-run flow estimates[24] of missing women (including missing girls at birth) in China and India over the seventy-year period from 1950 to 2020. This is the longest period for which such estimates are available in the literature.

Second, our estimates offer a complete age-profile of missing women and excess female mortality for both countries over the seventy-year period. In particular, by distinguishing the changing contributions of missing girls and women at different life stages – at birth, in infancy and childhood, in reproductive years and in mature and elderly age-brackets – our analysis

[23] Northern America includes Bermuda, Canada, Greenland, Saint Pierre and Miquelon, United States of America.
[24] The distinction between flow and stock estimates of missing women is discussed below in section 4.2.

offers insights into the changing significance of gender inequalities at prenatal, postnatal and later stages of life for the observed evolution of missing women.

Third, the long period covered by our study helps locate the missing women phenomenon within a broader historical context for the two countries. The seven decades from 1950-2020 represent a period of profound economic, social, technological and structural transformation in both China and India. The period is marked by a transition to rapid economic growth, significant poverty reduction and structural transformation of the economy as well as demographic transition characterized by a significant decline in mortality and fertility. Our time-period, thus, encompasses several episodic events and secular changes in both China and India that have potentially impacted the number of missing women. These include China's Great Famine of 1959-1961, the implementation of the One Child Policy (OCP) in China since the late 1970s until its eventual relaxation in the 2010s, the introduction and use of sex-selective abortion technology in both countries since the 1980s and the secular fertility decline in both countries, since the 1960s in China and the 1980s in India. By relating the time-pattern of trends in missing women and their age distribution to these events, our study offers insights into their underlying role in generating the observed historical trends of missing women in the two countries.

Without attempting a comprehensive summary of our detailed results, we note the following as a brief preview of some of our main findings. Our estimates show that, on average over the past seven decades, 1.3 million females were missing per year in China and 2 million females per year were missing in India. Of this total number, missing girls at birth and excess female deaths comprised 34 and 66 percent in China, and 17 and 83 percent in India. Over time, there has been a faster rise in the number of missing girls at birth in China as well as a faster decline in excess female deaths than India. The share of missing girls in total missing women has risen in both countries, while the composition of excess female deaths in both countries has shifted from younger to older age groups. The key markers in the observed trends of excess female deaths and female birth deficits are consistent with the time pattern of several prominent economic, social, technological and policy developments in the two countries over the 70-year period.

4.2 Data and methodology

4.2.1 Data

Our primary source of data is the *World Population Prospects: the 2019 Revision* (WPP 2019) assembled by United Nations Population Division. WPP 2019 provide age-specific data on population, birth rates, death rates and sex ratio at birth (SRB) by country and for each five-year interval between 1950 and 2020. In particular, we make extensive use of the Abridged Life Tables for males and females for 22 distinct age groups. The WPP database is widely considered to be the most reliable and comprehensive source of cross-country demographic data. While primarily based on national data sources (including censuses, vital registration statistics, demographic and health surveys, population registers and international migration statistics), the WPP subjects these data to a number of data quality and cohort-component checks "to ensure internal consistency by age and sex over time, and between the three demographic components of change (fertility, mortality and migration) and the enumerated population" (United Nations, 2019b). The database is also harmonized across countries to ensure cross-country comparability.[25] Based on these data, our main estimates of excess female mortality and missing women are, thus, presented for each of the fourteen 5-year intervals spanning 1950-2020.[26]

4.2.2 Methodology of constructing flow estimates of missing women

Conceptually, the notion of missing women involves a comparison of the actual number of women in a country with the counterfactual number of women who would be alive were there lower orders of gender bias in births and mortality. In principle, one can construct either stock or flow estimates of missing women. The stock estimates compare the actual sex ratio of the population with a counterfactual sex ratio to derive an estimate of the stock of missing women at a point in time. The flow estimates involve a comparison of the actual sex ratio of mortality rates with a counterfactual sex ratio of those mortality rates to derive an estimate of the flow of missing women over a period of time. Most of the existing literature calculates the stock measure of missing women, such as Sen (1990, 1992), Coale (1991), Klasen (1994) and Klasen

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[25] WPP 2019 Revision contains a full time series of population size by age and sex and the components of population change for 201 countries. For the 2019 Revision, 1,690 population censuses conducted between 1950 and 2018, as well as information on births and deaths from vital registration systems for 163 countries and demographic indicators from 2,700 surveys were utililzed (United Nations, 2019b).

[26] Parts of this database have also been utilized in other studies on missing women, including World Bank (2012), Bongaarts and Guilmoto (2015).

and Wink (2002), though beginning with Anderson and Ray (2010) flow estimates also emerged in the literature. The stock estimates are not directly comparable with the flow estimates, but could be seen as a cumulative result of past evolution of age-specific mortality rates, sex ratios at birth as well as migration. By contrast, the flow estimates directly focus on age-specific mortality rates and sex ratios at birth in the current period to locate the two primary sources of missing women: excess female deaths and missing births of girls. The flow estimates are, thus, by construction more informative of the sources of missing women. The current-period focus of the flow estimates is also helpful in directing attention to the ongoing changes in the magnitude of the missing women phenomenon, while stock estimates offer a measure of the cumulative history of the phenomenon up to the current period. In light of these advantages, in this study we limit ourselves to constructing only the flow estimates of missing women in China and India.

Following Anderson and Ray (2010, 2012), the methodology for constructing flow estimates of missing women is described below. Missing women (mw) at any age $a > 0$ is estimated as the product of excess female mortality and the number of women at age a:

$$mw(a) = [d^W(a) - d^{W*}(a)] \times N^W(a) \quad (1)$$

where $d^W(a)$ and $d^{W*}(a)$ are the actual and counterfactual death rates for women of age a and $N^W(a)$ is the number of women of age a. The difference between $d^W(a)$ and $d^{W*}(a)$ represents *excess female mortality*.

Let the sex ratio of death rates for age a be:

$$s(a) = d^W(a)/d^M(a) \quad (2)$$

and let $s^*(a)$ be the corresponding counterfactual sex ratio of death rates for age a. Then,

$$d^W(a) - d^{W*}(a) = [s(a) - s^*(a)] \times d^M(a) \quad (3)$$

In the following discussion, we will refer to $s(a) - s^*(a)$ as *relative excess female mortality*.

It then follows that missing women of age $a > 0$ can be expressed as:

$$mw(a) = [s(a) - s^*(a)] \times d^M(a) \times N^W(a) \quad (4)$$

It is apparent from (4) that we will have a positive estimate of missing women if, and only if, relative female excess mortality is positive.

To arrive at the total number of missing women, we need to add to the above the number of missing girls at birth, $mw(0)$, which in turn is estimated using information on sex ratios at birth (srb) as below:

$$mw(0) = [srb^* - srb] \times B^M \quad (5)$$

where srb and srb^* are the actual and counterfactual sex ratios at birth (ratio of female-to-male births) and B^M is number of male births. Thus, the total number of missing women is evaluated as:

$$mw = mw(0) + \sum_a mw(a) \quad (6)$$

4.2.3 Defining the counterfactual or reference population

The key challenge in estimating missing women using the above procedure is defining the counterfactual parameters representing the sex ratio of mortality rates and the sex ratio at birth (SRB) that could be considered a reasonable normative benchmark. The issue comes down to specifying a reference population and time period for which these parameters could be taken to approximate a more gender-equitable environment at least with respect to demographic indicators related to births and deaths. This has been a matter of intense controversy in the literature. As summarized in Table 4.1, a range of alternatives have been proposed for constructing the counterfactual. Broadly, three different types of alternatives can be distinguished.[27]

First, there are studies such as Coale (1991), Klasen (1994) and Klasen and Wink (2003) that have used life tables from the late-19th to the mid-20th century for countries that could be considered developed by current standards. While they differ in terms of whether countries in the "West" of those in the "East" ought to provide the gender-neutral benchmarks (and whether the benchmark for a country should be different depending upon its life expectancy, population growth and structure), they share the idea that the experience of today's rich countries when they were poor offers a reasonable benchmark for countries that are relatively poor today.

[27] Some of the alternatives in Table 4.1 relate to stock estimates that rely on specifying a counterfactual sex ratio of population.

Table 4.1 Alternative counterfactuals in the literature

Study	Countries/regions for which estimates of missing women are constructed (years)	Counterfactual used
Sen (1990)	China, India, other countries in South Asia, West Asia and North Africa	Sex ratio of population in Europe, North America and Japan (1.05)
Dreze and Sen (1989), Sen (1992)	South-east Asia, Latin America, North Africa, West Asia, Iran, China, India, Pakistan, Bangladesh (1986)	Sex ratio of population in sub-Saharan Africa (1.022)
Coale (1991)	China, India, Pakistan, Bangladesh, Nepal, West Asia, Egypt (various years, 1981-1991)	Adjusted sex ratio of population based on Model Life Tables for the "West" and constant SRB of 1.059 for developed countries
Klasen (1994)	China, India, Pakistan, Bangladesh, Nepal, West Asia, Egypt (various years, 1981-1991)	Adjusted sex ratio of population based on Model Life Tables "East" and SRB controlling for life expectancy
Klasen and Wink (2003)	China, India, Pakistan, Bangladesh, Nepal, West Asia, Egypt, Taiwan, South Korea, Sri Lanka, Afghanistan, Iran, Algeria, Tunisia, Sub-Saharan Africa (various years, 1991-2001)	Adjusted sex ratio of population based on Model Life Tables "East" and SRB controlling for life expectancy
Anderson and Ray (2010)	China, India, Sub-Saharan Africa (2000), United Sates (1900)	Age-specific mortality rate in Established Market Economies: Western Europe, Canada. United States, Australia, New Zealand and Japan; SRB: 1.059 for developed countries (same as Coale 1991)
Bongaarts and Guilmoto (2015)	Global estimates including China and India (1970-2010)	Adjusted age-specific sex ratios of population, mortality rates, controlling for life expectancy; average SRB in 1975-1980 of "non-African countries without sex discrimination"
Klasen and Vollmer (2018)	China, India, Sub-Saharan Africa (2000)	Age-specific mortality rates from Model Life Tables "West" or "expert" estimates from existing literature (20% of male advantage under age 5, 5% until age 50, 30% until age 80 and 20% beyond); SRB: same as Anderson and Ray (2010)

Note: "West" refers to 132 life tables for countries in Western Europe, Asia, Australasia and South Africa (white population), while "East" refers to 31 life tables from Central and Eastern Europe, including Germany. These life tables relate to the years 1870-1960 (Coale, Demeny and Vayghan, 1983). "Expert' refers to "consensus in the literature on the relative biological disadvantage of males" Klasen and Vollmer (2018).

Second, there are studies such as Anderson and Ray (2010, 2012) which favour using the experience of contemporary developed countries as a gender-neutral benchmark for estimating missing women. The key argument is that there can be no presumption that the late 19th-century/mid-20th century experience of currently developed countries was free of gender biases in mortality.

Finally, there are also studies such as Bongaarts and Guilmoto (2015) that rely upon the more recent experience of a set of reference countries though not limited to the current-day developed countries, but use it to generate country-specific benchmarks conditional on life expectancy. This is done by estimating cross-country models of sex ratios of population or mortality rates as functions of life expectancy, and using predicted values from these models conditional on a country's level of life expectancy. The presumed rationale is that counterfactual sex ratios of population or mortality ought to vary by the overall mortality level (proxied by life expectancy).

In light of this debate in the literature, our choice of the counterfactual is guided by three considerations. First, while it may be impossible to propose a benchmark that can be deemed completely free of gender bias in mortality/births, most observers will agree that the contemporary experience of more developed countries represents a more equitable environment in relation to sex-specific mortality/birth patterns relative to countries such as China and India, and thus offers a reasonable normative benchmark for the latter. Second, by the same token, the historical experience of developed countries from a century or longer ago (when they may have had similar levels of overall mortality) is likely to be prone to similar sorts of gender biases as observed in many of the current-day less developed countries. Third, the use of country-specific benchmarks conditional on life expectancy is potentially problematic as different levels of life expectancy are likely to be correlated with gender biases in mortality.

We investigate the last point using WPP 2019 data on male, female and overall life expectancy for 201 countries over the period 1950-2020. In particular, we regress the difference between female and male life expectancy on the overall life expectancy for each of the fourteen five-year periods. The results reported in Table 4.2 clearly show that the female advantage in life expectancy increases significantly with higher overall life expectancy.[28] This is a robust pattern and holds for all fourteen time periods. Thus, controlling for life expectancy will implicitly also control for relative female advantage (or disadvantage). Hence, benchmarks conditional on life expectancy will generate counterfactuals incorporating greater female disadvantage for countries with lower life expectancy. This effectively amounts to lowering the normative standards for countries with lower life expectancy, and hence underestimating the magnitude of missing women.

[28] The results are similar when using the ratio of female to male life expectancy as the dependent variable.

Table 4.2 Regressions of female and male life expectancy gaps

Period	Coefficient	Period	Coefficient
1950-1955	0.072***	**1985-1990**	0.119***
	(-0.01)		(-0.01)
1955-1960	0.087***	**1990-1995**	0.099***
	(-0.009)		(-0.012)
1960-1965	0.097***	**1995-2000**	0.089***
	(-0.008)		(-0.012)
1965-1970	0.111***	**2000-2005**	0.092***
	(-0.008)		(-0.01)
1970-1975	0.121***	**2005-2010**	0.087***
	(-0.01)		(-0.011)
1975-1980	0.115***	**2010-2015**	0.076***
	(-0.016)		(-0.014)
1980-1985	0.117***	**2015-2020**	0.065***
	(-0.013)		(-0.016)

Note: *** p<0.01, ** p<0.05, * p<0.1. Estimated coefficients and standard errors are scaled up by 1000. The dependent variable is the gap between female and male life expectancy: female life expectancy – male life expectancy. The regression for each period is estimated using data for 201 countries.

In light of the discussion above, we follow a similar approach to specifying the counterfactual as in Anderson and Ray (2010). Specifically, we use as the reference the contemporaneous average for the "more developed regions" as classified by the United Nations, comprising Europe, Northern America, Australia, New Zealand and Japan. Thus, for any given 5-year period, our counterfactual values of $s^*(a)$ in each of the 22 age groups and srb^* are taken to be the average values of the sex-ratio of age-specific mortality rates and sex ratios at birth respectively for countries in the more developed regions for the same 5-year period. Allowing the counterfactual to vary over the 70-year period allows the normative standard to be responsive to gradual improvements in the mortality environment within the more developed regions themselves. This is consistent with the idea of using contemporaneous "best practice" as an evaluative standard.

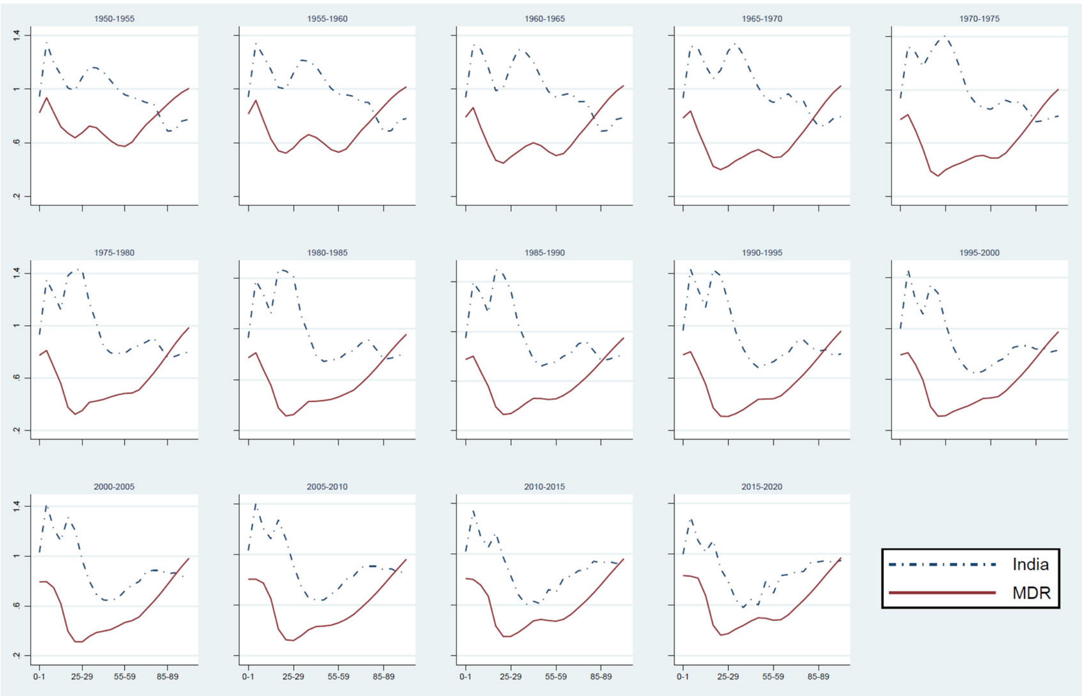
4.3 Results

4.3.1 Excess female mortality by age and over time

Figures 4.1 and Figure 4.2 plot female-to-male mortality ratios across different age groups in China and India together with the corresponding female-to-male mortality ratios for more developed regions. Several features of these graphs are notable.

Figure 4.1 Age-specific female-to-male ratio of death rates in China and more developed regions, 1950-2020

Figure 4.2 Age-specific female-to-male ratio of death rates in India and more developed regions, 1950-2020



First, the female-to-male mortality ratio in more developed regions ($s^*(a)$) is below one for all age groups throughout the seven decades. The ratio $s^*(a)$ is, in general, U-shaped with respect to age; it is close to one for the lowest and the highest age groups and well below one for intermediate age groups. This reflects the fact that females tend to have a biological advantage in survival over males that starts in early childhood and increases well into adulthood before starting to diminish at higher age groups. This is consistent with the generally higher life expectancy of women in developed countries.

Second, female-to-male mortality ratios in both China and India, $s(a)$, are higher than those in developed regions, $s^*(a)$. While, in absolute terms, mortality rates (both male and female) are higher in China and India than in developed regions, the difference between $s(a)$ and $s^*(a)$ shows that the mortality gaps of both China and India with respect to the developed world are wider for females than males. The difference between $s(a)$ and $s^*(a)$ can be interpreted as a measure of relative excess female mortality in both countries.

Third, for both India and China, relative excess female mortality, $s(a) - s^*(a)$, exhibits an inverted-U pattern, with smaller excess at younger age brackets, a widening over middle age groups and a decline thereafter. Over time, there seems to be a decline in relative excess female mortality in both countries.

There also seem to be some notable differences between China and India that become more apparent by plotting the female-to-male mortality ratios for the two countries against each other as in Figure 4.3.

Figure 4.3 Age-specific female-to-male ratio of death rates in China and India, 1950-2020

Relative excess female mortality is generally higher in India than in China. For instance, the female-to-male mortality ratio is overall below one for China most of the time, while that is not the case for India, where the ratio is above one over a wide range of younger age groups. From 1950 to 1965, this ratio for India is above one up to age 50-54; since then there has been an improvement, but India has a female-to-male mortality ratio above one up to age 20 even for the most recent decade. By comparison, China has witnessed a steady flattening of relative excess female mortality over time, especially noticeable since the 1970s.

Table 4.3 shows the average excess female mortality over all age groups (female population-weighted average of $d^W(a) - d^{W*}(a)$ over all ages a) in China and India during 1950-2020. The Table also shows the average actual female mortality rate over all age groups over the 70-year period. With improvements in health and nutrition over time there has been a sharp fall in average female (as well as male) mortality rates. This has also been accompanied by a declining trend in excess female mortality rates in both countries. However, our estimates indicate significantly higher rates of excess female mortality in India than China, with the former being more than twice as high as the latter up to the mid-1960s, and even higher in later years.

Table 4.3 Average actual and excess female mortality over all age groups, 1950-2020

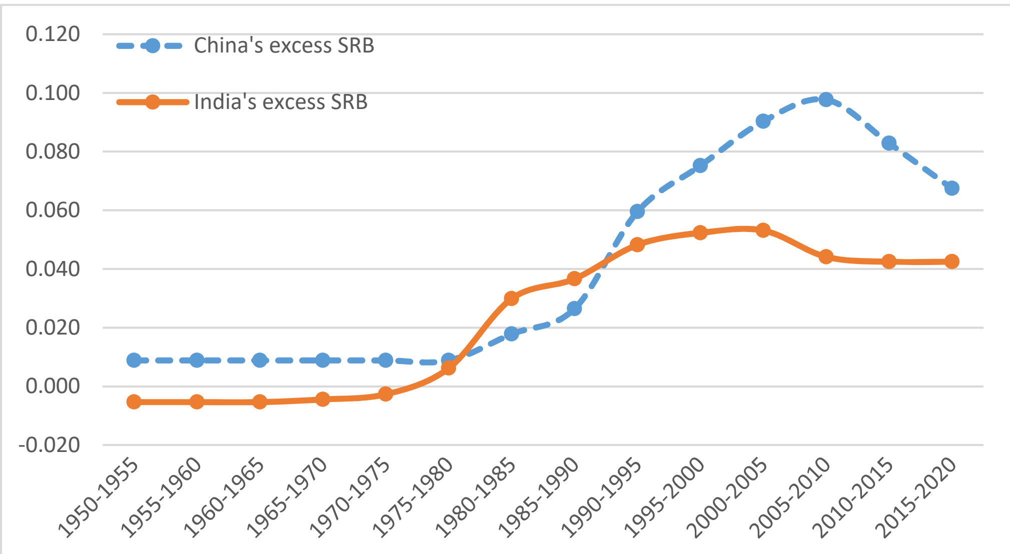
Period	Average actual female mortality (per 1000 female population)		Average excess female mortality (per 1000 female population)	
	China	India	China	India
1950-1955	25.5	32.0	3.3	7.6
1955-1960	24.2	29.2	3.5	7.9
1960-1965	23.3	25.9	4.8	7.8
1965-1970	14.8	23.0	2.5	7.2
1970-1975	10.8	20.1	2.4	6.3
1975-1980	8.1	17.3	2.0	5.3
1980-1985	7.2	15.4	1.7	4.8
1985-1990	7.3	13.9	1.6	4.5
1990-1995	6.8	12.0	1.3	3.9
1995-2000	6.5	10.5	1.1	3.3
2000-2005	6.6	9.5	1.2	3.1
2005-2010	6.5	8.7	1.0	2.8
2010-2015	6.4	7.7	0.6	2.3
2015-2020	6.5	7.5	0.4	2.2

Notes: Average actual (excess) mortality over all ages is the weighted average of actual (excess) female mortality by age groups weighed by the proportion of women in those age groups.

4.3.2 Adverse sex ratio at birth

As discussed in section 4.2, estimates of missing girls at birth are derived by comparing the (female-to-male) SRB in China and India with that in more developed regions. Table 4.4 reports these SRBs, while Figure 4.4 plots the excess of SRB in developed countries over the SRB in China and India over the 70-year period. The Figure shows that excess SRB (or female deficit at birth) is a relatively recent phenomenon. A female deficit at birth only started emerging at the start of the 1980s, with a rapid growth thereafter over the next two decades in both countries. The rise in female deficit at birth was distinctly sharper in China, with excess SRB for China overtaking India around 1990-95. China's excess SRB appears to have peaked around 2005-10, while the peak for India seems to have been around 2000-05. There has been some moderation in excess SRB beyond the peaks, with a more pronounced decline in China. Note that the sex ratio at birth for developed countries has remained highly stable over the seventy-year period, with only a marginal increase during 1980-85 and no change thereafter. Hence, the increase in excess SRB for China and India since the mid-1980s is entirely on account of the decline in sex ratio at birth in both countries.

Figure 4.4 Difference between female-to-male sex ratio at birth in more developed regions and that in China and India, 1950-2020



Note: Excess SRB refers to SRB in more developed regions – SRB in China/ India.

Table 4.4 Sex ratio at birth and missing girls at birth, 1950-2020

Period	Sex ratio at birth (female birth per male birth)		
	China	India	More developed regions
1950-1955	0.935	0.949	0.943
1955-1960	0.935	0.949	0.943
1960-1965	0.935	0.949	0.943
1965-1970	0.935	0.948	0.943
1970-1975	0.935	0.946	0.943
1975-1980	0.935	0.937	0.943
1980-1985	0.935	0.923	0.952
1985-1990	0.926	0.916	0.952
1990-1995	0.893	0.904	0.952
1995-2000	0.877	0.900	0.952
2000-2005	0.862	0.899	0.952
2005-2010	0.855	0.908	0.952
2010-2015	0.870	0.910	0.952
2015-2020	0.885	0.910	0.952

4.3.3 Estimates of missing women

We can now put together the two main components of the calculation of missing women. As obvious from equation (4), excess female mortality as documented in section 4.3.1 directly contributes to the number of missing women in different age groups. Similarly, our estimates of missing girls at birth derived from equation (5) draw upon the deficits in sex ratios at birth in China and India, relative to more developed regions as discussed in section 4.3.2. The resulting total number of missing women together with its two constitutive elements, the numbers of missing girls at birth and excess female deaths, are shown in Table 4.5. Several features of these estimates are notable.

First, on average for the 70-year period as a whole, we estimate about 1.3 million missing women per year in China and about 2.0 million in India. Cumulated over the 70 years, this amounts to a grand total of 89 million missing women in China and 139 million missing women in India. On average, for the whole period again, missing girls at birth have represented about a third of missing women in China and about one-sixth of missing women in India. These estimates are indicative of the greater significance of excess female deaths relative to fewer female births in India than China.

Table 4.5 Missing girls at birth, excess female deaths and total missing women, 1950-2020

Period	Missing girls at birth (`000s)		Missing women after birth (`000s)		Total missing women (`000s)	
	China	India	China	India	China	India
1950-1955	117	-46	928	1443	1045	1397
1955-1960	109	-49	1066	1642	1175	1593
1960-1965	115	-52	1622	1798	1737	1746
1965-1970	132	-47	938	1820	1070	1773
1970-1975	133	-30	1023	1791	1156	1761
1975-1980	112	75	919	1700	1031	1775
1980-1985	201	393	859	1719	1060	2112
1985-1990	340	514	881	1789	1221	2303
1990-1995	762	696	744	1727	1506	2423
1995-2000	789	763	674	1618	1463	2381
2000-2005	863	778	790	1636	1653	2414
2005-2010	907	635	665	1597	1572	2232
2010-2015	773	578	395	1427	1168	2005
2015-2020	619	546	283	1399	902	1945
Average	**427**	**340**	**842**	**1650**	**1269**	**1990**

Second, it is not surprising that the trends in the number of missing girls at birth mirror the trends in excess SRB noted above. During 1950-80, the number of missing girls on average is small for China (0.12 million) and negligible for India (in fact, a small negative number of -0.025). This is followed by a period of rapid increase. During the 1980s, the annual average number of missing girls at birth reached 0.27 million in China and 0.45 million in India. However, since the 1990s, the number of missing girls at birth in China exceeded that in India; during 1990-2010, the number averaged 0.83 million in China and 0.72 million in India. There was some moderation over the following decade though the average for 2010-2020 in China (0.7 million) still exceeded that for India (0.6 million). It is also notable that the number of missing girls at birth peaked in China during 2005-10, while it peaked a bit earlier in India during 2000-05.

Third, reflecting the higher rates of female excess mortality in India relative to China, the numbers of excess female deaths in India are substantially higher than those in China throughout the period. For instance, during the 1950s, the number of excess female deaths averaged about 1 million compared to India's 1.5 million; during 2010-20, these numbers averaged about 0.3 million and 1.4 million respectively. These estimates also indicate a much slower decline in missing women after birth in India than in China reflecting, in part, the slower decline in excess female mortality in India relative to China and, in part, the relatively faster population growth in India than China.

Fourth, our estimates indicate that for the most recent period, 2015-20, there are about 2.8 million missing women in India and China combined; of which, the larger share of about 1.9 million comes from India. The difference between India and China in the total number of missing women was smaller in earlier years, for instance, 1.4 million in India versus 1 million in China during 1950-55, and almost the same number (1.74 million) in both countries during 1960-65. The gap has been growing since, which again reflects the faster decline in China's excess female mortality that is not overturned by its faster increase in the number of unborn girls.

4.3.4 Comparison with other estimates

How do our estimates of missing women in China and India compare with other related estimates in the literature? Tables 4.6 summarize estimates from other studies for China and India respectively together with our estimates for some common years. We offer several comments on these estimates.

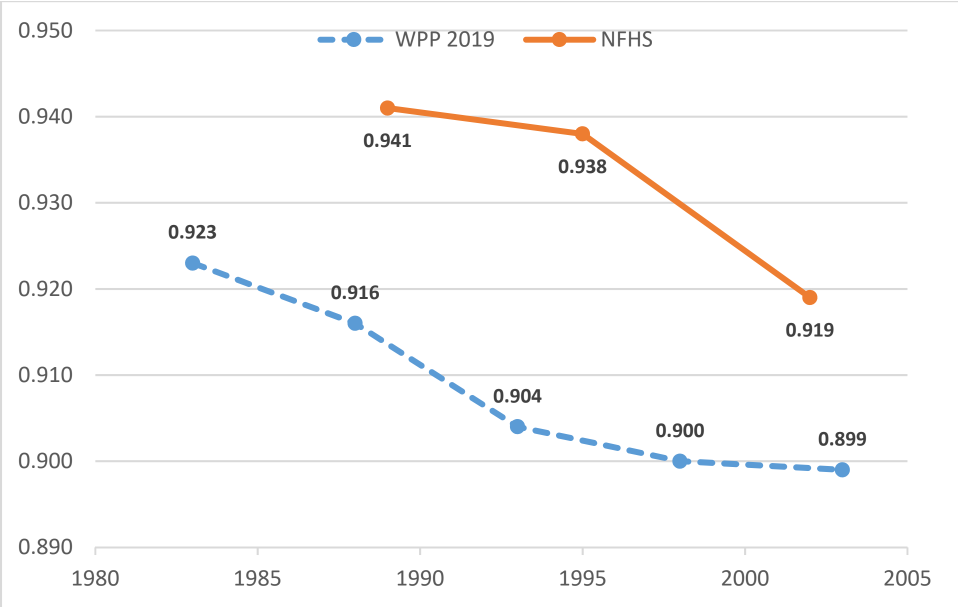
First, our estimates of missing women are higher than those by Bongaarts and Guilmoto (2015) for both China and India. This seems to be primarily due to their use of country-specific benchmarks conditional on life expectancy. As discussed above, controlling for life expectancy is likely to generate counterfactuals incorporating greater female disadvantage for countries with lower life expectancy, resulting in a potential underestimation of missing women.

Second, our estimates of missing women for China are broadly comparable to those by Anderson and Ray (2010) for 2000 despite their use of different data sources. However, their estimates for India are considerably lower than our estimates mainly due to their substantially lower estimates of missing girls at birth. The latter in turn is mainly because of their use of a significantly higher SRB of 931 female per 1000 male births, relative to 899 female per 1000 male births used in our estimates for 2000-05. Anderson and Ray (2010) use an average SRB estimated from the National Family and Health Surveys (NFHS) for India for 1992-93, 1998-99 and 2005-06. The NFHS-based estimates of SRB are higher than those from Sample Registration Surveys that are also used in WPP 2019. More importantly, both sources show a consistent pattern that the SRB becomes less favourable to girls over time; see Figure 4.5. However, since 1992-93 was the year of the first NFHS, we cannot use this source to develop a consistent time series of missing girls at birth over the 70-year period for which we thus rely on the WPP 2019 estimates. The WPP-based estimates of SRB are also arguably more comparable with China as they are based on a common methodology.

Table 4.6 Alternative estimates of missing women in China and India (millions per year)

China					
Our estimates	**1985-90**	**1990-95**	**1995-00**	**2000-05**	**2005-10**
Missing girls at birth	0.34	0.76	0.79	0.86	0.91
Excess female deaths	0.88	0.74	0.67	0.79	0.67
Total missing women	1.22	1.50	1.46	1.65	1.58
Bongaarts and Guilmoto (2015)	**1985-90**	**1990-95**	**1995-00**	**2000-05**	**2005-10**
Missing girls at birth	0.57	0.54	0.45	0.59	0.59
Excess female deaths	0.47	0.68	0.66	0.75	0.89
Total missing women	1.04	1.22	1.11	1.34	1.48
Anderson and Ray (2010)				**2000**	
Missing girls at birth				0.64	
Excess female deaths				1.09	
Total missing women				1.73	
World Bank (2012)		**1990**			**2008**
Missing girls at birth		0.89			1.09
Excess female deaths		0.58			0.16
Total missing women		1.47			1.25
India					
Our estimates	**1985-90**	**1990-95**	**1995-00**	**2000-05**	**2005-10**
Missing girls at birth	0.51	0.70	0.76	0.78	0.64
Excess female deaths	1.79	1.73	1.62	1.64	1.60
Total missing women	2.30	2.43	2.38	2.42	2.24
Bongaarts and Guilmoto (2015)	**1985-90**	**1990-95**	**1995-00**	**2000-05**	**2005-10**
Missing girls at birth	0.96	0.82	0.72	0.59	0.43
Excess female deaths	0.20	0.44	0.55	0.62	0.63
Total missing women	1.16	1.26	1.27	1.21	1.06
Anderson and Ray (2010)				**2000**	
Missing girls at birth				0.18	
Excess female deaths				1.53	
Total missing women				1.71	
World Bank (2012)		**1990**			**2008**
Missing girls at birth		0.27			0.26
Excess female deaths		0.99			0.60
Total missing women		1.26			0.86

Figure 4.5 Sex ratio at birth (female births per male birth) in India from alternative sources



Note: The WPP 2019 series shows 5-year averages for 1980-85, 1985-90, 1990-95, 1995-2000 and 2000-05. The NFHS series shows the sex ratio at birth for all children born in the 5 calendar years preceding NFHS-1, NFHS-2 and NFHS-3, and relate to the years 1987-91, 1993-97 and 2000-04.

Third, the estimates of missing women in World Bank (2012) for China for 1990 are similar to our estimates, but their estimate for China for 2008 is lower than ours. For India, their estimate for 1990 is about half our estimate and that for 2008 is less than two-fifths our estimate. Most of these differences are on account of lower numbers for excess female mortality after birth in the World Bank estimates. Some of this is due to the difference in data sources, but a large part of the difference is attributable to the World Bank estimates being limited to the number of missing women under age 60. However, our estimates of the age distribution of missing women (discussed below) indicates that missing women above age 60 are a large fraction of all missing women after birth: 48% and 54% in China for 1990-95 and 2005-10 respectively, and 25% and 41% in India for the same years.[29]

4.3.5 Key markers in the trends of missing women

A rigorous causal analysis of the observed long-term trends in missing women is beyond the scope of this study as such analysis is not feasible with the available aggregative data that we have used for estimating missing women. However, we seek to further understanding of the proximate influences on the observed time patterns of missing women by relating them to key episodic events and potential responses to changes in policy as well as technological options relevant to fertility choices. We also relate the trends in missing women to broader

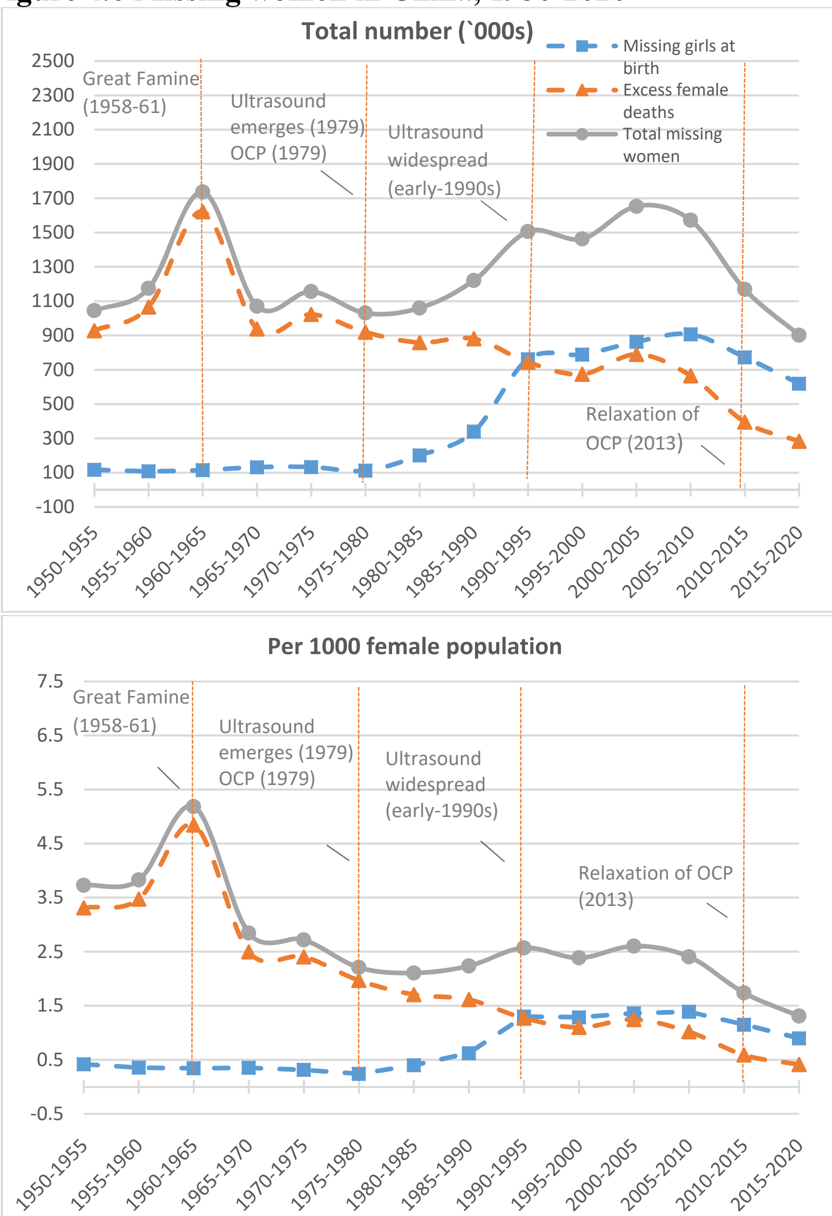
[29] See Tables in the Appendix.

improvements in living standards, including access to better healthcare and nutrition, that have been responsible for falling mortality rates, though at potentially different rates for males and females. The following two subsections explore these issues for China and India.

4.3.5a Trends in China

The top panel of Figure 4.6 plots missing women in China over the 7-decade period as well as its two components relating to missing girls at birth and excess female deaths. The bottom panel presents the same trends in relative terms as a proportion of the female population. The Figure also marks key events/ policy milestones for China over this period.

Figure 4.6 Missing women in China, 1950-2020



The time pattern of the total number (and proportion) of missing women is the combined result of the time patterns of excess female deaths and missing girls at birth, which we discuss below.

i) Excess female deaths

There are two notable features of the observed trend in excess female deaths for China. First, there is clear hump around the late 1950s and early 1960s that seems directly related to the Great Famine of 1958-61. While the exact mortality estimates due to the Great Famine remain debatable in the literature, there is little doubt that it caused a huge loss of lives with estimates ranging between 16 to 30 million (Dreze and Sen, 1989). More pertinently, there is evidence that "female children (beyond the neonatal period) suffered more than male children from the increased mortality in the years of the great famine" (p477, Coale and Banister, 1994). Similarly, Dasgupta and Li (1999) report that the male-to-female sex ratio of the Chinese population rose during the Great Famine years, noting that "…young girls at the time of the famine experienced the maximum excess mortality, so the peak excess [sex] ratios are in the cohorts born in 1954-8, a few years before the famine"(p628). The hump in missing women around the Great Famine years in our estimates is consistent with this evidence.

The second notable feature relating to the trajectory of China's excess female deaths in Figure 4.6 is the relatively steady declining trend since the 1970s. Over the decades since the 1970s, China made rapid strides in economic and social development. Table 4.7 presents a few select markers of this progress. For instance, per capita incomes have been roughly doubling every decade since 1980. The percentage of population in absolute poverty fell from 84 to 16 percent during 1981-2005. There were huge improvements in social indicators, such the infant mortality rate, the immunization rate and the prevalence of underweight children. There were also massive improvements in literacy with an almost complete closing of the gender gap by 2018 (the latest year for which these data are available). This economic and social progress has been an important factor in promoting better health and lower mortality rates for the Chinese population. However, the scale of this progress has been large enough to give it a universalistic character, with the result that process has proved to be more beneficial to women who had initially been lagging behind. Thus, for instance, at the end of the 1960s, there was still significant excess mortality for women, as documented in Table 4.3. The universalistic nature of the progress in human development since then was arguably instrumental in promoting a catch-up process that is reflected in the declining trend in missing women.

Table 4.7 Economic and social development in China

GDP per capita (constant 2010 US$)	**1970**	**1980**	**1990**	**2000**	**2010**	**2018**
	229	347	729	1768	4550	7753
Poverty headcount index ($1.25, %)		**1981**	**1993**		**2005**	
		84	54		16	
Infant mortality rate (per 1000 live births)	**1970**	**1980**	**1990**	**2000**	**2010**	**2018**
	80	48	42	30	14	7
Literacy rate (%)		**1982**	**1990**	**2000**	**2010**	**2018**
Female		51	68	87	92	95
Male		79	87	95	97	98
Immunization (DPT) (% of children 12-23 months)		**1983**	**1990**	**2000**	**2010**	**2018**
		58	97	85	99	99
Underweight children (% of children under 5)			**1987**	**2000**	**2010**	**2013**
			19	7	3	2
Total fertility (live births per woman)*	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**
	6.3	3.0	2.7	1.6	1.6	1.7

Note: * relates to the preceding 5-year period.
Source: World Development Indicators; Ravallion (2011); United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) (2019)

ii) Missing girls at birth

As noted earlier, missing girls at birth emerged as a significant phenomenon in China only around the early 1980s, with sharp increases in the shortfall of girls at birth over the following decades. The emergence and growth of female deficits at birth is directly related to sex-selective abortions for which there appear to have been two triggers, one at the policy level and the other technological. The latter came in the form of ultrasound technology, which allowed pre-natal sex determination. Although a few counties began to acquire ultrasound equipment as early as 1965, China manufactured its first ultrasound machine in 1979 (Zeng et al. 1993; Chen, Li and Meng, 2013). The availability of ultrasound machines grew rapidly thereafter. According to data assembled by Chen, Li and Meng (2013), the proportion of counties with ultrasound machines was under 10% in 1979, which rose to over 60% by 1985, and by 1990 all counties had ultrasound equipment.

The policy-level trigger came from the One Child Policy (OCP) introduced in 1979, which initially restricted couples to have only one child, though later allowed exceptions for some minority groups as well as relaxations for rural households in some provinces (Greenhalgh 1986; Gu et al. 2007).

There is already a significant body of research that links sex-selective abortions in China to the OCP and the availability of ultrasound technology.[30] The twin-triggers promoted prenatal sex selection in a number of ways. Access to ultrasound technology made foetal sex selection technically feasible, while the increasing affordability of this technology enhanced incentives for its use. At the same time, the implementation of OCP induced a "forced" fertility decline that accelerated the already ongoing processes of falling fertility. For instance, total fertility nearly halved from 3.0 in 1975-80 to 1.6 in 1995-2000 (Table 4.7). The decline in fertility, policy-induced or otherwise, can be a powerful influence on sex selection. If a couple plans to have only one child and also wants to have at least one son (perhaps due to sons perceived as important for old age security or for carrying the family name), the motivation for not leaving things to chance can be strong. Our estimates of the trends in missing girls at birth are consistent with these factors influencing the sex ratio at birth. Consistent with this line of reasoning, we also find that with the relaxation of the OCP since 2013 and its eventual abolition in January 2016, the number of missing girls at birth plateaus and starts to decline.

4.3.5b Trends in India

Figure 4.7 shows trends in missing women in India over the 70-year period, as absolute numbers in the top panel and as proportions of the female population in the bottom panel. As in the case of China above, we discuss these trends in terms of the potential factors influencing the two components relating to missing girls at birth and excess female deaths.

i) Excess female deaths

The most notable feature of the estimates of the number of excess female deaths in Figure 4.7 is the absence of a definite trend over the 70-year period. The absolute number at the beginning of the period (during 1950-55) was 1.44 million, while that at the end (during 2015-20) is 1.40 million. There was some increase in the intervening years up to 1985-90 which was followed by a decline in later years. This contrasts with the trend decline observed for China in the post-Great Famine years. The proximate reasons for the difference are likely to be found the relatively slower pace of economic and social development in India. Table 4.8 summarizes some key indicators for India. A quick comparison with corresponding indicators for China in Table 4.7 confirms that with respect to nearly all indicators, the progress in India is an order of magnitude slower than that in China. By the same token, economic and social progress in India has had less of a universalistic element than in China, and thus India has not

[30] See, for instance, Banister (2004), Dasgupta, Chung and Shuzhuo (2009), Zhu, Lu and Hesketh (2009), Ebenstein (2010), Li, Yi and Zhang (2011), Bongaarts (2013).

had an analogous catch-up process, whereby women have been able to significantly improve upon their initially disadvantaged position.

Figure 4.7 Missing women in India, 1950-2020

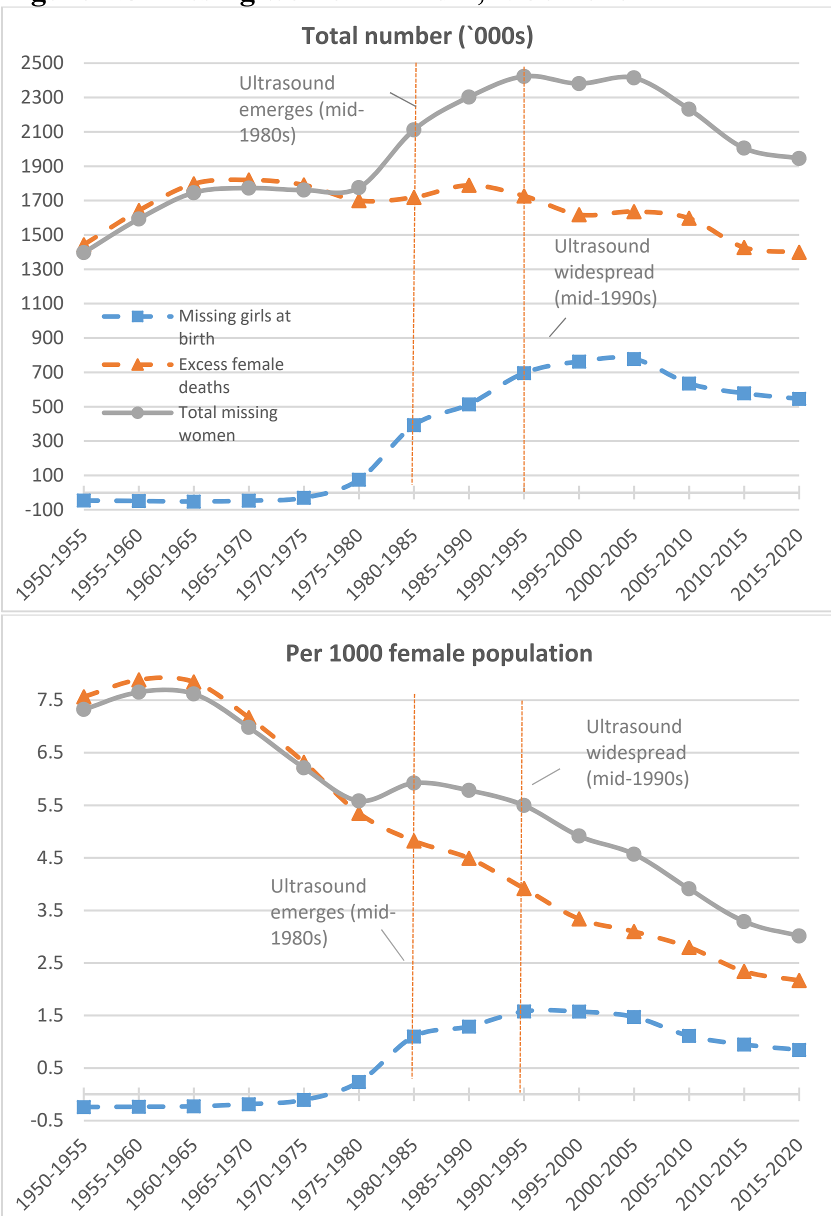


Table 4.8 Economic and social development in India

GDP per capita (constant 2010 US$)	1970	1980	1990	2000	2010	2018
	396	423	581	827	1358	2101
Poverty headcount index ($1.25, %)		**1981**	**1993**		**2005**	
		60	49		42	
Infant mortality rate (per 1000 live births)	**1970**	**1980**	**1990**	**2000**	**2010**	**2018**
	143	115	89	67	45	30
Literacy rate (%)		**1981**	**1991**	**2001**	**2011**	**2018**
Female		26	34	48	59	66
Male		55	62	73	79	82
Immunization (DPT) % of children 12-23 months)		**1983**	**1990**	**2000**	**2010**	**2018**
		14	70	58	79	89
Underweight children under 5 (%)			**1989**	**1999**	**2006**	**2014**
			56	46	44	29
Total fertility (live births per woman)*	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**
	5.7	5.0	4.3	3.5	2.8	2.2

Note: * relates to the preceding 5-year period.
Source: World Development Indicators; Ravallion (2011). United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) (2019), WPP (2019).

Nonetheless, there has been a decline in excess female deaths in relative terms as a proportion of the female population. This simply reflects the fact while the absolute number of excess female deaths has not changed much, female population has been growing over time with overall population growth that has been relatively high in India despite the moderation over the last two decades.[31]

ii) Missing girls at birth

Similar to China, missing girls at birth emerged as a significant phenomenon in India around the mid-1980s (Figure 4.7). There seem to be two main drivers for this. While there was no policy counterpart to China's OCP in India, the availability of ultrasound technology since the mid-1980s in India provided a technological trigger similar to China. For instance, the domestic production of ultrasound machines rose rapidly from an annual average of 1,314 in 1988-91 to 5,651 in 1992-95, to 11,290 in 1996-99, and to 19,581 in 2000-03 (George 2006). The number of imported ultrasound machines also increased more than six times over the same period (Mahal, Varshney and Taman 2006). The availability of ultrasound technology offered an easier and non-invasive means of sex determination relative to older alternatives such as

[31] The contrast with China is instructive here. For instance, while in 1970, India's female population was about 268 million as against 403 million for China, by 2015, at 629 million, it had nearly caught up with China's 684 million.

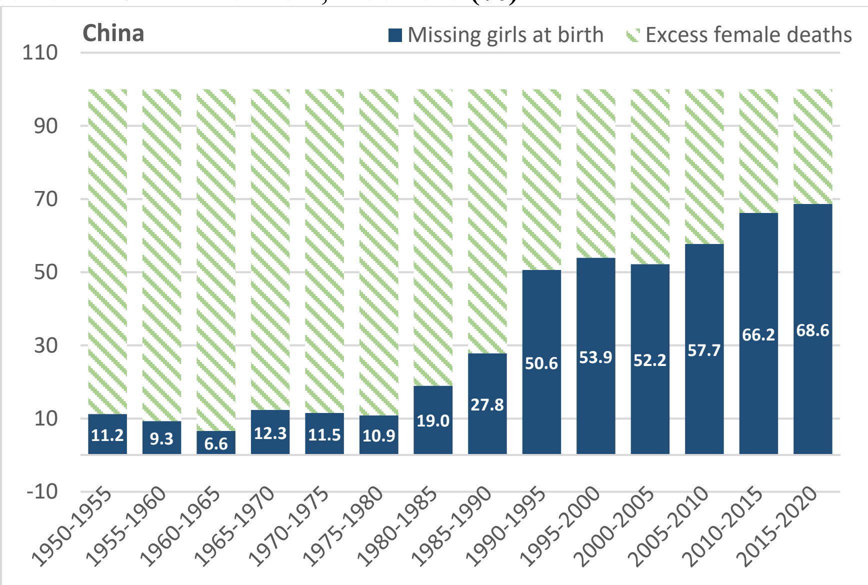
amniocentesis. The growth in our estimated number of missing girls at birth parallels the spread of ultrasound machines.

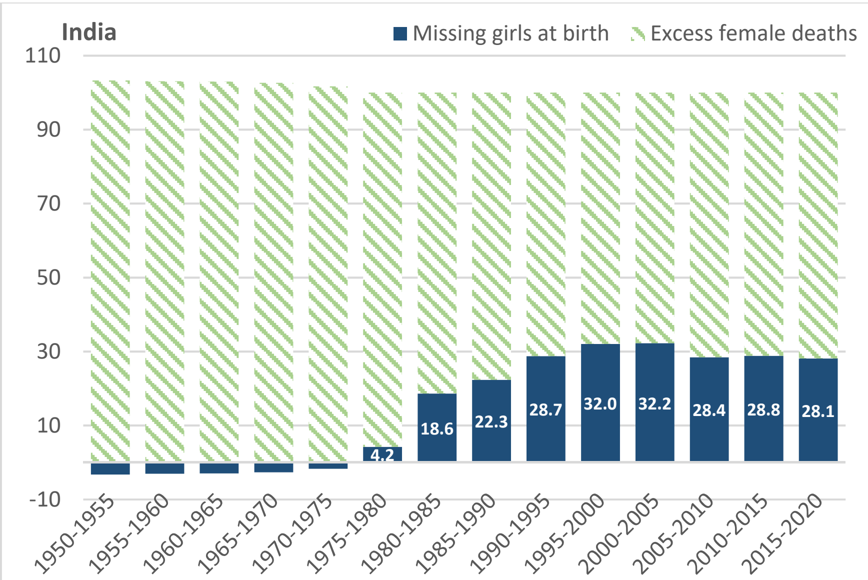
The decline in fertility in India also provided an impetus to sex selection for reasons similar to those in China. The total fertility rate more than halved over the four decades since 1980 (Table 4.8). As argued earlier for China, the decline in desired family size in the absence of any correction of the prevailing norms of son preference contributed to the growing phenomenon of sex-selective abortions. Estimates by Jayachandran (2017), for instance, suggest that falling fertility contributed between a third and a half of the worsening of the child sex ratio in India over the 30 years since 1981. Similarly, Jha et al. (2011) estimate sex-selective abortions in India during 1991-2011 based on comparisons of actual and expected child sex ratios in the 0-6 year age cohorts, which indicate an increasing trend in sex-selective abortions over this period consistent with the trends in Figure 4.7.

4.3.6 Age profile of missing women

We now turn to the implications of our estimates for the age profile of missing women in China and India and how it has been changing over the 70-year period. The most dramatic change is depicted in Figure 4.8 and relates the share of missing girls at birth in the total number of missing women. From being low or negligible up to about 1980, this share rose dramatically in both countries in subsequent decades. By 2015-20, our estimates suggest that missing girls at birth have come to account for more than a quarter of all missing women in India and a massive two-thirds of missing women in China. In section 4.3.5, we have already discussed the combination of factors that are likely to have driven this big shift from post- to pre-natal female deficits. The much bigger shift for China reflects the favourable role of the faster pace and wider reach of its economic and social development in mitigating excess female deaths on the one hand, as well as the unfavourable consequences of its One Child Policy for worsening sex ratio at birth on the other.

Figure 4.8 Shares of missing girls at birth and excess female deaths (all ages) in total missing women in China and India, 1950-2020 (%)

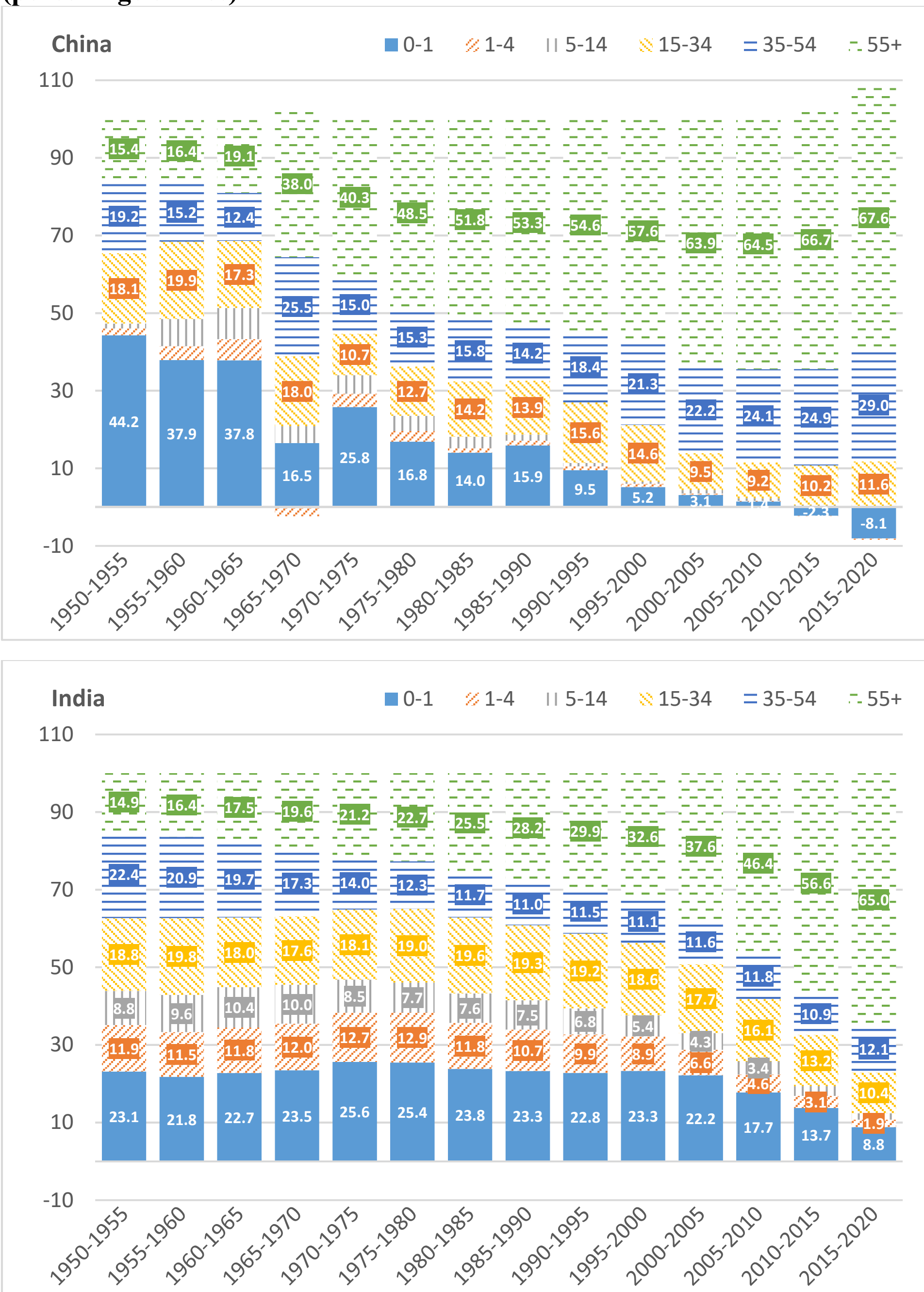




While the excess female deaths component of missing women has shrunk over time, its age composition has also been changing. Figure 4.9 summarizes these changes by broad age groups for China and India.[32]

[32] Detailed tables on the age composition of missing women for all 22 age groups are included in the Appendix.

Figure 4.9 Age distribution of excess female deaths in China and India, 1950-2020 (percentage shares)



The pattern of changes in the age composition of excess female deaths are similar for China and India in several respects. Specifically, the shares of younger age groups (0-1, 1-4, 5-14 years) in excess female deaths have declined in both countries. For both countries, there has been also a decline in the share of missing women in the reproductive ages of 15-34 years. Finally, there has been a huge increase in the share of the 55+ age group which alone now accounts for about two-thirds of all excess female deaths in both countries.

There are also two notable points of difference between China and India. First, excess deaths of girls up to age 14 have been virtually eliminated in China over the last decade, though in India despite their declining share they continue to account for upwards of 10% of excess female deaths. Second, India has witnessed a steady decline in the share of the 35-54 year age group in excess female deaths, while in the case of China their share has been rising since 1990. This age group now accounts for about 29% of all excess female deaths in China as against 12% in India.

It is obvious from our estimation methodology outlined in section 4.2 that there are two underlying forces driving the trends in the age composition of excess female deaths: changes in relative excess female mortality rates (the difference between actual and counterfactual female-to-male death rates) for different age groups and changes in the share of different age groups in the total female population. Table 4.9 presents the trend rates of change in these two parameters for China and India over the 70-year period.

Both countries have undergone a major demographic transition over this period. This is evident in the secular aging of their populations. While population shares in the younger age groups have declined (significant negative trends for the shares of 0-1, 1-4 and 5-14 years), those in the higher age groups have increased (significant positive trends for 35-54 and 55+ years).

However, the trends in relative excess female mortality by age groups have been different across China and India. The trends have been more favourable to women in China relative to India. Thus, for China, there are negative trends in relative excess female mortality across all age groups, of which those for 0-1, 5-14 and 15-34 years have also been statistically significant, potentially reflecting the large improvement in infant mortality and reproductive health for women. In India, however, significant improvements in relative excess mortality were limited to females in the 5-14 and 35-54 age groups, while there was no significant change for the 15-34 age groups and there was a worsening (positive) trend in relative excess mortality for the youngest (0-4) and the oldest (55+) age group. This reflects the relatively more limited progress in India in reducing female child mortality and mortality of mature-age women.

Table 4.9 Trends in excess female mortality by age and the age composition of female population, China and India, 1950-2020

Age group	Trends+: Relative excess female mortality $s(a)$-$s^*(a)$	Trends+: Share in total female population	1950-1955: Share in total female population (%)	2015-2020: Share in total female population (%)
	China			
0-1	-3.308***	-0.855***	7.0	2.3
	(0.765)	(0.113)		
1-4	-1.078	-1.116***	8.4	3.5
	(0.951)	(0.090)		
5-14	-1.826*	-1.163***	20.0	11.4
	(0.914)	(0.180)		
15-34	-2.432**	0.021	31.1	27.9
	(0.938)	(0.105)		
35-54	-0.551	0.564***	21.7	31.3
	(0.754)	(0.079)		
55+	-0.041	0.196***	11.9	23.6
	(0.280)	(0.028)		
	India			
0-1	1.414***	-0.609***	6.8	3.5
	(0.363)	(0.037)		
1-4	2.295*	-0.681***	8.7	5.2
	(1.083)	(0.073)		
5-14	-1.926*	-0.476***	23.0	18.3
	(1.109)	(0.104)		
15-34	-0.052	0.087**	34.0	34.4
	(1.810)	(0.033)		
35-54	-5.987***	0.234***	19.3	24.3
	(0.623)	(0.024)		
55+	2.022***	0.096***	8.2	14.4
	(0.368)	(0.013)		

Note: + Linear time trends. Estimated coefficients and standard errors (in parentheses) are scaled up by 1000. *** p<0.01, ** p<0.05, * p<0.1.

These diverse trends, together with the changing age composition of the population, propelled by demographic transition help us understand the observed trends in the age composition of missing women as shown in Figure 4.9. Thus, for instance, the falling shares of the younger age groups (0-34 years) amongst missing women in China is the joint outcome of improvements in women's relative mortality position as well as declining or stable (in case of the 15-34 age bracket) shares of these groups in the population, while the increasing shares of the higher age groups (35+ years) amongst missing women have been entirely on account of their rising shares in the total population. By comparison, for India, the shares of all groups except those above 55 in total excess female deaths have been declining. However, it is only for the 5-14 and 35-54 years age groups that the improvement in women's relative mortality position has contributed to this decline. For the other age groups below 55, the decline in their shares in excess female deaths has occurred despite a lack of improvement, or even a worsening, in women's relative mortality position. In contrast, the large increase in the share of the 55+ group in excess female deaths reflects both their rising share in the population and a relative worsening of their mortality position.

4.4 Discussion and conclusion

There has been some debate in the literature about how estimates of missing women should be interpreted. Since all estimates invoke counterfactual standards relating to sex ratios of the population, births or deaths against which actual values for a country are assessed, much of the debate has centred on whether the counterfactual standards represent environments devoid of discrimination against women. The (pragmatic) view taken in our study is (a) that it is sufficient to use a standard representing a distinctly lower degree of discrimination, although not necessarily one completely free of discrimination, and (b) that contemporaneous sex ratios of births and deaths in the more developed regions of the world offer such a sufficient standard. Our estimates of missing women, thus, have informational content as reasonable, though imperfect, measures of gender discrimination that are normatively significant.

From this perspective, our study on missing women in China and India makes four contributions. First, using a consistent methodology, it has sought to provide long-run estimates of missing women for the two most populous countries in the world that also account for most of the missing women globally. Second, the 70-year period covered by the study has helped sketch a historical time profile of missing women in the two countries from the 1950s up to the present. Third, the study has sought to provide estimates of the changing age composition of missing women over this period. Fourth, it has sought to enhance our understanding of the observed patterns of missing women by linking them to economic, social, technological and policy developments in the two countries. In all four respects, the study also offers a comparative perspective on China and India.

Our headline estimates indicate that China's annual missing women ranged between 0.9 million and 1.7 million during 1950-2020 with an average of 1.3 million per year, while missing women in India ranged between 1.4 million and 2.4 million annually with an average of 2 million per year. Of all missing women, missing girls at birth averaged 0.4 million per year in China (34% of total) and 0.3 million per year in India (17% of total).

The time profile of our estimates shows that while the number of missing women in India has been higher than that in China throughout the 70-year period, the gap has been growing since the mid-1960s. In both countries, missing girls at birth emerged as a significant phenomenon only around the mid-1980s. Thereafter, missing girls at birth grew faster in China than India, but China made more rapid progress in reducing excess female deaths. It is the growing gap in excess female mortality between India and China that accounts for the growing gap between their numbers of missing women.

Our findings on the age composition of missing women (including those missing at birth) document the rapid rise in the share of female birth deficits in total missing women in both countries since the mid-1980s. While the component of missing women relating to excess female deaths has correspondingly been shrinking over time, there is a significant shift from younger to older age groups amongst all excess female deaths. By our estimates, about two-thirds of all excess female deaths now relate to older women in the 55+ age group.

Our analysis also offers some insights into the driving forces behind the observed time patterns of the changing magnitudes of missing women in China and India. In relation to excess female deaths, the observed time patterns are consistent with excess mortality of women during the Great Famine of 1958-61 and the more universalistic improvement in social indicators in China relative to India. In relation to missing girls at birth, our estimated trends are consistent with the introduction and spread of sex-determination (ultrasound) technology in China and India, the timing and pace of fertility decline associated with demographic transition in both countries, and the introduction, relaxation and discontinuation of the One Child Policy in China.

While there is a reasonable case to be made for the role of the above set of factors in driving the estimated trends of missing women, our "aggregative" analysis is not a substitute for rigorous causal analysis of the mechanisms underlying these trends. That will require further research relying on more detailed micro data that can tease out the impacts of individual factors and policies.

There are indications that the magnitude of missing women is past its peak in both China and India even in absolute terms. In relative terms as a proportion of the female population, the magnitude has been on the decline over a longer period. There are grounds for being optimistic of further decline in the future as women's education, health and socioeconomic status continues to improve with future economic growth. But as the estimates of the rising numbers of missing girls at birth in China and India remind us, it does not follow that economic growth will automatically ensure fewer missing women. Hence, exercises using methods similar to our study will continue to have a useful role in monitoring future progress in this important indicator of gender equity.

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Appendix:

Age profile of missing women in China and India, 1950-2020

i) China

Year	Sex ratio at birth (Female birth per male birth)		Actual male births in China (`000s)	Actual female births in China (`000s)	Expected female births in China (`000s)	Missing girls at birth in China (`000s)
	More developed regions	China				
	A	B	C	D	E = A * C	F = E - D
1950-1955	0.943	0.935	13250	12383	12500	117
1955-1960	0.943	0.935	12393	11582	11692	109
1960-1965	0.943	0.935	13002	12151	12266	115
1965-1970	0.943	0.935	14946	13968	14100	132
1970-1975	0.943	0.935	15139	14149	14282	133
1975-1980	0.943	0.935	12730	11897	12009	112
1980-1985	0.952	0.935	11283	10545	10746	201
1985-1990	0.952	0.926	12861	11909	12249	340
1990-1995	0.952	0.893	12804	11432	12194	762
1995-2000	0.952	0.877	10499	9209	9999	789
2000-2005	0.952	0.862	9551	8234	9096	863
2005-2010	0.952	0.855	9283	7934	8841	907
2010-2015	0.952	0.870	9339	8121	8895	773
2015-2020	0.952	0.885	9180	8124	8743	619

1950-1955

Age	Age Specific death rate 1950-55 (deaths per 1000 population)				Expected female death rate in China 1950-55	Excess female mortality in China 1950-1955	Female population by age group in China 1950-1955 (000s')	Missing women in China 1950-1955		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								117	11.2	11.2
0-1	67.6	55.6	142.9	138.7	117.7	21.0	19 519	411	39.3	50.5
1-4	5.0	4.7	23.7	22.9	22.2	0.7	23 571	17	1.6	52.1
5-9	1.2	1.0	9.5	8.0	7.9	0.1	30 285	4	0.3	52.4
10-14	0.9	0.6	5.8	4.5	4.2	0.3	25 657	8	0.8	53.2
15-19	1.6	1.1	6.0	4.8	4.0	0.8	24 591	19	1.8	55.0
20-24	2.4	1.5	6.4	5.4	4.1	1.3	22 664	30	2.8	57.9
25-29	2.6	1.8	6.5	7.5	4.4	3.1	20 421	63	6.0	63.8
30-34	2.8	2.0	7.2	8.2	5.3	2.9	19 387	57	5.4	69.3
35-39	3.6	2.5	9.4	9.7	6.7	3.0	18 268	55	5.2	74.5
40-44	5.1	3.4	14.6	14.1	9.7	4.4	16 184	71	6.8	81.3
45-49	7.8	4.8	21.8	16.1	13.4	2.7	14 265	38	3.6	84.9
50-54	12.0	7.0	26.6	16.7	15.5	1.2	12 148	15	1.4	86.3
55-59	18.2	10.4	39.3	24.7	22.6	2.1	10 426	22	2.1	88.5
60-64	27.3	16.5	63.1	47.9	38.2	9.7	8 702	84	8.1	96.5
65-69	40.9	27.5	88.5	68.4	59.7	8.8	6 593	58	5.5	102.1
70-74	63.4	46.7	132.0	96.5	97.2	-0.8	4 281	-3	-0.3	101.8
75-79	98.6	77.4	204.6	158.4	160.7	-2.4	2 199	-5	-0.5	101.3
80-84	149.6	125.1	272.6	217.9	228.0	-10.1	861	-9	-0.8	100.4
85-89	219.9	195.1	330.6	273.5	293.4	-19.9	207	-4	-0.4	100.1
90-94	310.3	290.1	402.3	364.1	376.1	-12.0	33	0	0.0	100.0
95-99	417.4	407.2	475.2	432.5	463.5	-31.1	4	0	0.0	100.0
100+	539.1	542.4	532.5	504.9	535.7	-30.8	0	0	0.0	100.0
							280 268	**1045**	**100.0**	

1955-1960

Age	Age Specific death rate 1955-1960 (deaths per 1000 population)				Expected female death rate in China 1955-1960	Excess female mortality in China 1955-1960	Female population by age group in China 1955-1960 (000s')	Missing women in China 1955-1960		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								109	9.3	9.3
0-1	48.9	39.9	146.7	140.0	119.6	20.5	19 753	404	34.4	43.7
1-4	2.7	2.5	22.5	21.9	20.6	1.3	29 018	38	3.2	46.9
5-9	0.9	0.7	7.6	7.0	5.8	1.2	40 096	47	4.0	50.9
10-14	0.7	0.4	5.0	4.1	3.1	0.9	29 401	27	2.3	53.3
15-19	1.3	0.7	5.5	4.3	3.0	1.3	25 096	33	2.8	56.0
20-24	1.9	1.0	6.1	4.8	3.2	1.7	24 001	40	3.4	59.4
25-29	2.2	1.2	6.4	6.8	3.6	3.2	21 974	71	6.0	65.4
30-34	2.5	1.5	7.2	8.0	4.5	3.5	19 645	69	5.9	71.3
35-39	3.0	2.0	9.2	9.6	6.1	3.5	18 546	65	5.6	76.9
40-44	4.4	2.8	13.5	11.5	8.7	2.8	17 271	49	4.2	81.1
45-49	6.8	4.1	19.4	13.3	11.6	1.7	15 103	26	2.2	83.3
50-54	11.0	6.1	28.4	17.3	15.6	1.7	13 192	22	1.9	85.1
55-59	17.4	9.2	44.4	26.4	23.6	2.9	10 957	32	2.7	87.8
60-64	26.8	14.9	65.8	45.9	36.4	9.5	8 737	83	7.0	94.9
65-69	40.3	25.1	93.0	70.0	57.9	12.1	6 514	79	6.7	101.6
70-74	62.2	43.0	148.5	102.5	102.8	-0.2	4 353	-1	-0.1	101.5
75-79	96.5	72.4	237.2	175.1	177.8	-2.7	2 235	-6	-0.5	101.0
80-84	146.4	118.8	344.3	271.1	279.3	-8.2	788	-6	-0.6	100.4
85-89	215.2	187.9	431.9	358.3	377.1	-18.9	211	-4	-0.3	100.1
90-94	304.0	283.1	521.6	458.2	485.8	-27.6	34	-1	-0.1	100.0
95-99	409.8	401.8	628.0	534.1	615.8	-81.7	4	0	0.0	100.0
100+	530.9	540.0	723.1	645.0	735.4	-90.4	0	0	0.0	100.0
							306 928	**1175**	**100.0**	

1960-1965

Age	Age Specific death rate 1960-1965 (deaths per 1000 population)				Expected female death rate in China 1960-1965	Excess female mortality in China 1960-1965	Female population by age group in China 1960-1965 (000s')	Missing women in China 1960-1965		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								115	6.6	6.6
0-1	37.5	29.7	149.1	147.4	118.0	29.4	20 893	613	35.3	41.9
1-4	1.7	1.4	23.1	22.9	19.9	2.9	30 067	88	5.1	47.0
5-9	0.7	0.5	7.5	7.2	5.4	1.9	45 404	85	4.9	51.9
10-14	0.6	0.4	5.0	4.0	2.9	1.2	38 982	45	2.6	54.5
15-19	1.2	0.5	5.3	4.4	2.5	1.9	28 773	54	3.1	57.6
20-24	1.7	0.8	5.4	4.9	2.4	2.5	24 483	61	3.5	61.1
25-29	2.0	1.0	5.7	6.3	2.8	3.4	23 283	80	4.6	65.7
30-34	2.3	1.3	7.0	7.8	3.7	4.0	21 158	86	4.9	70.6
35-39	3.0	1.7	9.0	9.4	5.2	4.2	18 785	79	4.6	75.2
40-44	4.2	2.5	13.1	11.3	7.9	3.4	17 586	59	3.4	78.6
45-49	6.5	3.8	18.8	12.9	10.9	2.0	16 241	33	1.9	80.5
50-54	10.3	5.5	28.2	17.2	15.1	2.1	14 012	29	1.7	82.2
55-59	16.7	8.4	43.9	26.3	22.2	4.1	11 856	49	2.8	85.0
60-64	26.5	13.8	63.4	43.9	33.0	10.9	9 201	101	5.8	90.8
65-69	39.9	23.2	89.3	67.8	51.8	15.9	6 589	105	6.1	96.9
70-74	61.3	40.1	140.2	98.6	91.7	6.8	4 288	29	1.7	98.5
75-79	95.0	68.3	193.7	148.3	139.3	9.0	2 290	21	1.2	99.7
80-84	144.0	113.5	274.3	221.7	216.4	5.3	811	4	0.2	100.0
85-89	211.5	181.9	330.0	284.8	283.8	1.0	189	0	0.0	100.0
90-94	298.9	277.2	402.2	383.3	373.0	10.4	33	0	0.0	100.0
95-99	403.3	397.1	483.5	464.7	476.1	-11.4	3	0	0.0	100.0
100+	523.8	537.7	556.7	550.4	571.4	-21.1	0	0	0.0	100.0
							334 926	**1737**		

1965-1970

Age	Age Specific death rate 1965-1970 (deaths per 1000 population)				Expected female death rate in China 1965-1970	Excess female mortality in China 1965-1970	Female population by age group in China 1965-1970 (000s')	Missing women in China 1965-1970		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								132	12.3	12.3
0-1	29.9	23.5	108.8	91.2	85.4	5.8	26 653	155	14.5	26.8
1-4	1.3	1.1	15.8	12.5	13.2	-0.7	33 765	-22	-2.1	24.7
5-9	0.6	0.4	3.0	2.5	2.1	0.4	48 249	20	1.9	26.6
10-14	0.6	0.3	1.7	1.4	1.0	0.5	44 542	21	2.0	28.5
15-19	1.2	0.5	2.4	2.1	1.0	1.1	38 381	40	3.8	32.3
20-24	1.7	0.7	2.8	2.6	1.1	1.5	28 218	41	3.8	36.1
25-29	1.9	0.8	3.6	3.3	1.5	1.7	23 918	41	3.9	40.0
30-34	2.4	1.1	4.4	4.1	2.0	2.1	22 630	46	4.3	44.4
35-39	3.2	1.6	5.6	5.3	2.8	2.6	20 440	53	4.9	49.3
40-44	4.5	2.4	7.7	6.9	4.1	2.8	18 012	50	4.7	53.9
45-49	6.6	3.6	10.4	9.3	5.7	3.6	16 717	60	5.6	59.5
50-54	10.3	5.4	14.8	12.8	7.7	5.0	15 223	77	7.2	66.7
55-59	16.5	8.1	23.3	18.0	11.5	6.6	12 787	84	7.9	74.6
60-64	26.3	13.0	39.5	27.1	19.6	7.6	10 288	78	7.3	81.8
65-69	40.6	22.1	58.9	40.7	32.0	8.7	7 367	64	6.0	87.8
70-74	62.0	38.1	84.2	60.5	51.8	8.7	4 737	41	3.9	91.7
75-79	94.9	64.9	125.0	108.5	85.5	23.0	2 575	59	5.5	97.2
80-84	142.4	108.0	181.2	161.7	137.4	24.2	1 033	25	2.3	99.5
85-89	207.4	173.5	258.4	234.4	216.1	18.3	263	5	0.4	100.0
90-94	291.4	265.5	361.1	335.8	329.1	6.7	41	0	0.0	100.0
95-99	392.0	382.7	460.4	415.2	449.5	-34.3	4	0	0.0	100.0
100+	509.6	522.5	574.0	484.4	588.6	-104.2	0	0	0.0	100.0
							375 843	**1070**		

1970-1975

Age	Age Specific death rate 1970-1975 (deaths per 1000 population)				Expected female death rate in China 1970-1975	Excess female mortality in China 1970-1975	Female population by age group in China 1970-1975 (000s')	Missing women in China 1970-1975		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								133	11.5	11.5
0-1	24.4	19.0	79.6	72.3	61.9	10.4	25 356	264	22.8	34.4
1-4	1.1	0.9	7.9	7.4	6.5	0.9	38 904	35	3.0	37.4
5-9	0.5	0.4	2.4	2.2	1.7	0.5	58 636	31	2.7	40.1
10-14	0.6	0.3	1.2	1.0	0.7	0.4	47 815	18	1.5	41.6
15-19	1.2	0.5	1.1	1.0	0.4	0.6	44 216	25	2.1	43.7
20-24	1.8	0.6	1.5	1.3	0.5	0.8	38 006	31	2.7	46.4
25-29	1.8	0.7	1.7	1.6	0.7	1.0	27 868	27	2.3	48.7
30-34	2.3	1.0	2.2	2.1	1.0	1.2	23 556	27	2.4	51.1
35-39	3.2	1.5	3.0	2.9	1.4	1.5	22 205	34	3.0	54.0
40-44	4.7	2.2	4.3	4.1	2.1	2.1	19 942	42	3.6	57.6
45-49	6.9	3.4	7.3	5.7	3.7	2.0	17 433	35	3.0	60.6
50-54	10.2	5.2	12.0	8.8	6.1	2.7	15 976	43	3.7	64.3
55-59	15.9	7.8	19.6	14.1	9.6	4.5	14 247	63	5.5	69.8
60-64	25.0	12.2	33.1	22.6	16.2	6.4	11 560	74	6.4	76.2
65-69	39.1	20.6	49.4	35.4	26.0	9.5	8 809	83	7.2	83.5
70-74	60.5	35.8	75.2	57.2	44.5	12.7	5 811	74	6.4	89.8
75-79	92.9	61.2	117.0	98.5	77.0	21.5	3 187	69	5.9	95.8
80-84	139.7	102.1	172.3	154.0	126.0	28.0	1 345	38	3.3	99.0
85-89	204.1	165.0	251.2	229.0	203.0	26.1	394	10	0.9	99.9
90-94	287.6	254.1	347.4	327.3	307.0	20.3	65	1	0.1	100.0
95-99	388.1	369.1	462.1	404.6	439.4	-34.7	6	0	0.0	100.0
100+	506.2	508.8	566.7	481.7	569.6	-88.0	1	0	0.0	100.0
							425 338	**1156**		

1975-1980

Age	Age Specific death rate 1975-1980 (deaths per 1000 population)				Expected female death rate in China 1975-1980	Excess female mortality in China 1975-1980	Female population by age group in China 1975-1980 (000s')	Missing women in China 1975-1980		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								112	10.9	10.9
0-1	20.9	16.2	60.4	54.4	46.8	7.6	20 280	155	15.0	25.9
1-4	1.0	0.8	5.0	4.8	4.1	0.7	35 080	25	2.5	28.4
5-9	0.5	0.3	1.9	1.6	1.3	0.4	63 003	22	2.2	30.5
10-14	0.5	0.3	0.9	0.7	0.5	0.2	58 222	14	1.3	31.9
15-19	1.2	0.4	1.0	0.9	0.4	0.5	47 576	25	2.4	34.2
20-24	1.8	0.6	1.1	1.1	0.3	0.7	43 940	32	3.1	37.3
25-29	1.9	0.7	1.5	1.4	0.5	0.9	37 700	34	3.3	40.6
30-34	2.1	0.9	1.8	1.7	0.7	1.0	27 595	26	2.6	43.2
35-39	3.1	1.3	2.3	2.2	1.0	1.2	23 274	28	2.7	45.9
40-44	4.7	2.0	3.3	2.9	1.5	1.5	21 857	32	3.1	49.0
45-49	7.0	3.2	5.2	4.1	2.4	1.8	19 522	35	3.4	52.4
50-54	10.4	4.9	9.1	7.0	4.3	2.7	16 890	45	4.4	56.8
55-59	15.2	7.4	14.5	10.5	7.0	3.5	15 199	54	5.2	62.0
60-64	23.5	11.4	25.5	18.5	12.4	6.1	13 144	80	7.8	69.8
65-69	36.9	18.8	41.6	29.8	21.3	8.5	10 146	87	8.4	78.2
70-74	57.3	32.8	68.7	54.4	39.3	15.2	7 099	108	10.4	88.6
75-79	88.3	56.1	112.7	89.0	71.6	17.4	4 026	70	6.8	95.4
80-84	133.4	94.2	181.2	146.9	128.0	19.0	1 745	33	3.2	98.6
85-89	195.9	153.1	256.1	222.3	200.2	22.1	530	12	1.1	99.8
90-94	277.5	237.9	342.1	320.8	293.3	27.4	100	3	0.3	100.0
95-99	376.6	349.1	453.2	396.6	420.1	-23.5	10	0	0.0	100.0
100+	494.8	488.0	562.9	476.9	555.2	-78.3	1	0	0.0	100.0
							466 940	**1031**		

1980-1985

Age	Age Specific death rate 1980-1985 (deaths per 1000 population)				Expected female death rate in China 1980-1985	Excess female mortality in China 1980-1985	Female population by age group in China 1980-1985 (000s')	Missing women in China 1980-1985		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								201	19.0	19.0
0-1	17.3	13.4	48.8	43.8	37.7	6.0	20 026	120	11.4	30.3
1-4	0.9	0.7	3.4	3.1	2.8	0.3	29 903	10	0.9	31.2
5-9	0.4	0.3	1.4	1.2	1.0	0.2	54 632	14	1.3	32.5
10-14	0.4	0.2	0.7	0.6	0.4	0.2	62 676	12	1.1	33.7
15-19	1.0	0.4	0.9	0.8	0.3	0.4	58 006	26	2.4	36.1
20-24	1.7	0.5	1.0	1.0	0.3	0.6	47 350	30	2.8	38.9
25-29	1.9	0.6	1.3	1.2	0.4	0.8	43 678	34	3.2	42.1
30-34	2.2	0.8	1.6	1.5	0.6	0.9	37 422	33	3.1	45.2
35-39	2.7	1.2	2.1	1.9	0.9	1.0	27 344	26	2.5	47.7
40-44	4.4	1.9	3.1	2.6	1.3	1.2	22 998	28	2.7	50.3
45-49	6.8	3.0	4.7	3.7	2.0	1.6	21 503	35	3.3	53.7
50-54	10.4	4.6	8.2	6.1	3.6	2.4	19 029	46	4.4	58.0
55-59	15.4	7.1	13.2	9.3	6.1	3.2	16 220	52	4.9	63.0
60-64	22.3	10.9	23.2	16.4	11.4	5.1	14 217	72	6.8	69.8
65-69	34.3	17.8	37.0	25.9	19.1	6.8	11 765	79	7.5	77.3
70-74	54.0	30.8	65.7	48.3	37.5	10.8	8 372	91	8.5	85.8
75-79	84.1	52.8	106.3	83.5	66.7	16.8	5 063	85	8.0	93.8
80-84	128.5	88.8	173.8	137.6	120.2	17.4	2 296	40	3.8	97.6
85-89	190.7	145.0	245.9	215.5	186.9	28.5	714	20	1.9	99.5
90-94	272.9	226.7	328.4	308.8	272.8	36.1	140	5	0.5	100.0
95-99	373.4	334.9	441.0	391.1	395.5	-4.4	17	0	0.0	100.0
100+	493.9	472.9	554.6	471.2	531.0	-59.8	1	0	0.0	100.0
							503 372	**1060**		

1985-1990

Age	Age Specific death rate 1985-1990 (deaths per 1000 population)				Expected female death rate in China 1985-1990	Excess female mortality in China 1985-1990	Female population by age group in China 1985-1990 (000s')	Missing women in China 1985-1990		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								340	27.9	27.9
0-1	14.8	11.5	46.2	41.3	35.7	5.6	25 040	140	11.4	39.3
1-4	0.7	0.6	3.1	2.8	2.5	0.3	31 931	11	0.9	40.2
5-9	0.4	0.2	1.2	0.9	0.8	0.1	49 431	6	0.5	40.7
10-14	0.4	0.2	0.7	0.5	0.4	0.1	54 409	8	0.6	41.3
15-19	0.9	0.4	0.8	0.7	0.3	0.4	62 464	25	2.0	43.4
20-24	1.4	0.5	1.0	0.9	0.3	0.6	57 741	32	2.6	46.0
25-29	1.7	0.6	1.2	1.1	0.4	0.7	47 086	32	2.6	48.6
30-34	2.0	0.8	1.5	1.3	0.6	0.8	43 386	34	2.8	51.4
35-39	2.6	1.1	2.0	1.6	0.8	0.8	37 120	30	2.5	53.9
40-44	3.6	1.6	2.9	2.2	1.3	0.9	27 059	24	1.9	55.8
45-49	5.8	2.7	4.1	3.2	1.9	1.3	22 667	31	2.5	58.3
50-54	9.2	4.2	7.1	5.1	3.2	1.9	21 029	40	3.3	61.6
55-59	14.3	6.5	11.5	8.0	5.2	2.7	18 375	50	4.1	65.7
60-64	21.6	10.4	21.2	15.3	10.3	5.1	15 280	77	6.3	72.0
65-69	31.5	16.5	33.0	24.7	17.2	7.5	12 852	96	7.8	79.8
70-74	49.5	28.4	59.1	45.5	33.9	11.5	9 877	114	9.3	89.2
75-79	78.1	49.1	104.8	76.7	65.9	10.7	6 132	66	5.4	94.6
80-84	120.9	83.4	165.6	128.0	114.2	13.8	3 001	41	3.4	98.0
85-89	181.8	137.3	240.7	202.5	181.9	20.6	987	20	1.7	99.6
90-94	263.3	216.8	319.0	285.7	262.7	23.0	201	5	0.4	100.0
95-99	364.3	323.6	430.4	376.0	382.3	-6.3	25	0	0.0	100.0
100+	486.7	462.0	539.2	462.7	511.8	-49.0	2	0	0.0	100.0
							546 097	**1221**		

1990-1995

Age	Age Specific death rate 1990-1995 (deaths per 1000 population)				Expected female death rate in China 1990-1995	Excess female mortality in China 1990-1995	Female population by age group in China 1990-1995 (000s')	Missing women in China 1990-1995		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								762	50.6	50.6
0-1	11.9	9.3	45.9	39.4	35.7	3.6	19 446	71	4.7	55.3
1-4	0.6	0.5	2.7	2.4	2.2	0.2	35 780	7	0.5	55.8
5-9	0.3	0.2	1.0	0.7	0.7	0.0	56 485	2	0.1	55.9
10-14	0.4	0.2	0.6	0.4	0.3	0.1	49 268	5	0.3	56.2
15-19	1.0	0.4	0.8	0.7	0.3	0.3	54 230	19	1.2	57.5
20-24	1.6	0.5	1.0	0.8	0.3	0.5	62 177	31	2.0	59.5
25-29	1.9	0.6	1.3	1.0	0.4	0.6	57 427	34	2.3	61.8
30-34	2.4	0.8	1.5	1.2	0.5	0.7	46 786	32	2.1	63.9
35-39	3.3	1.2	2.0	1.5	0.7	0.7	43 063	32	2.1	66.1
40-44	4.5	1.8	2.9	2.0	1.2	0.9	36 770	33	2.2	68.3
45-49	6.0	2.6	4.0	3.1	1.7	1.3	26 702	35	2.3	70.6
50-54	9.4	4.1	7.4	4.9	3.2	1.7	22 212	37	2.5	73.0
55-59	14.5	6.4	12.0	7.8	5.3	2.5	20 374	50	3.3	76.4
60-64	21.7	10.1	21.1	14.4	9.8	4.5	17 387	79	5.2	81.6
65-69	31.2	16.1	36.0	23.6	18.5	5.1	13 885	71	4.7	86.4
70-74	47.1	26.9	63.7	43.4	36.4	7.0	10 877	77	5.1	91.5
75-79	74.0	46.5	100.4	69.6	63.1	6.6	7 398	49	3.2	94.7
80-84	114.0	78.8	150.8	119.9	104.3	15.6	3 785	59	3.9	98.6
85-89	171.0	130.1	231.2	191.2	175.8	15.4	1 358	21	1.4	100.0
90-94	247.8	206.0	325.3	274.1	270.4	3.7	300	1	0.1	100.1
95-99	344.0	309.2	425.6	364.4	382.4	-18.0	40	-1	0.0	100.0
100+	463.7	445.8	540.1	440.8	519.3	-78.5	3	0	0.0	100.0
							585 754	**1506**		

1995-2000

Age	Age Specific death rate 1995-2000 (deaths per 1000 population)				Expected female death rate in China 1995-2000	Excess female mortality in China 1995-2000	Female population by age group in China 1995-2000 (000s')	Missing women in China 1990-1995		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								789	53.9	53.9
0-1	9.7	7.7	38.8	33.0	30.8	2.2	15 707	35	2.4	56.3
1-4	0.5	0.4	2.3	2.1	1.9	0.2	28 768	6	0.4	56.7
5-9	0.3	0.2	0.8	0.6	0.5	0.0	54 830	1	0.1	56.8
10-14	0.4	0.2	0.5	0.4	0.3	0.0	56 335	3	0.2	57.0
15-19	1.0	0.4	0.8	0.6	0.3	0.3	49 120	14	1.0	57.9
20-24	1.6	0.5	1.0	0.7	0.3	0.4	53 993	22	1.5	59.5
25-29	1.8	0.6	1.2	0.9	0.4	0.5	61 867	31	2.1	61.6
30-34	2.2	0.8	1.5	1.0	0.5	0.5	57 099	31	2.1	63.7
35-39	3.1	1.2	1.8	1.3	0.7	0.7	46 472	31	2.1	65.8
40-44	4.6	1.8	2.6	1.9	1.0	0.8	42 694	35	2.4	68.2
45-49	6.4	2.7	3.8	2.8	1.6	1.2	36 323	42	2.9	71.1
50-54	8.6	3.9	7.0	4.5	3.1	1.3	26 202	35	2.4	73.5
55-59	13.5	6.2	11.4	7.2	5.2	2.0	21 556	44	3.0	76.5
60-64	20.6	9.6	19.1	13.4	8.9	4.5	19 338	87	6.0	82.4
65-69	29.8	15.2	34.4	21.5	17.6	3.9	15 901	62	4.2	86.7
70-74	45.0	25.6	61.5	40.1	35.1	5.0	11 876	60	4.1	90.7
75-79	70.4	44.4	99.6	68.0	62.7	5.3	8 289	44	3.0	93.7
80-84	108.4	75.5	145.2	113.8	101.2	12.6	4 697	59	4.0	97.8
85-89	162.7	125.1	213.9	183.2	164.5	18.7	1 785	33	2.3	100.0
90-94	236.4	199.2	301.6	254.9	254.2	0.7	439	0	0.0	100.1
95-99	329.4	300.7	394.8	352.0	360.4	-8.4	63	-1	0.0	100.0
100+	447.4	437.0	508.8	429.3	497.0	-67.7	6	0	0.0	100.0
							613 361	**1463**		

2000-2005

Age	Age Specific death rate 2000-2005 (deaths per 1000 population)				Expected female death rate in China 2000-2005	Excess female mortality in China 2000-2005	Female population by age group in China 2000-2005 (000s')	Missing women in China 2000-2005		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								863	52.2	52.2
0-1	8.2	6.5	30.0	25.3	23.8	1.5	16 556	25	1.5	53.7
1-4	0.4	0.3	1.5	1.3	1.2	0.1	23 491	3	0.2	53.8
5-9	0.2	0.2	0.6	0.5	0.4	0.0	44 218	2	0.1	54.0
10-14	0.3	0.2	0.4	0.3	0.2	0.1	54 698	5	0.3	54.3
15-19	0.9	0.3	0.6	0.5	0.2	0.2	56 162	13	0.8	55.1
20-24	1.5	0.5	0.8	0.6	0.3	0.3	48 875	16	1.0	56.0
25-29	1.8	0.6	1.1	0.8	0.3	0.4	53 691	22	1.3	57.3
30-34	2.1	0.7	1.4	0.9	0.5	0.4	61 516	25	1.5	58.8
35-39	2.9	1.1	1.9	1.2	0.7	0.5	56 734	29	1.7	60.6
40-44	4.5	1.8	2.5	1.7	1.0	0.8	46 090	35	2.1	62.6
45-49	6.8	2.8	3.3	2.6	1.3	1.2	42 207	51	3.1	65.7
50-54	9.3	4.1	5.5	4.2	2.4	1.7	35 695	62	3.7	69.5
55-59	12.1	5.7	9.1	6.7	4.3	2.4	25 483	61	3.7	73.1
60-64	18.6	9.0	16.9	12.4	8.2	4.2	20 535	87	5.3	78.4
65-69	27.3	14.0	30.0	20.9	15.4	5.5	17 790	97	5.9	84.3
70-74	41.3	23.7	56.2	39.0	32.2	6.7	13 723	92	5.6	89.9
75-79	64.8	41.1	95.7	66.0	60.7	5.4	9 144	49	3.0	92.8
80-84	100.1	70.2	137.9	113.7	96.7	17.1	5 320	91	5.5	98.3
85-89	151.0	116.8	211.0	176.2	163.2	13.1	2 272	30	1.8	100.1
90-94	220.8	187.2	299.1	252.6	253.6	-1.0	606	-1	0.0	100.1
95-99	310.2	284.9	395.4	357.2	363.2	-6.0	97	-1	0.0	100.0
100+	426.8	419.8	520.8	425.8	512.2	-86.4	9	-1	0.0	100.0
							634 914	**1653**		

2005-2010

Age	Age Specific death rate 2005-2010 (deaths per 1000 population)				Expected female death rate in China 2005-2010	Excess female mortality in China 2005-2010	Female population by age group in China 2005-2010 (000s')	Missing women in China 2005-2010		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								907	57.7	57.7
0-1	6.8	5.5	19.9	16.7	16.0	0.6	15 463	10	0.6	58.3
1-4	0.3	0.3	0.8	0.7	0.7	0.0	23 365	1	0.1	58.4
5-9	0.2	0.1	0.5	0.4	0.4	0.0	39 875	2	0.1	58.5
10-14	0.2	0.1	0.4	0.3	0.2	0.1	44 112	3	0.2	58.7
15-19	0.7	0.3	0.6	0.4	0.2	0.2	54 498	9	0.6	59.3
20-24	1.4	0.4	0.7	0.5	0.2	0.3	55 847	17	1.1	60.3
25-29	1.8	0.6	1.0	0.7	0.3	0.3	48 553	16	1.0	61.3
30-34	2.1	0.8	1.4	0.9	0.5	0.4	53 349	19	1.2	62.5
35-39	2.6	1.0	1.7	1.1	0.7	0.4	61 115	25	1.6	64.1
40-44	3.7	1.6	2.3	1.6	1.0	0.6	56 278	35	2.2	66.4
45-49	5.8	2.5	3.2	2.4	1.4	1.0	45 584	43	2.8	69.1
50-54	8.7	3.8	5.2	3.7	2.3	1.4	41 530	57	3.6	72.7
55-59	11.9	5.5	8.7	5.9	4.0	1.9	34 802	67	4.2	77.0
60-64	15.7	7.7	16.2	11.1	7.9	3.1	24 382	77	4.9	81.8
65-69	23.2	12.3	29.1	19.5	15.3	4.1	18 995	78	5.0	86.8
70-74	36.1	20.9	54.8	37.0	31.8	5.1	15 446	79	5.1	91.9
75-79	57.7	36.6	93.9	62.6	59.6	3.0	10 676	32	2.0	93.9
80-84	90.8	63.2	133.0	104.8	92.6	12.2	5 973	73	4.6	98.5
85-89	139.7	106.5	204.6	167.1	156.1	11.0	2 654	29	1.9	100.4
90-94	208.1	173.1	294.1	239.5	244.6	-5.1	804	-4	-0.3	100.1
95-99	297.6	267.4	389.1	348.1	349.5	-1.5	137	0	0.0	100.1
100+	417.0	401.8	501.5	395.8	483.2	-87.4	15	-1	-0.1	100.0
							653 453	**1572**		

2010-2015

Age	Age Specific death rate 2010-2015 (deaths per 1000 population)				Expected female death rate in China 2010-2015	Excess female mortality in China 2010-2015	Female population by age group in China 2010-2015 (000s')	Missing women in China 2010-2015		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								773	66.2	66.2
0-1	5.7	4.6	13.9	10.7	11.2	-0.6	16 144	-9	-0.8	65.4
1-4	0.3	0.2	0.6	0.4	0.4	0.0	23 637	0	0.0	65.4
5-9	0.1	0.1	0.4	0.3	0.3	0.0	38 710	1	0.1	65.5
10-14	0.2	0.1	0.3	0.2	0.2	0.0	39 792	0	0.0	65.6
15-19	0.5	0.2	0.5	0.3	0.2	0.1	43 951	5	0.5	66.1
20-24	1.0	0.4	0.7	0.4	0.2	0.2	54 212	10	0.9	66.9
25-29	1.5	0.5	0.9	0.5	0.3	0.2	55 530	12	1.0	67.9
30-34	1.9	0.7	1.1	0.7	0.4	0.3	48 262	13	1.1	69.0
35-39	2.3	1.0	1.4	0.9	0.6	0.3	53 027	16	1.3	70.4
40-44	2.9	1.4	2.0	1.3	0.9	0.4	60 685	24	2.0	72.4
45-49	4.4	2.1	2.9	1.9	1.4	0.5	55 741	26	2.3	74.7
50-54	7.0	3.4	5.0	3.1	2.4	0.7	44 950	33	2.8	77.4
55-59	10.7	5.1	8.3	5.2	3.9	1.3	40 620	52	4.5	81.9
60-64	14.9	7.3	15.7	9.9	7.7	2.2	33 465	74	6.3	88.3
65-69	19.9	10.5	28.6	17.9	15.1	2.9	22 705	65	5.6	93.8
70-74	31.4	18.2	52.2	33.2	30.2	2.9	16 666	49	4.2	98.0
75-79	51.5	32.6	88.1	56.2	55.9	0.3	12 247	3	0.3	98.3
80-84	83.1	57.8	127.3	94.0	88.4	5.5	7 231	40	3.4	101.7
85-89	131.1	99.8	194.0	149.8	147.7	2.2	3 158	7	0.6	102.3
90-94	200.0	166.1	278.4	214.8	231.3	-16.5	1 017	-17	-1.4	100.8
95-99	291.8	262.1	368.3	296.7	330.8	-34.1	205	-7	-0.6	100.2
100+	416.0	400.8	475.2	355.4	457.9	-102.5	25	-3	-0.2	100.0
							671 976	**1168**		

2015-2020

Age	Age Specific death rate 2015-2020 (deaths per 1000 population)				Expected female death rate in China 2015-2020	Excess female mortality in China 2015-2010	Female population by age group in China 2015-2010 (000s')	Missing women in China 2015-2020		
	More developed regions		China					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								619	68.6	68.6
0-1	4.9	4.1	11.6	8.2	9.6	-1.4	15 856	-23	-2.5	66.1
1-4	0.2	0.2	0.5	0.4	0.4	0.0	24 129	-1	-0.1	66.0
5-9	0.1	0.1	0.3	0.3	0.3	0.0	39 689	0	0.0	66.0
10-14	0.2	0.1	0.3	0.2	0.2	0.0	38 642	0	0.0	66.1
15-19	0.5	0.2	0.4	0.3	0.2	0.1	39 654	4	0.5	66.5
20-24	0.9	0.3	0.6	0.4	0.2	0.2	43 709	7	0.8	67.3
25-29	1.3	0.5	0.8	0.5	0.3	0.2	53 929	9	1.0	68.4
30-34	1.7	0.7	1.0	0.6	0.4	0.2	55 249	12	1.3	69.7
35-39	2.3	1.0	1.2	0.8	0.5	0.2	48 001	12	1.3	71.0
40-44	2.9	1.4	1.7	1.2	0.8	0.3	52 700	18	2.0	73.0
45-49	4.0	2.0	2.6	1.7	1.3	0.4	60 199	22	2.5	75.5
50-54	6.2	3.1	4.4	2.7	2.2	0.5	55 086	30	3.3	78.8
55-59	9.8	4.7	7.3	4.6	3.5	1.0	44 092	45	5.0	83.8
60-64	14.5	7.0	13.9	8.6	6.7	1.9	39 247	74	8.2	92.0
65-69	19.1	10.0	25.2	15.6	13.2	2.4	31 407	75	8.3	100.3
70-74	28.9	16.8	46.2	28.9	26.9	2.0	20 209	41	4.5	104.8
75-79	47.4	30.2	78.6	49.1	50.1	-0.9	13 572	-13	-1.4	103.4
80-84	76.6	53.5	114.6	82.7	80.1	2.7	8 666	23	2.6	106.0
85-89	121.1	92.8	176.4	133.2	135.2	-2.1	4 098	-8	-0.9	105.0
90-94	185.5	155.3	255.9	192.9	214.2	-21.3	1 336	-28	-3.2	101.9
95-99	272.5	246.8	341.8	269.5	309.6	-40.1	302	-12	-1.3	100.5
100+	394.0	383.1	446.0	328.8	433.7	-104.9	46	-5	-0.5	100.0
							689 819	**902**		

ii) India

Year	Sex ratio at birth (Female birth per male birth)		Actual male births in India (`000s)	Actual female births in India (`000s)	Expected female births in India (`000s)	Missing girls at birth in India (`000s)
	More developed regions	India				
	A	**B**	**C**	**D**	**E = A * C**	**F = E - D**
1950-1955	0.943	0.949	8500	8064	8019	-46
1955-1960	0.943	0.949	9083	8617	8568	-49
1960-1965	0.943	0.949	9729	9230	9178	-52
1965-1970	0.943	0.948	10419	9875	9829	-47
1970-1975	0.943	0.946	11194	10590	10561	-30
1975-1980	0.943	0.937	12090	11331	11406	75
1980-1985	0.952	0.923	13148	12129	12522	393
1985-1990	0.952	0.916	14019	12838	13351	514
1990-1995	0.952	0.904	14427	13044	13740	696
1995-2000	0.952	0.900	14587	13130	13892	763
2000-2005	0.952	0.899	14654	13178	13956	778
2005-2010	0.952	0.908	14404	13082	13718	635
2010-2015	0.952	0.910	13612	12386	12964	578
2015-2020	0.952	0.910	12859	11700	12246	546

1950-1955

Age	Age Specific death rate 1950-55 (deaths per 1000 population)				Expected female death rate in India 1950-55	Excess female mortality in India 1950-1955	Female population by age group in India 1950-1955 (000s')	Missing women in India 1950-1955		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								-46	-3.3	-3.3
0-1	67.6	55.6	211.4	199.6	174.1	25.6	13 054	334	23.9	20.6
1-4	5.0	4.7	25.4	34.2	23.8	10.4	16 505	172	12.3	33.0
5-9	1.2	1.0	8.7	10.3	7.1	3.2	23 033	73	5.3	38.2
10-14	0.9	0.6	6.6	7.3	4.8	2.6	20 939	53	3.8	42.0
15-19	1.6	1.1	8.7	8.8	5.9	2.9	19 425	57	4.1	46.1
20-24	2.4	1.5	11.0	10.9	7.0	3.9	17 210	67	4.8	50.9
25-29	2.6	1.8	11.8	12.8	7.9	4.9	15 016	73	5.2	56.1
30-34	2.8	2.0	12.9	15.0	9.3	5.6	13 192	74	5.3	61.5
35-39	3.6	2.5	14.9	17.3	10.6	6.6	11 571	77	5.5	67.0
40-44	5.1	3.4	17.6	19.9	11.7	8.2	10 077	82	5.9	72.9
45-49	7.8	4.8	22.1	23.5	13.6	9.9	8 308	82	5.9	78.8
50-54	12.0	7.0	28.6	28.6	16.6	11.9	6 853	82	5.9	84.6
55-59	18.2	10.4	37.9	36.3	21.7	14.5	5 272	77	5.5	90.1
60-64	27.3	16.5	51.7	48.6	31.3	17.3	4 043	70	5.0	95.1
65-69	40.9	27.5	71.3	65.7	48.1	17.7	2 761	49	3.5	98.6
70-74	63.4	46.7	100.2	90.2	73.8	16.4	1 709	28	2.0	100.6
75-79	98.6	77.4	138.4	123.8	108.7	15.1	1 060	16	1.1	101.8
80-84	149.6	125.1	213.7	167.8	178.7	-11.0	512	-6	-0.4	101.4
85-89	219.9	195.1	323.0	221.8	286.7	-64.9	191	-12	-0.9	100.5
90-94	310.3	290.1	472.6	327.8	441.9	-114.1	49	-6	-0.4	100.1
95-99	417.4	407.2	446.4	340.3	435.5	-95.1	10	-1	-0.1	100.0
100+	539.1	542.4	627.5	486.4	631.3	-144.9	1	0	0.0	100.0
							190 791	**1397**	**100.0**	

1955-1960

Age	Age Specific death rate 1955-1960 (deaths per 1000 population)				Expected female death rate in India 1955-1960	Excess female mortality in India 1955-1960	Female population by age group in India 1955-1960 (000s')	Missing women in India 1955-1960		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								-49	-3.1	-3.1
0-1	48.9	39.9	192.5	181.3	156.9	24.4	14 641	358	22.4	19.4
1-4	2.7	2.5	23.0	30.8	21.1	9.8	19 390	189	11.9	31.3
5-9	0.9	0.7	7.4	9.2	5.7	3.6	26 698	95	6.0	37.2
10-14	0.7	0.4	5.5	6.3	3.4	2.8	22 089	62	3.9	41.1
15-19	1.3	0.7	7.2	7.3	3.9	3.4	20 181	69	4.3	45.4
20-24	1.9	1.0	9.0	9.0	4.7	4.3	18 563	80	5.0	50.5
25-29	2.2	1.2	9.7	10.8	5.4	5.4	16 290	88	5.5	55.9
30-34	2.5	1.5	10.7	13.0	6.7	6.3	14 074	89	5.6	61.5
35-39	3.0	2.0	12.7	15.3	8.4	6.9	12 228	85	5.3	66.9
40-44	4.4	2.8	15.3	17.9	9.8	8.1	10 598	86	5.4	72.3
45-49	6.8	4.1	19.7	21.4	11.8	9.6	9 090	87	5.5	77.7
50-54	11.0	6.1	25.6	25.7	14.1	11.6	7 344	85	5.4	83.1
55-59	17.4	9.2	33.8	32.6	17.9	14.6	5 884	86	5.4	88.5
60-64	26.8	14.9	46.6	44.6	25.8	18.8	4 314	81	5.1	93.6
65-69	40.3	25.1	64.8	61.4	40.4	21.0	3 076	65	4.1	97.7
70-74	62.2	43.0	94.1	85.0	65.1	19.9	1 898	38	2.4	100.0
75-79	96.5	72.4	129.7	116.8	97.2	19.6	1 021	20	1.3	101.3
80-84	146.4	118.8	200.2	157.3	162.4	-5.1	525	-3	-0.2	101.1
85-89	215.2	187.9	302.6	206.9	264.2	-57.3	201	-12	-0.7	100.4
90-94	304.0	283.1	442.7	305.8	412.3	-106.5	51	-5	-0.3	100.1
95-99	409.8	401.8	418.2	321.1	410.1	-89.0	9	-1	-0.1	100.0
100+	530.9	540.0	587.8	458.9	597.8	-138.9	1	0	0.0	100.0
							208 166	**1593**	**100.0**	

1960-1965

Age	Age Specific death rate 1960-1965 (deaths per 1000 population)				Expected female death rate in India 1960-1965	Excess female mortality in India 1960-1965	Female population by age group in India 1960-1965 (000s')	Missing women in India 1960-1965		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								-52	-3.0	-3.0
0-1	37.5	29.7	177.6	166.7	140.6	26.1	15 672	409	23.4	20.4
1-4	1.7	1.4	20.9	27.9	18.0	9.8	21 529	211	12.1	32.5
5-9	0.7	0.5	6.5	8.4	4.7	3.8	31 046	118	6.7	39.3
10-14	0.6	0.4	4.6	5.4	2.7	2.7	25 729	69	3.9	43.2
15-19	1.2	0.5	5.6	5.5	2.6	2.9	21 426	62	3.5	46.7
20-24	1.7	0.8	6.7	6.8	3.0	3.8	19 468	74	4.2	51.0
25-29	2.0	1.0	7.3	8.6	3.6	5.0	17 756	89	5.1	56.0
30-34	2.3	1.3	8.5	11.0	4.5	6.4	15 426	99	5.7	61.7
35-39	3.0	1.7	10.4	13.2	6.0	7.2	13 177	95	5.4	67.2
40-44	4.2	2.5	13.0	15.7	7.8	7.9	11 316	89	5.1	72.3
45-49	6.5	3.8	17.5	18.9	10.1	8.8	9 665	85	4.9	77.1
50-54	10.3	5.5	23.2	22.7	12.4	10.3	8 139	84	4.8	82.0
55-59	16.7	8.4	30.8	28.9	15.5	13.4	6 410	86	4.9	86.9
60-64	26.5	13.8	43.3	41.5	22.5	18.9	4 904	93	5.3	92.2
65-69	39.9	23.2	60.4	58.6	35.0	23.5	3 341	79	4.5	96.7
70-74	61.3	40.1	88.3	80.1	57.8	22.3	2 160	48	2.8	99.5
75-79	95.0	68.3	121.7	110.4	87.5	22.9	1 167	27	1.5	101.0
80-84	144.0	113.5	187.9	148.5	148.2	0.3	526	0	0.0	101.0
85-89	211.5	181.9	284.0	195.0	244.2	-49.3	218	-11	-0.6	100.4
90-94	298.9	277.2	415.4	288.2	385.2	-97.1	59	-6	-0.3	100.1
95-99	403.3	397.1	392.5	304.0	386.4	-82.4	11	-1	-0.1	100.0
100+	523.8	537.7	551.6	434.5	566.2	-131.7	2	0	0.0	100.0
							229 148	**1746**		

1965-1970

Age	Age Specific death rate 1965-1970 (deaths per 1000 population)				Expected female death rate in India 1965-1970	Excess female mortality in India 1965-1970	Female population by age group in India 1965-1970 (000s')	Missing women in India 1965-1970		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								-47	-2.6	-2.6
0-1	29.9	23.5	166.8	155.7	130.9	24.8	17 181	427	24.1	21.4
1-4	1.3	1.1	19.4	25.6	16.2	9.4	23 278	219	12.3	33.8
5-9	0.6	0.4	5.6	7.3	3.9	3.4	34 226	118	6.6	40.4
10-14	0.6	0.3	3.5	4.1	2.0	2.2	30 068	65	3.7	44.1
15-19	1.2	0.5	4.0	4.3	1.7	2.6	25 107	66	3.7	47.8
20-24	1.7	0.7	4.8	5.5	1.9	3.6	20 828	74	4.2	52.0
25-29	1.9	0.8	5.3	6.8	2.2	4.5	18 789	85	4.8	56.8
30-34	2.4	1.1	6.4	8.5	3.0	5.6	16 989	95	5.3	62.1
35-39	3.2	1.6	8.1	10.1	4.0	6.1	14 616	89	5.0	67.2
40-44	4.5	2.4	10.7	12.0	5.6	6.4	12 362	79	4.5	71.6
45-49	6.6	3.6	14.9	15.1	8.2	6.9	10 477	72	4.1	75.7
50-54	10.3	5.4	20.5	19.1	10.7	8.4	8 794	74	4.2	79.8
55-59	16.5	8.1	28.0	25.2	13.7	11.5	7 230	83	4.7	84.5
60-64	26.3	13.0	40.7	38.0	20.2	17.9	5 437	97	5.5	90.0
65-69	40.6	22.1	56.7	54.8	30.9	23.9	3 859	92	5.2	95.2
70-74	62.0	38.1	83.1	75.3	51.1	24.2	2 393	58	3.3	98.5
75-79	94.9	64.9	114.8	104.6	78.5	26.1	1 364	36	2.0	100.5
80-84	142.4	108.0	177.3	141.3	134.5	6.8	623	4	0.2	100.7
85-89	207.4	173.5	268.0	193.9	224.1	-30.2	227	-7	-0.4	100.3
90-94	291.4	265.5	392.0	286.6	357.2	-70.6	66	-5	-0.3	100.1
95-99	392.0	382.7	370.3	290.0	361.5	-71.5	13	-1	-0.1	100.0
100+	509.6	522.5	520.5	414.5	533.8	-119.2	2	0	0.0	100.0
							253 930	**1773**		

1970-1975

Age	Age Specific death rate 1970-1975 (deaths per 1000 population)				Expected female death rate in India 1970-1975	Excess female mortality in India 1970-1975	Female population by age group in India 1970-1975 (000s')	Missing women in India 1970-1975		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								-30	-1.7	-1.7
0-1	24.4	19.0	154.0	144.3	119.7	24.6	18 619	458	26.0	24.3
1-4	1.1	0.9	17.5	23.2	14.2	8.9	25 425	227	12.9	37.2
5-9	0.5	0.4	4.6	5.9	3.2	2.7	37 583	101	5.7	42.9
10-14	0.6	0.3	2.5	3.0	1.4	1.6	33 397	52	3.0	45.9
15-19	1.2	0.5	2.9	3.8	1.1	2.6	29 552	77	4.4	50.3
20-24	1.8	0.6	3.6	4.9	1.3	3.6	24 590	89	5.1	55.4
25-29	1.8	0.7	3.9	5.5	1.6	3.9	20 302	80	4.5	59.9
30-34	2.3	1.0	4.9	6.3	2.1	4.2	18 200	77	4.4	64.3
35-39	3.2	1.5	6.2	7.2	2.8	4.3	16 338	71	4.0	68.3
40-44	4.7	2.2	8.7	8.5	4.1	4.3	13 956	60	3.4	71.7
45-49	6.9	3.4	12.3	11.0	6.2	4.9	11 676	57	3.2	75.0
50-54	10.2	5.2	17.8	15.4	9.0	6.3	9 725	62	3.5	78.5
55-59	15.9	7.8	25.3	21.6	12.4	9.2	7 960	73	4.2	82.6
60-64	25.0	12.2	38.1	34.0	18.6	15.4	6 250	96	5.5	88.1
65-69	39.1	20.6	53.4	49.2	28.1	21.1	4 372	92	5.2	93.3
70-74	60.5	35.8	78.5	70.7	46.5	24.2	2 832	69	3.9	97.2
75-79	92.9	61.2	109.1	99.3	71.8	27.5	1 552	43	2.4	99.7
80-84	139.7	102.1	168.5	141.1	123.2	17.9	747	13	0.8	100.4
85-89	204.1	165.0	254.7	193.7	205.8	-12.1	272	-3	-0.2	100.2
90-94	287.6	254.1	372.6	286.3	329.2	-42.9	69	-3	-0.2	100.1
95-99	388.1	369.1	352.0	278.1	334.7	-56.6	15	-1	0.0	100.0
100+	506.2	508.8	494.7	397.4	497.2	-99.8	3	0	0.0	100.0
							283 437	**1761**		

1975-1980

Age	Age Specific death rate 1975-1980 (deaths per 1000 population)				Expected female death rate in India 1975-1980	Excess female mortality in India 1975-1980	Female population by age group in India 1975-1980 (000s')	Missing women in India 1975-1980		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								75	4.2	4.2
0-1	20.9	16.2	135.8	126.5	105.2	21.3	20 281	432	24.4	28.6
1-4	1.0	0.8	14.6	19.7	11.8	7.9	27 836	219	12.4	40.9
5-9	0.5	0.3	3.9	4.8	2.6	2.2	41 352	89	5.0	46.0
10-14	0.5	0.3	2.0	2.3	1.1	1.1	36 907	42	2.4	48.3
15-19	1.2	0.4	2.4	3.3	0.9	2.4	32 986	80	4.5	52.8
20-24	1.8	0.6	3.0	4.3	1.0	3.4	29 076	98	5.5	58.3
25-29	1.9	0.7	3.2	4.6	1.1	3.5	24 121	84	4.7	63.0
30-34	2.1	0.9	4.1	4.8	1.7	3.1	19 844	62	3.5	66.5
35-39	3.1	1.3	5.3	5.4	2.2	3.1	17 710	55	3.1	69.6
40-44	4.7	2.0	7.6	6.4	3.3	3.1	15 816	49	2.7	72.4
45-49	7.0	3.2	10.7	8.5	4.9	3.6	13 392	48	2.7	75.1
50-54	10.4	4.9	16.2	12.7	7.6	5.1	11 021	56	3.2	78.3
55-59	15.2	7.4	23.6	18.7	11.4	7.2	8 949	65	3.7	81.9
60-64	23.5	11.4	36.7	30.5	17.8	12.7	7 005	89	5.0	86.9
65-69	36.9	18.8	51.7	43.9	26.4	17.5	5 145	90	5.1	92.0
70-74	57.3	32.8	75.7	66.3	43.2	23.0	3 293	76	4.3	96.3
75-79	88.3	56.1	106.0	96.2	67.4	28.8	1 878	54	3.0	99.3
80-84	133.4	94.2	163.7	136.6	115.6	21.0	865	18	1.0	100.3
85-89	195.9	153.1	247.5	187.5	193.4	-5.9	330	-2	-0.1	100.2
90-94	277.5	237.9	362.1	277.2	310.4	-33.2	84	-3	-0.2	100.1
95-99	376.6	349.1	342.1	268.9	317.0	-48.1	17	-1	0.0	100.0
100+	494.8	488.0	480.8	384.3	474.2	-89.9	3	0	0.0	100.0
							317 912	**1775**		

1980-1985

Age	Age Specific death rate 1980-1985 (deaths per 1000 population)				Expected female death rate in India 1980-1985	Excess female mortality in India 1980-1985	Female population by age group in India 1980-1985 (000s')	Missing women in India 1980-1985		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								393	18.6	18.6
0-1	17.3	13.4	117.6	109.4	90.9	18.5	22 163	409	19.4	38.0
1-4	0.9	0.7	11.7	16.1	9.5	6.6	30 582	203	9.6	47.6
5-9	0.4	0.3	3.3	4.3	2.3	2.0	45 605	91	4.3	51.9
10-14	0.4	0.2	1.8	2.0	1.0	1.0	40 703	40	1.9	53.8
15-19	1.0	0.4	2.1	3.1	0.8	2.3	36 479	84	4.0	57.8
20-24	1.7	0.5	2.7	3.9	0.9	3.1	32 442	100	4.8	62.5
25-29	1.9	0.6	2.9	4.1	0.9	3.1	28 521	89	4.2	66.7
30-34	2.2	0.8	3.7	4.1	1.4	2.7	23 637	64	3.0	69.8
35-39	2.7	1.2	4.7	4.5	2.0	2.5	19 408	48	2.3	72.0
40-44	4.4	1.9	7.0	5.5	3.0	2.5	17 250	44	2.1	74.1
45-49	6.8	3.0	10.1	7.5	4.4	3.1	15 291	47	2.2	76.3
50-54	10.4	4.6	15.5	11.7	6.9	4.8	12 749	61	2.9	79.2
55-59	15.4	7.1	23.0	17.6	10.7	6.9	10 233	70	3.3	82.6
60-64	22.3	10.9	36.6	29.6	17.9	11.7	7 954	93	4.4	87.0
65-69	34.3	17.8	51.8	43.0	26.8	16.2	5 841	94	4.5	91.4
70-74	54.0	30.8	74.3	66.0	42.4	23.6	3 929	93	4.4	95.8
75-79	84.1	52.8	105.0	95.8	65.9	29.9	2 205	66	3.1	99.0
80-84	128.5	88.8	162.1	136.0	112.1	23.9	1 056	25	1.2	100.1
85-89	190.7	145.0	245.1	186.7	186.3	0.4	388	0	0.0	100.2
90-94	272.9	226.7	358.5	276.0	297.8	-21.8	104	-2	-0.1	100.0
95-99	373.4	334.9	338.7	267.7	303.8	-36.0	21	-1	0.0	100.0
100+	493.9	472.9	476.0	382.7	455.8	-73.2	4	0	0.0	100.0
							356 565	**2112**		

1985-1990

Age	Age Specific death rate 1985-1990 (deaths per 1000 population)				Expected female death rate in India 1985-1990	Excess female mortality in India 1985-1990	Female population by age group in India 1985-1990 (000s')	Missing women in India 1985-1990		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								514	22.3	22.3
0-1	14.8	11.5	102.2	96.8	79.1	17.7	23 541	416	18.1	40.4
1-4	0.7	0.6	9.6	13.4	7.7	5.7	33 250	191	8.3	48.7
5-9	0.4	0.2	2.9	3.8	2.0	1.8	50 404	93	4.0	52.7
10-14	0.4	0.2	1.6	1.8	0.9	0.9	44 946	42	1.8	54.5
15-19	0.9	0.4	2.0	2.9	0.8	2.2	40 242	87	3.8	58.3
20-24	1.4	0.5	2.6	3.7	0.8	2.9	35 874	104	4.5	62.8
25-29	1.7	0.6	2.8	3.7	0.9	2.8	31 838	88	3.8	66.7
30-34	2.0	0.8	3.5	3.7	1.3	2.4	27 989	66	2.9	69.6
35-39	2.6	1.1	4.5	4.1	1.9	2.2	23 171	51	2.2	71.8
40-44	3.6	1.6	6.6	5.1	3.0	2.1	18 957	39	1.7	73.5
45-49	5.8	2.7	9.7	7.0	4.4	2.5	16 731	43	1.8	75.3
50-54	9.2	4.2	15.0	11.1	6.8	4.4	14 610	64	2.8	78.1
55-59	14.3	6.5	22.6	17.0	10.3	6.7	11 884	80	3.5	81.6
60-64	21.6	10.4	36.0	28.8	17.4	11.4	9 132	104	4.5	86.1
65-69	31.5	16.5	51.8	42.8	27.1	15.8	6 653	105	4.6	90.6
70-74	49.5	28.4	73.2	66.0	42.0	23.9	4 467	107	4.6	95.3
75-79	78.1	49.1	104.2	95.7	65.5	30.2	2 631	79	3.4	98.7
80-84	120.9	83.4	160.9	135.9	111.0	25.0	1 241	31	1.3	100.1
85-89	181.8	137.3	243.3	186.6	183.8	2.8	475	1	0.1	100.1
90-94	263.3	216.8	355.8	275.8	293.1	-17.2	123	-2	-0.1	100.0
95-99	364.3	323.6	336.2	267.6	298.6	-31.0	26	-1	0.0	100.0
100+	486.7	462.0	472.5	382.4	448.5	-66.1	5	0	0.0	100.0
							398 189	**2303**		

1990-1995

Age	Age Specific death rate 1990-1995 (deaths per 1000 population)				Expected female death rate in India 1990-1995	Excess female mortality in India 1990-1995	Female population by age group in India 1990-1995 (000s')	Missing women in India 1990-1995		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								696	28.7	28.7
0-1	11.9	9.3	88.7	85.6	69.1	16.5	23 877	394	16.2	45.0
1-4	0.6	0.5	7.8	11.2	6.3	4.9	34 799	171	7.0	52.0
5-9	0.3	0.2	2.4	3.0	1.6	1.4	54 665	77	3.2	55.2
10-14	0.4	0.2	1.4	1.6	0.8	0.8	49 754	40	1.7	56.8
15-19	1.0	0.4	1.8	2.5	0.7	1.9	44 457	83	3.4	60.2
20-24	1.6	0.5	2.4	3.3	0.7	2.5	39 592	101	4.2	64.4
25-29	1.9	0.6	2.7	3.2	0.8	2.4	35 232	83	3.4	67.8
30-34	2.4	0.8	3.3	3.2	1.1	2.1	31 287	65	2.7	70.5
35-39	3.3	1.2	4.3	3.5	1.5	2.0	27 487	55	2.3	72.8
40-44	4.5	1.8	6.0	4.4	2.4	2.0	22 685	45	1.9	74.6
45-49	6.0	2.6	9.0	6.1	3.9	2.2	18 438	40	1.7	76.3
50-54	9.4	4.1	13.8	9.7	6.1	3.7	16 047	59	2.4	78.7
55-59	14.5	6.4	20.8	15.1	9.2	5.9	13 689	81	3.3	82.0
60-64	21.7	10.1	33.0	25.4	15.3	10.0	10 689	107	4.4	86.5
65-69	31.2	16.1	48.5	38.6	25.0	13.7	7 720	106	4.4	90.8
70-74	47.1	26.9	68.0	59.7	38.9	20.8	5 154	107	4.4	95.2
75-79	74.0	46.5	97.7	87.2	61.4	25.8	3 047	79	3.2	98.5
80-84	114.0	78.8	150.8	126.0	104.4	21.7	1 517	33	1.4	99.8
85-89	171.0	130.1	228.0	184.4	173.4	11.0	568	6	0.3	100.1
90-94	247.8	206.0	333.6	272.6	277.3	-4.8	151	-1	0.0	100.1
95-99	344.0	309.2	315.1	243.8	283.2	-39.4	32	-1	-0.1	100.0
100+	463.7	445.8	442.9	348.4	425.9	-77.4	6	0	0.0	100.0
							440 893	**2423**		

1995-2000

Age	Age Specific death rate 1995-2000 (deaths per 1000 population)				Expected female death rate in India 1995-2000	Excess female mortality in India 1995-2000	Female population by age group in India 1995-2000 (000s')	Missing women in India 1995-2000		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								763	32.0	32.0
0-1	9.7	7.7	75.2	75.2	59.8	15.5	24 340	377	15.8	47.9
1-4	0.5	0.4	6.2	9.1	5.0	4.1	35 414	144	6.0	53.9
5-9	0.3	0.2	1.9	2.3	1.4	1.0	56 873	55	2.3	56.2
10-14	0.4	0.2	1.2	1.3	0.7	0.6	54 079	34	1.4	57.6
15-19	1.0	0.4	1.6	2.2	0.6	1.5	49 270	76	3.2	60.8
20-24	1.6	0.5	2.2	2.8	0.7	2.1	43 806	94	3.9	64.7
25-29	1.8	0.6	2.6	2.8	0.8	1.9	38 949	75	3.1	67.9
30-34	2.2	0.8	3.2	2.8	1.1	1.7	34 688	57	2.4	70.3
35-39	3.1	1.2	4.2	3.1	1.6	1.5	30 789	47	2.0	72.3
40-44	4.6	1.8	5.7	3.8	2.2	1.6	26 981	43	1.8	74.0
45-49	6.4	2.7	8.3	5.4	3.5	1.9	22 138	42	1.8	75.8
50-54	8.6	3.9	12.7	8.5	5.7	2.7	17 775	48	2.0	77.8
55-59	13.5	6.2	19.0	13.5	8.7	4.8	15 150	72	3.0	80.9
60-64	20.6	9.6	29.9	22.3	13.9	8.3	12 465	104	4.4	85.3
65-69	29.8	15.2	45.0	34.8	23.0	11.8	9 204	109	4.6	89.8
70-74	45.0	25.6	63.3	54.0	36.1	17.9	6 128	110	4.6	94.4
75-79	70.4	44.4	91.6	79.4	57.7	21.7	3 643	79	3.3	97.8
80-84	108.4	75.5	141.4	122.7	98.5	24.1	1 825	44	1.8	99.6
85-89	162.7	125.1	213.7	179.5	164.4	15.1	712	11	0.5	100.1
90-94	236.4	199.2	312.7	265.3	263.6	1.7	184	0	0.0	100.1
95-99	329.4	300.7	295.4	241.6	269.7	-28.1	41	-1	0.0	100.0
100+	447.4	437.0	415.2	345.3	405.6	-60.3	9	-1	0.0	100.0
							484 462	**2381**		

2000-2005

Age	Age Specific death rate 2000-2005 (deaths per 1000 population)				Expected female death rate in India 2000-2005	Excess female mortality in India 2000-2005	Female population by age group in India 2000-2005 (000s')	Missing women in India 2000-2005		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								778	32.2	32.2
0-1	8.2	6.5	62.0	63.9	49.2	14.7	24 691	362	15.0	47.2
1-4	0.4	0.3	4.7	6.7	3.8	3.0	36 070	107	4.4	51.7
5-9	0.2	0.2	1.5	1.8	1.1	0.7	58 287	41	1.7	53.4
10-14	0.3	0.2	1.0	1.2	0.6	0.5	56 351	29	1.2	54.6
15-19	0.9	0.3	1.5	1.9	0.6	1.4	53 586	73	3.0	57.6
20-24	1.5	0.5	2.1	2.5	0.7	1.9	48 588	90	3.7	61.4
25-29	1.8	0.6	2.6	2.5	0.8	1.7	43 134	72	3.0	64.4
30-34	2.1	0.7	3.2	2.5	1.1	1.4	38 386	54	2.2	66.6
35-39	2.9	1.1	4.2	2.9	1.6	1.3	34 176	44	1.8	68.4
40-44	4.5	1.8	5.5	3.6	2.2	1.4	30 268	42	1.7	70.1
45-49	6.8	2.8	7.9	5.1	3.2	1.8	26 383	49	2.0	72.2
50-54	9.3	4.1	11.8	7.8	5.2	2.6	21 416	57	2.3	74.5
55-59	12.1	5.7	17.6	12.7	8.2	4.5	16 870	75	3.1	77.6
60-64	18.6	9.0	27.3	21.0	13.2	7.8	13 909	108	4.5	82.1
65-69	27.3	14.0	41.8	33.3	21.5	11.9	10 864	129	5.3	87.5
70-74	41.3	23.7	59.8	52.4	34.3	18.1	7 420	134	5.5	93.0
75-79	64.8	41.1	87.3	77.5	55.4	22.1	4 426	98	4.1	97.1
80-84	100.1	70.2	134.8	119.6	94.5	25.1	2 228	56	2.3	99.4
85-89	151.0	116.8	203.8	175.0	157.6	17.4	872	15	0.6	100.0
90-94	220.8	187.2	298.1	258.7	252.7	6.0	237	1	0.1	100.1
95-99	310.2	284.9	281.6	235.6	258.7	-23.1	51	-1	0.0	100.0
100+	426.8	419.8	395.9	336.7	389.3	-52.6	11	-1	0.0	100.0
							528 223	**2414**		

2005-2010

Age	Age Specific death rate 2005-2010 (deaths per 1000 population)				Expected female death rate in India 2005-2010	Excess female mortality in India 2005-2010	Female population by age group in India 2005-2010 (000s')	Missing women in India 2005-2010		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								635	28.5	28.5
0-1	6.8	5.5	50.7	52.4	40.9	11.5	24 542	283	12.7	41.1
1-4	0.3	0.3	3.4	4.8	2.7	2.0	36 475	74	3.3	44.5
5-9	0.2	0.1	1.2	1.4	0.9	0.5	59 601	30	1.3	45.8
10-14	0.2	0.1	0.9	1.0	0.6	0.4	57 800	24	1.1	46.9
15-19	0.7	0.3	1.3	1.6	0.5	1.1	55 841	62	2.8	49.7
20-24	1.4	0.4	1.9	2.1	0.6	1.5	52 851	79	3.6	53.2
25-29	1.8	0.6	2.3	2.1	0.7	1.4	47 853	66	2.9	56.1
30-34	2.1	0.8	3.0	2.2	1.1	1.2	42 530	50	2.2	58.4
35-39	2.6	1.0	4.0	2.6	1.6	1.0	37 844	38	1.7	60.1
40-44	3.7	1.6	5.2	3.4	2.3	1.1	33 622	37	1.7	61.8
45-49	5.8	2.5	7.4	4.8	3.2	1.5	29 629	45	2.0	63.8
50-54	8.7	3.8	10.9	7.5	4.8	2.7	25 567	68	3.0	66.8
55-59	11.9	5.5	16.3	12.0	7.5	4.4	20 382	90	4.0	70.9
60-64	15.7	7.7	24.9	20.1	12.2	7.9	15 556	123	5.5	76.4
65-69	23.2	12.3	38.4	32.0	20.3	11.7	12 196	142	6.4	82.8
70-74	36.1	20.9	56.5	50.9	32.8	18.1	8 822	159	7.1	89.9
75-79	57.7	36.6	83.2	75.6	52.8	22.7	5 404	123	5.5	95.4
80-84	90.8	63.2	128.4	116.7	89.4	27.3	2 739	75	3.3	98.7
85-89	139.7	106.5	194.1	170.8	148.1	22.7	1 084	25	1.1	99.8
90-94	208.1	173.1	284.0	252.4	236.2	16.2	299	5	0.2	100.1
95-99	297.6	267.4	268.3	229.9	241.0	-11.1	68	-1	0.0	100.0
100+	417.0	401.8	377.1	328.5	363.3	-34.8	15	-1	0.0	100.0
							570 717	**2232**		

2010-2015

Age	Age Specific death rate 2010-2015 (deaths per 1000 population)				Expected female death rate in India 2010-2015	Excess female mortality in India 2010-2015	Female population by age group in India 2010-2015 (000s')	Missing women in India 2010-2015		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								578	28.8	28.8
0-1	5.7	4.6	40.0	40.8	32.4	8.5	23 080	196	9.8	38.6
1-4	0.3	0.2	2.3	3.1	1.9	1.3	35 633	45	2.2	40.8
5-9	0.1	0.1	0.9	1.0	0.7	0.3	60 159	20	1.0	41.8
10-14	0.2	0.1	0.7	0.7	0.5	0.3	59 178	16	0.8	42.6
15-19	0.5	0.2	1.1	1.3	0.5	0.8	57 348	45	2.2	44.9
20-24	1.0	0.4	1.7	1.6	0.6	1.0	55 191	57	2.8	47.7
25-29	1.5	0.5	2.0	1.7	0.7	0.9	52 159	50	2.5	50.2
30-34	1.9	0.7	2.7	1.8	1.0	0.8	47 257	37	1.9	52.0
35-39	2.3	1.0	3.7	2.2	1.6	0.7	41 991	28	1.4	53.4
40-44	2.9	1.4	4.8	3.0	2.3	0.7	37 283	28	1.4	54.8
45-49	4.4	2.1	7.0	4.3	3.4	0.9	32 969	28	1.4	56.2
50-54	7.0	3.4	10.2	7.4	4.9	2.5	28 760	71	3.6	59.7
55-59	10.7	5.1	15.7	11.0	7.4	3.6	24 394	87	4.4	64.1
60-64	14.9	7.3	22.8	18.5	11.1	7.4	18 892	139	6.9	71.0
65-69	19.9	10.5	35.1	29.1	18.5	10.6	13 751	145	7.3	78.3
70-74	31.4	18.2	53.7	46.8	31.1	15.6	10 026	157	7.8	86.1
75-79	51.5	32.6	79.7	69.8	50.5	19.3	6 531	126	6.3	92.4
80-84	83.1	57.8	117.4	110.8	81.6	29.2	3 414	100	5.0	97.4
85-89	131.1	99.8	177.4	165.4	135.1	30.3	1 363	41	2.1	99.4
90-94	200.0	166.1	259.5	244.5	215.6	28.9	382	11	0.6	100.0
95-99	291.8	262.1	245.2	227.2	220.2	7.1	88	1	0.0	100.0
100+	416.0	400.8	344.6	324.8	332.1	-7.3	20	0	0.0	100.0
							609 869	**2005**		

2015-2020

Age	Age Specific death rate 2015-2020 (deaths per 1000 population)				Expected female death rate in India 2015-2020	Excess female mortality in India 2015-2010	Female population by age group in India 2015-2010 (000s')	Missing women in India 2015-2020		
	More developed regions		India					Number	% of total missing women	Cumulative % of total missing women
	Male	Female	Male	Female						
	A	B	C	D	E = C * (B/A)	F = D - E	G	H = G*(F/1000)		
At birth								546	28.1	28.1
0-1	4.9	4.1	32.9	32.9	27.4	5.5	22 284	123	6.3	34.4
1-4	0.2	0.2	1.7	2.2	1.4	0.8	33 848	27	1.4	35.8
5-9	0.1	0.1	0.7	0.8	0.6	0.2	58 106	12	0.6	36.4
10-14	0.2	0.1	0.6	0.6	0.4	0.2	59 807	12	0.6	37.0
15-19	0.5	0.2	0.9	1.0	0.4	0.6	58 787	35	1.8	38.8
20-24	0.9	0.3	1.5	1.3	0.5	0.8	56 788	43	2.2	41.0
25-29	1.3	0.5	1.7	1.4	0.7	0.7	54 584	39	2.0	43.0
30-34	1.7	0.7	2.4	1.5	1.0	0.6	51 612	29	1.5	44.5
35-39	2.3	1.0	3.5	2.0	1.5	0.5	46 741	23	1.2	45.7
40-44	2.9	1.4	4.5	2.9	2.1	0.8	41 427	32	1.6	47.3
45-49	4.0	2.0	6.7	4.0	3.3	0.7	36 617	24	1.3	48.6
50-54	6.2	3.1	9.6	7.6	4.8	2.8	32 031	91	4.7	53.2
55-59	9.8	4.7	15.3	10.6	7.3	3.3	27 476	89	4.6	57.8
60-64	14.5	7.0	21.2	17.7	10.3	7.4	22 720	168	8.6	66.5
65-69	19.1	10.0	32.5	27.3	17.0	10.3	16 849	173	8.9	75.4
70-74	28.9	16.8	51.5	44.3	29.9	14.4	11 465	165	8.5	83.8
75-79	47.4	30.2	77.0	66.5	49.1	17.4	7 570	132	6.8	90.6
80-84	76.6	53.5	115.3	107.9	80.5	27.3	4 223	115	5.9	96.6
85-89	121.1	92.8	174.2	163.7	133.5	30.2	1 733	52	2.7	99.2
90-94	185.5	155.3	254.9	242.0	213.3	28.7	491	14	0.7	100.0
95-99	272.5	246.8	240.8	224.9	218.1	6.9	115	1	0.0	100.0
100+	394.0	383.1	338.4	321.5	329.1	-7.7	27	0	0.0	100.0
							645 300	**1945**		