Appendix A Population Imputation

1. Data collection

When estimating population by age, gender and education in urban and rural areas, we use the following data sources:

Table1. 1 Data Sources of Normal Provinces

Data	Sources	Notes
National, urban and rural population aged 6 years and over, by age, sex and education level: 1982,1987, 1990,1995, 2000,2005, 2010,2015	• 1982, *China Demographic Statistics Yearbook* 1988 edited by Department of Demographic Statistics of National Bureau of Statistics • 1987, *China 1987 1% Demographic Sampling* Survey edited by Department of Demographic Statistics of National Bureau of Statistics • 1990, *China 1990 Census* edited by Census Office of State Council, and Department of Demographic Statistics of National Bureau of Statistics • 1995, *China Demographic Statistics Yearbook.* 1998 edited by Department of Demographic and Employment Statistics of National Bureau of Statistics • 2000, http://www.stats.gov.cn/tjsj/ndsj/renkoupucha /2000pucha/pucha.htm • 2005, http://www.stats.gov.cn/tjsj/ndsj/renkou/2	

Data	Sources	Notes
	005 /renkou.htm • 2010, *China 2010 Census* • 2015, *China 2015 1% Demographic Sampling* Survey edited by Department of Demographic Statistics of National Bureau of Statistics	
National, urban and rural population aged 0-5 years, by age and sex: 1982,1987, 1990,1995, 2000,2005, 2010,2015	• 1982, *China 1982 Census* edited by State Department Census Office, Department of Demographic Statistics of National Bureau of Statistics • 1987, *China Demographic Statistics Yearbook. 1989* edited by Department of Demographic Statistics of National Bureau of Statistics • 1990, *China 1990 Census* edited by State Department Census Office, Department of Demographic Statistics of National Bureau of Statistics • 1995, *China Demographic Statistics Yearbook. 1996* edited by Department of Demographic and Employment Statistics of National Bureau of Statistics • 2000, http://www.stats.gov.cn/tjsj/ndsj/renkoupucha /2000pucha /pucha.htm • 2005, http://www.stats.gov.cn/tjsj/ndsj/renkou/2005 /renkou.htm • 2010, *China 2010 Census and China Demographic Statistics Yearbook* 2012 • 2015, *China 2015 1% Demographic*	We assume that the population aged 0-6years receive no schooling

Data	Sources	Notes
	Sampling Survey edited by Department of Demographic Statistics of National Bureau of Statistics	
National, urban and rural population by age and sex: 1982-2015	• *China Demographic Statistics Yearbook. 1988-1993* edited by Department of Demographic Statistics of National Bureau of Statistics • *China Demographic Statistics Yearbook. 1994-1998,* 2006 edited by Department of Demographic and Employment Statistics of National Bureau of Statistics • *China Demographic Statistics Yearbook. 1999-2005* edited by Department of Demographic and Social Science Statistics of National Bureau of Statistics • *China Demographic and Employment Statistics Yearbook 2007-2010,* edited by Department of Demographic and Employment Statistics of National Bureau of Statistics	
Mortality rate by age and sex: 1986, 1989-1990, 1994-2018	• *China Demographic Statistics Yearbook：1988-2019*	In the yearbooks of 1988 and 1989, only the mortality rate for 1986 is available. In the yearbooks of 1992 and 1993, the mortality rate is not separated by age and sex.
Enrollment by education level:	• *Educational Statistics yearbook of China.1987* edited by the Plan and Finance Bureau of National Educational	*Part of Educational Statistics Yearbook of China.* are

Data	Sources	Notes
1980-2018	Committee • *Educational Statistics yearbook of China. 1989-1992*, edited by the Plan and Development Department of National Educational Committee • *Educational Statistics yearbook of China 1993-1996,* edited by the Plan and Development Department of National Educational Committee • *Educational Statistics yearbook of China 1997,* edited by the Plan and Development Department of National Educational Ministry • *Educational Statistics yearbook of China. 1998-2018*edited by the Plan and Development Department of National Educational Ministry	downloaded fromhttp://www.cnki.net/.
National, urban and rural population and birth rate for each year	• *China Statistics Yearbook 2019.* • *Statistics Summary for 56 years in China.* China Statistics Press	
Students by age, grade of primary and junior school: 2003-2018	• *Educational Statistics yearbook of China.2003-2018,* edited by the Plan and Development Department of National Educational Ministry	

Table HK.A.2.1 Data Sources of Hong Kong

Data	Sources	Notes
Population by age, sex and education level	• 1981, Hong Kong 1981 Population Census Main Tables • 1986, Hong Kong 1986 Population By-Census Main Tables • 1991, Hong Kong 1991 Population Census Main Tables • 1996, Hong Kong 1996 Population By-Census Main Tables • 2001, Hong Kong 2001 Population Census Thematic Report • 2006, Hong Kong 2006 Population By-Census Thematic Report • 2011, Hong Kong 2011 Population Census Thematic Report • 1985-2018Census and Statistics Department of Hong Kong	
Total population	• 1980-2018, Hong Kong *Statistics Yearbook*	It is the resident population.
Enrollment by education level	• 1985-2018, Hong Kong Education Bureau	
Mortality rate by age and sex	• Hong Kong Mortality Table	
Birth by sex	• 1985-2018, Hong Kong *Statistics Yearbook*	
Employment rate by age, sex and education level	• 1985-2018, Hong Kong Census and Statistics Department	
Consumer Price Index (CPI)	• 1981-2018, Hong Kong *Statistics Yearbook*	
Enrollment rate	• Hong Kong Education Bureau	

Data	Sources	Notes
Nominal GDP by industry	• Hong Kong *Statistics Yearbook*	
Real GDP Index by Industry	• Hong Kong *Statistics Yearbook*	
Employed population by Industry	• Hong Kong *Statistics Yearbook*	
Average discount rate （based on the basic loan interest of Central Bank）	• Monetary Policy Bureau of PBC • http://www.pbc.gov.cn/publish/zhengcehuobisi/631/2012/20120706181352694274852/20120706181352694274852_.html	The data is not available for some years.
10-year treasury bond rate	• *China Financial Statistics Yearbook* • *China Financial Statistics Yearbook(English Version)*	The data is not available for 2009, 2005 and 1994.

Table TW.A.2.1 Data Sources of Taiwan

Data	Sources	Notes
Population age, sex and education level	• Department of Household Registration, M.O.I • Taiwan Population *Statistics Yearbook*	
Population aged 6 years and over, by age and sex gender	• Department of Household Registration, M.O.I	
Total Population	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan	

Data	Sources	Notes
Enrollment by education level	• Not available.	
Mortality rate by age and sex	• Department of Household Registration, M.O.I	Data is based on date of occurrence
Birth by sex	• Department of Household Registration, M.O.I	Data is based on the date of occurrence, which is before the end of May in the following year.
Employment rate by age, sex and education level	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan: Human Capital Survey	Before 1999 (included), "College" includes graduates
Consumer Price Index (CPI)	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan	
Enrollment rate	• Taiwan Education Bureau	From 1988, Taiwan started to record enrollment rate of graduates from middle level professional school, so the table includes data from 1988.
Nominal GDP by industry	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan	
Real GDP by industry	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan	
Employed population by industry	• Directorate-General of Budget, Accounting and Statistics, Executive Yuan: Human Capital Survey	Before 1998, based on "Standard industrial Classification (the sixth edition)"; In 1999-2000, based on "standard industrial classification (the seventh edition)"; In 2001-2011, based

Data	Sources	Notes
		on "Standard industrial Classification (the eighth edition)"; In 2012-2019, based on "Standard industrial Classification (the ninth edition)".

2. Data processing

2.1 Basic population data

2.1.1 Census data

Due to direct registration and computer aggregation, the census data do not take into account the left-out population.[44] The total populations from the 1982, 1990, 2000 and 2010 census data published at that time are slightly different from the population released in *China Statistics Yearbook 2011*. Thus, some adjustments need to be made to the population data by age, sex and educational attainment. The adjustment is implemented by the following method. The adjusted urban population by age, sex and educational attainment equals the urban population by age, sex and educational attainment from the census data times the ratio of total urban population released in *China Statistics Yearbook 2010* to the total urban population in the census data. A similar formula is applied to the rural population.

2.1.2 1%-Sample data

We adjust the sample data to match the total rural and urban data. Urban

[44] See Zhang, Weimin and Hongyan Cui (2003),"The estimation accuracy of China Census 2000", *Population Research*, Vol.27, No.4 (July), pp.25-35.

population by age, sex and educational attainment is divided by urban sampling ratio, which is the ratio of urban sample population to urban total population released in *China Statistics Yearbook 2008*. The same method is applied to the rural data.

2.2 New enrollment

2.2.1 Educational category in China

There are six education levels in China: no schooling, primary school, junior middle school (including regular junior middle school and vocational junior middle school), senior middle school (including regular senior middle school, regular specialized middle school and vocational high school), college, and university and above. "College" and "university and above" were combined as "college and above" before 2000.

2.2.2 National enrollment data

The new enrollments by gender of primary school from 1985 to 1990 are not available, so it is assumed that the share of females in the new enrollments equals that in Grade 1.

From 1980 to 1983, we have no information about the share of females in the new enrollments, so we use female share in new enrollment of the closest year.

From 1983 to 2003, we only have the total new enrollment of college and university and the total females in college and university. To get the female enrollments in college and university, we assume that the proportion of female is the same as in college and university enrollments.

From 2004 to 2018, the female enrollment data for university and college is available in the statistic yearbooks. The enrollment of 2018 is obtained by using method of line fitting from 2012 to 2017.

2.2.3 New enrollment data of urban and rural areas

The new enrollments by gender in urban and rural areas in each educational level are not available. We assume that the proportions of female enrollment in urban and rural areas equal the corresponding proportions at the national level.

The new enrollments of specialized middle school are not separated by urban and rural. So we assume that the ratio of urban to rural new enrollments in specialized middle school is the same as that of regular senior middle school.

From 2003 to 2018, the new enrollments of vocational high school are not separated by urban and rural, thus the same processing method is applied as above.

3. Imputation method

We use the perpetual inventory method to impute the population data.

3.1 Perpetual inventory method

The perpetual inventory formula is:

$$L(y,e,a,s) = L(y-1,e,a,s)\cdot\left(1-\delta(y,a,s)\right) + IF(y,e,a,s) \\ -OF(y,e,a,s) + EX(e,a,s)$$

Where $L(y,e,a,s)$ is the population in year y with education level e, age a and sex s. $\delta(y,a,s)$ is the mortality rate. $IF(y,e,a,s)$ is the inflow of population of age a, sex s and education level e in year y. $OF(y,e,a,s)$ represents the outflow of population of age a and sex s and education level e in year y. $EX(e,a,s)$ is a residual term.

$$IF(y,e,a,s) = \lambda(y,e,a,s) \cdot ERS(y,e,s)$$

$$OF(y,e,a,s) = \lambda(y,e+1,a,s) \cdot ERS(y,e+1,s)$$

ERS is the new enrollment of different education levels, λ is the age distribution of new enrollment of different education levels and

$$\sum_a \lambda(y,e,a,s) = 1$$

3.2 Estimate the age distribution λ

A simplified method was used to estimate the age distribution ratio λ. We assume that the enrollment age of primary school, junior high school, senior high school, junior college and above are 7, 13, 16 and 19 respectively:

Table A1.3.2 Enrollment age distribution ratio λ

Age	Primary school	Junior middle school	senior middle school	university
5				
6				
7	1			
8				
9				
10				
11				
12				
13		1		
14				
15				
16			1	

17	
18	
19	1

3.3 Method of imputing population data: 1985-2018

When adopting the perpetual inventory method to estimate the urban and rural population, we ignore migrants between urban and rural China. To take these migrants into account, we make the following adjustments. For example, from 1982 to 1990, we get the estimated 1990 population data by gender, education and age using the perpetual inventory method. The actual 1990 population by gender, education and age subtracting the estimated 1990 population by gender, education and age gives the net migrants between urban and rural China in these eight years. We assume that the number of immigrants in each year is the same, and then we add the average difference to the estimated population data.

4. Some specific problems

4.1 National, rural and urban population at age zero: 1985-2018

4.1.1 National population at age zero

The total population at the end of the year and the birth rates for each year are obtained from Table 3-1 'Population and Its Composition' and Table 3-2 'Birth Rate, Death Rate and Natural Growth Rate of Population' in *China Statistic Yearbook 2011*. We assume that the population at the beginning of a given year equals that at the end of the previous year. Thus, the average of the population at the end of the given year and the previous year is the average population of the given year. The product of the average population and the corresponding birth rate gives the new-born population. Multiplying the new-born population by the survival rate of those aged zero at the corresponding year gives the population at age zero at the end of the year.

(Definition: birth rate, also called gross birth rate, refers to the ratio of the new-born population in a given region during a given period, usually one year, and the average population of the same period. The birth rate here is yearly birth rate, which is calculated from the following equation: Birth rate = (new-born population / average population)* 1000‰, where new-born population is the number of the new-born babies who are alive when they are detached from the mothers no matter how long they have been in their mother's body. Average population is the average of the populations at the beginning and at the end of the year, or the population at the middle of the year.)

4.1.2 Rural and urban population at age zero

The data used include total national population for each year from 1983 to 2018, birth rate for each year from 1983 to 2018, national, rural and urban population by age and gender from the population sampling surveys for 1987 and each year from 1989 to 2018.

The share of urban population at age zero in the national population at age zero can be calculated from these sampling data, and this share is assumed to be the true share. In other words, multiplying it with the national population at age zero produces the urban population at age zero. Further, the gender ratio from the sampling data is also assumed to be true, thus we can divide the urban population at age zero into the two genders. Similar steps are used for the rural population at age zero.

Since there is no population sampling data for 1983-1986 and 1988, we assume the numbers of those aged 1, 3, 4, 5, 6 in 1989 equals the new-born population for 1988, 1986, 1985, 1984 and 1983 with the sampling weights adjusted, respectively. Migration between urban and rural regions is neglected here.

4.2 The death rate of those aged 65 and over

When imputing the population by age, gender and education level with perpetual inventory method, the number of those aged 65 and over should be multiplied by the death rate. The death rate is calculated in the following way. With the population and the death rate, both by age and gender, from the population sampling data for each year, the number of deaths of those aged 65 and over for each year can be calculated. Dividing it by the corresponding total population gives the death rate of those aged 65 and over. Since there is no population sampling data for 1983-1986, 1988 and 1991-1993, the death rate of the closest year is used.

4.3 Application of the age distributions of every education level for each year

The age distributions are obtained from the macro- and micro-level data, and the enrollment numbers for each year are used with adjustments. They change over time, but do not vary between urban and rural region.

Appendix B Mincer Parameters

Main Equation:

$$\ln(inc) = \alpha + \beta \cdot Sch + \gamma \cdot Exp + \delta \cdot Exp^2 + u$$

where *inc* is income; *Sch* is years of schooling; *exp* is years of work experience; α, β, γ, δ are corresponding parameters; u is an error term.

1. Samples and methods

1.1 Surveys

(1) The annual Urban Household Survey (UHS);

(2) Chinese Health and Nutrition Survey (CHNS);

(3) Chinese Household Income Project (CHIP);

(4) China Household Finance Survey (CHFS);

(5) China Family Panel Studies (CFPS)

(6) China Labor-force Dynamics Survey (CLDS)

1.2 Components of income

(1) Main job and Secondary job salaries;

(2) Other cash income from work;

(3) Pension;

(4) The estimated market value of received items;

(5) Various subsidies;

(6) Individual's share of household income according to working-hour share.

1.3 Work experience

Exp = Age–*16*, if *Sch* <10

Exp = Age–*Sch*–6, if *Sch* >9

Exp = 0, if *Exp* <0

1.4 Selection of sample

(1) 16-60 years old for males, and 16-55 years old for females;

(2) Must have information on income and educational attainment;

(3) Students, retirees, people who are unemployed but looking for a job, the disabled, people who are waiting to enter school and housekeepers are excluded.

1.5 Imputation method

(1) To make all parameters comparable, we first use UHS, CHIP, CHNS, CHFS, CFPS, and CLDS to obtain all urban and rural parameters by gender and then compute the annual results by weighting the sample sizes of the available data sets for that year. When both UHS and CHNS are available for a given year, we drop CHNS estimates due to the relatively low quality of income measures.

(2) We use UHS to obtain urban parameters for 1986-1997.

(3) We use CHIP to obtain urban and rural parameters for 1988, 1995, 2002, 2007 and 2013, and urban parameters for 1999.

(4) [45]We use CHNS to obtain urban parameters for 2000, 2004, 2006, 2009, 2011 and 2015, and rural parameters for 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011 and 2015.

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[45] We have urban datasets of UHS for 1989, 1991, 1993 and 1997, so we do not use the CHNS datasets of those years for urban parameter estimation.

(5) We use CHFS to obtain urban and rural parameters for 2010, 2012, 2014 and 2016.

(6) We use CFPS to obtain urban and rural parameters for 2010, 2012, 2014, 2016 and 2018.

(7) We use CLDS to obtain urban and rural parameters for 2014.

As an example, for the intercept term, we can obtain the urban intercept α^u88 (UHS), assuming the sample size is n^u88 (UHS).

We estimate the urban intercept α^u88 (UHS) using UHS 1988, with the sample size of n^u88 (UHS). We also could obtain the urban and rural intercepts α^u88 (CHIP), α^r88 (CHIP), with the sample size of n^u88(CHIP), n^r88(CHIP) respectively. The annual urban and rural intercepts are:

$$\alpha^u 88 = \frac{\alpha^u 88(UHS) \times n^u 88(UHS)}{n^u 88(UHS) + n^u 88(CHIP)} + \frac{\alpha^u 88(CHIP) \times n^u 88(CHIP)}{n^u 88(UHS) + n^u 88(CHIP)}$$

$$\alpha^r 88 = \alpha^r 88(CHIP)$$

The same principle is applied to estimate other parameters for urban and rural areas.

1.6 Parameter α

$$\ln(inc) = \alpha + \beta \cdot Sch + \gamma \cdot Exp + \delta \cdot Exp^2$$

$\hat{y} = \alpha \times e^{\widehat{\ln y}}$, where α is an adjustment factor. We estimate it as follows:

(1) Obtain $\widehat{\ln y}$ from the regression of $\ln(y_i)$ on all right-hand-side variables.

(2) Obtain $\hat{m}_i = e^{\widehat{\ln y}}$.

(3) Regress y_i on $\hat{m}_i$ without the intercept: $\hat{y} = \alpha \times \hat{m}_i$ and keep α.

(4) For the given values *Sch*, *Exp*, *Exp*^2, obtain $\widehat{\ln y}$.

(5) $\hat{y} = \alpha \times e^{\hat{\ln y}}$.

2. Data

We use six well-known household surveys in China. UHS, CFPS, CHNS, CHIP, CHFS, CLDS.

Table B.1 shows the distribution of the six datasets across years.

3. Key variables

3.1. UHS

3.1.1 Definition of income

1) Salaries from working in the state-owned, collective or other institutions;

2) Other income from working units;

3) Private employment income;

4) Income from re-employment after retirement;

5) Other employment income;

6) Other working income;

7) Pension;

8) Price subsidies;

9) Household avocation production income.

3.1.2 Years of schooling

(1)1986-1991

LEVEL	Sch
College	16
Professional school	11
Senior middle school	12
Junior middle school	9
Primary school	6
Others	0

(2)1992-1997

LEVEL	Sch
College	16
Community college	15
Professional school	11
Senior middle school	12
Junior middle school	9
Primary school	6
Others	0

3.1.3 Selection of samples

(1) Include male individuals from 16 to 60 years old and female individuals from 16 to 55 years old;

(2) Discard individuals whose value of regular wage is missing, and individuals who did not to report education information;

(3) Discard individuals who are self-employed, short term contract workers, the retired, job seekers, the disabled, homemakers, students in school, workers waiting for a job assignment, students waiting to enter school, etc.

3.2 CHIP

3.2.1 Definition of income

Urban income definitions:

In 1988 it includes: employment salary and subsidies, other income from work units, pension;

In 1995 it includes: employment salary and subsidies, other income from work units, other goods from work units, pension;

The same principle is applied in CHIP 2002, CHIP 2007 and 2013.

Rural income definitions:

Sum of individual income and household income;

In 1988, individual income includes: regular income, pension, other cash income, and other goods from work units; household income is net household income from agriculture.

In 1995, individual income includes: regular income (such as salary, bonus, and subsidies), pension, other cash income, and received goods from work units; household income is net household income from agriculture.

In 1999, the data set does not include rural information.

In 2002, individual income includes: wages, pensions, subsidies, received goods from work units; household income is net household income from agriculture.

In 2007, it only has the total household income, including both non-agricultural income and agricultural income.

In 2013, it only shows individual's total employment income and household's total disposable income. The employment income includes total wage income or net business income.

3.2.2 Years of schooling

(1)1988

LEVEL	Sch
College and above	16
Professional school	15
Middle level professional, technical or vocational school	11
Upper middle school	12
Lower middle school	9
Junior middle school	6
4 or more years of elementary school	4
1-3 years of elementary school	2
Illiterate or semi-illiterate	0

(2)1995&1999&2002

LEVEL	Sch
College and above	16
Professional school	15
Middle level professional school	11
Upper middle school	12
Lower middle school	9
Elementary school	6
Illiterate or semi-illiterate	0

(3)2007&2013

LEVEL	Sch
Graduate school	18
College and above	16
Professional school	15
Middle level professional, technical or vocational school	11
Upper middle school	12
Lower middle school	9
Elementary school	6
Illiterate or semi-illiterate	0

3.2.3 Selection of samples

(1) Include male individuals from 16 to 60 years old and female individuals from 16 to 55 years old;

(2) Discard individuals whose value of years of schooling is missing, individuals who failed to report education level information;

(3) Keep individuals whose current status is working or employed, or re-employed after retirement;

(4) Discard individuals who are self-employed, private enterprise owners or managers;

(5) Discard individuals whose reported income is 0 or below.

3.3 CHNS

3.3.1 Income variables

Income includes wages, subsidies, other job-related income and household agricultural income. For CHNS, we use the sum of INDINC (Total net individual income, nominal), INDSUB (Individual subsidies) and individual share of HHSUB (Household subsidies) to generate the variable of final individual income.

3.3.1.1 Total net individual income, nominal (INDINC)

Variable: INDINC - Total net individual income, nominal

Data files: INDBUSN - business income
INDFARM - farming income
INDFISH - fishing income
INDGARD - gardening income
INDLVST - livestock income
INDRETIRE - retirement income
INDWAGE - non-retirement wages

a) Non-Retirement Wages

Variable: INDWAGE - Total individual income from all non-retirement wages earned by individuals. Annual wage is calculated for each job recorded in the wage file.

Generally, annual wage income is the months of work times Average Monthly non-Retirement Wage, plus Bonuses and Other Cash or In-Kind Income. For 1989, annualized income from piece work is calculated.

Source:

C3, months worked last year (job level), 1991 - 2011

C8, average monthly wages (job level), 1991 - 2011

C6, wages per piece of completed work, 1989

C7, the average number of pieces completed/work, 1989

I19, the value of bonuses received last year (job level), 1989-2011

I101, other cash income (job level), 2006-2011

I103, the value of other non-cash income (job level), 2006-2011

B2, B3B, B4, B5, B9, B10, filter questions (person level)

b) Retirement Income

Variable: INDRET - Total Individual Retirement Income

Source:

J5, retirement pensions/salaries (individual), 1989 - 2000

B2D, retirement wage from this job (job level), 2004 – 2011

c) Business Income

Variable: INDBUS - Total individual net income from all businesses operated by the household that the individual participates in.

Source:

The individual proportion of net income from household businesses:

H6, Months worked in household business last year

H7, Days per week worked in household business last year

H8, Hours per day worked in household business last year

Total household net income from all household businesses:

H2, Business type

H3, Revenue from this business

H4, Expenses

d) Farming Income

Variable: INDFARM - Total individual net income from farming.

Source:

The individual proportion of net income from household farming:

E4A, months worked on farm last year

E4B, days worked on farm per week last year

E4C, hours worked on farm per day last year

E2A, worked on HH farm/orchard last year (from 2004 on)

E4, 12-month average hours worked on farm per week (1989 only)

Total household net income from farming:

E7, cash for collective farming (individual level), 1989 - 2011

E9, in-kind for collective farming (individual level), 1989 - 2011

E13B, expenses to raise crop (crop level), 1989

E15B, receipts from the sale of the crop (crop level), 1989

E17B, receipts if crop kept had been sold (crop level), 1989

E19B, receipts if crop given away had been sold (crop level), 1989

E13, kg of crop grown (crop level), 1991-1997

E14, kg of crop sold to the government (crop level), 1991-1997

E15, government price for the crop (crop level), 1991-1997

E16, kg of crop sold to the free market (crop level), 1991-1997

E17, the free-market price for the crop (crop level), 1991-1997

E12, expenses to raise all crops (household level), 1991-2011

E14A, receipts from the sale of all crops (household level), 1991-2011

E16A, the value of all crops consumed (household level), 1991-2011

e) Fishing Income

Variable: INDFISH - Individual income from fishing.

Source:

The individual proportion of net income from household farming:

G4A, months worked on fishing last year

G4B, days worked on fishing per week last year

G4C, hours worked on fishing per day last year

G2, filter: worked on fishing last year (from 2004 on)

G4, 12-month average hours worked on fishing per week (1989 only)

Total household net income from farming:

G7, wages received from collective fishing (individual)

G9, the market value of fish received in-kind from the collective (individual)

G11, revenue from fish sales (household)

G13, the value of fish consumed at home (household)

G15, the value of fish given as a gift (household)

G16, expenses of fishing business (household)

f) Gardening Income

Variable: INDGARD - Total individual net income from gardening

Source:

The individual proportion of net income from household gardening:

D3A, months worked on gardening last year

D3B, days worked on gardening per week last year

D3C, hours worked on gardening per day last year

D2A, worked in HH garden last year (from 2004 on)

D3, 12-month average hours worked on gardening per week (1989 only)

Total household net income from household garden or orchard

D5, revenue from the sale of home garden produce, 1989 - 2011

D6, the market value of consumed produce, 1989 - 2011

D7, expenses to grow produce, 1991-2011

g) Livestock Income

Variable: INDLVST - Total individual net income from raising livestock.

Source:

The individual proportion of net HH income (HHLVST) from household livestock business:

F4A, months worked on raising livestock last year

F4B, days worked on raising livestock per week last year

F4C, hours worked on raising livestock per day last year

F2A, raising livestock last year (from 2004 on)

F4, 12-month average hours worked on raising livestock per week (1989 only)

Total household net income from all livestock activities:

F7, wages received from collective animal husbandry (individual)

F9, market value of livestock received in-kind from the collective (individual)

F14, expenses to raise livestock (livestock level)

F15, expenses from using home-grown feed (livestock level)

F17, revenue from the sale of livestock products (livestock level)

F19, the value of livestock products consumed at home (livestock level)

F21, the value of livestock products given as gifts (livestock level)

3.3.1.2 Subsidies

The subsidies include INDSUB (Individual subsidies) and individual share of HHSUB (Household subsidies). We allocate household subsidies equally among household individuals; the household subsidies are divided by the number of members in a household.

INDSUB=(I9+I11+I12+I13+I13A+I14+I14A+I14B)*12

HHSUB=I10A+I15A+I16A+I17A+I21+K47

Source:

ANNUAL subsidies for the following items, at the Household level:

I10A, one-child subsidy, 1991 - 2011

I15A, gas subsidy, 1993 - 2011

I16A, coal subsidy, 1993 - 2011

I17A, electricity subsidy, 1993 - 2011

I21, food/gift/discounts from work unit, 1989 - 2011

K47, childcare subsidy, 1989 - 2011

MONTHLY subsidies for the following items, at the Individual level:

I9, food subsidy, 1989 - 1997

I11, health subsidy, 1989 - 1997

I12, bath/haircut subsidy, 1989 - 1997

I13, book/newspaper subsidy, 1989 - 1997

I13A, housing subsidy, 1989 - 1997

I14, other subsidies, 1989 - 1997

I14A, the average monthly subsidy from job 1, 2000 - 2011

I14B, the average monthly subsidy from job 2, 2004 – 2011

3.3.2 Imputing individual share of household income

Agricultural income includes incomes from five sources: gardening, farming, livestock raising, fishing, and small handicraft and commercial household businesses. These incomes come from either collective or household businesses or both.

We assume each individual's contribution to the household income is proportional to his or her share of time allocated to five activities: gardening, farming, raising livestock, fishing and small handicraft and commercial household business. First, we add up all working hours of all family members in each of these activities. Second, we calculate the working hour share of each member in the family's total hours. Third, we multiply the household income by the share to approximate individual income for each category. Finally, we add up individual income from the four categories for each family member.

3.3.3 Years of schooling

Level	**Sch**
None	0
Completed primary school	6
Junior middle school degree	9
Senior middle school degree	12
Middle technical, professional , or vocational degree	11
3- or 4- year college degree	16
Master's degree or above	18

3.3.4 Selection of sample

(1) Males from 16 to 60 years of age and females from 16 to 55 years of age;

(2) Exclude individuals who are students, unemployed persons, persons with disabilities, scholars to be promoted, or housewives;

(3) Discard individuals whose value of year of schooling, age and sex is missing;

(4) Drop individual whose wage is negative or zero;

(5) First Occupation: We delete samples who's nature of the work is

self-employed, paid family workers, and in the urban sample, we discard individuals, who are private business owner;

(6) Income range: Keep individuals who's income are between 1/20 and 15 times the average income.

3.4 CHFS

3.4.1 Definition of income

(1) The income divides into urban income and rural incomes. Urban income mainly includes wage income and social security income; rural income mainly includes wage income, household income from agriculture and social security income.

(2) Wage income mainly includes three components: wages, bonuses, and allowances. Social Security income mainly includes three components: social endowment insurance, retirement and pensions.

3.4.2 Personal income distribution of agricultural production

In rural income, wage income and social security income are personal income, but the income of agricultural production is household income. Therefore, it is necessary to determine how the household income is allocated to individuals and thus calculate the total personal income.

(1) Allocation method

Step 1: Statistics for each family on farming and agricultural production should be recorded as working as family labor.

Step 2: Calculation of family practitioners produced income, and apportioned to individual farming, sharing: Family net income of agricultural production / Labor force engaged in agricultural household production.

3.4.3 Years of schooling

Level	Sch
No school	0
Primary school	6
Junior middle school	9
Senior middle school	12
Middle professional degree	11
Post-secondary professional degree	15
College	16
Master’s degree	18
PhD degree	22

3.4.4 Selection of samples

(1) Include male individuals from 16 to 60 years old and female individuals from 16 to 55 years old.

(2) Discard individuals whose value of year of schooling is missing, individuals who did not report education level information.

(3) Keep individuals whose current status is working or employed, or re-employed after retirement.

(4) First Occupation:

In urban samples of 2010, we discard individuals, who work for businesses or private companies; self-employed individuals farmers at home, and other samples, and we delete samples without income data sample. In the rural sample of 2010, we delete the samples without income data. In the urban sample of 2012, we discard individuals, who work for businesses or private companies; self-employed individuals farmers at home and other samples; and seasonal jobs, and we delete samples without income data sample. In the rural sample of 2012, we delete the samples without income data.

(5) Second Occupation: Urban and rural samples without income data

are deleted from the sample.

(6) Family agricultural production and management: Rural sample households engaged in agricultural production but we delete samples without income data.

Attention: Some units of income are ten thousand Yuan.

(7) Family agricultural production and management: Urban sample households engaged in agricultural production were deleted samples.

(8) Social Security Income: Rural and urban samples were deleted with the relevant guaranteed income but without income data.

3.5 CFPS

3.5.1 Definition of income

(1) The income divides into urban income and rural incomes. Urban income mainly includes wage income and social security income; rural income mainly includes wage income, household income from agriculture and social security income.

(2) Wage income mainly includes three components: wages, bonuses and allowances. Social Security income mainly includes three components: social endowment insurance, retirement and pensions.

(3) Agriculture income refers to the net income from farming, gardening, livestock, fishing and side-line occupation.

3.5.2 Personal income distribution of agricultural production

In rural income, wage income and social security income are personal income, but the income of agricultural production is household income. Therefore, it is necessary to determine how the household income is allocated to individuals, and thus calculate the total personal income.

(1) Allocation method

Step 1: statistics for each family on farming and agricultural production should be recorded as working as family labor.

Step 2: Calculation of family practitioners produced income, and apportioned to individual farming, sharing: Family net income of agricultural production / Labor force engaged in agricultural household production.

3.5.3 Years of schooling

Level	Sch
No school	0
Primary school	6
Junior middle school	9
Senior middle school/ Middle professional degree	12
College /Post-secondary professional degree	15
university	16
Master's degree	18
PhD degree	22

3.5.4 Selection of samples

(1) Include male individuals from 16 to 60 years old and female individuals from 16 to 55 years old.

(2) Discard individuals whose value of year of schooling is missing, individuals who did not report education level information.

(3) Keep individuals whose current status is working or employed, or re-employed after retirement.

(4) First Occupation:

In the urban sample, we discard individuals, who work for businesses or private companies; self-employed individuals farmers at home, and other samples, and we delete samples without income data. In the rural sample, we delete the samples without income data.

(5) Second Occupation: Urban and rural samples without income data were deleted from the sample.

(6) Family agricultural production and management: Rural sample households engaged in agricultural production but we delete samples without income data.

(7) Social Security Income: Rural and urban samples were deleted with the relevant guaranteed income but without income data.

3.6 CLDS

3.6.1 Definition of income

(1) The income divides into urban income and rural incomes. Urban income mainly includes wage income; rural income mainly includes agriculture income and agricultural government subsidies.

(2) Wage income mainly includes three components: wages, bonuses and allowances.

(3) Agriculture income refers to the net income from farming, gardening, livestock, fishing and side-line occupation.

3.6.2 Personal income distribution of agricultural production

In rural income, agriculture income and agricultural government subsidies are household income. Therefore, it is necessary to determine how the household income is allocated to individuals, and thus calculate the total personal income.

(1) Allocation method

Step 1: Calculation of the whole hours for farm work of each family members according to the days of agricultural production in this year for the individual, the average number of hours a day to do farm work in the busy season, and the number of hours a day to do farm work in slack season.

Step 2: Calculation of the ratio of each family practitioner farm work hours to the whole farm work hours for the family. We could obtain personal rural income by calculating family rural income times each person's ratio of farm work.

3.6.3 Years of schooling

Level	Sch
No school	0
Primary school	6
Junior middle school	9
Senior middle school/ Middle professional degree	12
College /Post-secondary professional degree	15
university	16
Master's degree	18
PhD degree	22

3.6.4 Selection of samples

(1) Include male individuals from 16 to 60 years old and female individuals from 16 to 55 years old.

(2) Discard individuals whose value of year of schooling is missing, individuals who did not report education level information.

(3) Drop individuals whose current status is farming, employers, or self-employed in the urban area.

(4) Drop students.

(5) Drop individual whose wage is zero.

4. Imputing parameters

4.1. Imputation method of urban parameters

4.1.1 Parameter estimates based on UHS, CHIP, CHNS, CHFS

We use UHS, CHIP, CHNS, CHFS, CFPS data to estimate the earnings equation by gender and year. Table B.1.1-B.1.4 contain means and standard deviations of each variable for UHS, CHIP, CHNS, CHFS, and CFPS.

4.1.2 General idea about imputation

We use UHS, CHIP, CHNS, CHFS, CFPS and CLDS to estimate parameters of the basic Mincer equation, and obtain the fitted values for the intercept, return to education, and experience related terms. They are weighted by respective sample size if more than one sample is available. Then we use the parameter estimates to fit a time trend model, and then obtain the fitted values of each parameter by gender for the years 1985-2017. These fitted values are the final urban imputed parameters.

4.1.3 Specifications

We treat α , β , γ , δ separately and use the parameters for each group as the dependent variable and use time (i.e., year) as the independent variable.

For α , β , γ and δ , we use the linear time trend model. The regression equation is: $Y = a0 + a1 * time + u$.

For α , β , γ and δ , we assume that they increase or decrease at a constant rate each year. Taking the α _male as an example, we assume that the intercept increases at the growth rate of a1 per year.

Figure B.1- Figure B.8 show the parameter estimates for each group and the sample regression lines of the time trend models. The fitted values of the time trend models are the values of our imputed parameters for the period 1985 to 2018.

Tables and figures of appendix B

Table B.1 Micro Datasets

Year	UHS	CHIP	CHNS	CHFS	CFPS	CLDS
1985	U					
1986	U					
1987	U					
1988	U	U/R				
1989	U		U/R			
1990	U					
1991	U		U/R			
1992	U					
1993	U		U/R			
1994	U					
1995	U	U/R				
1996	U					
1997	U		U/R			
1998						
1999		U				
2000			U/R			
2001						
2002		U/R				
2003						
2004			U/R			
2005						
2006			U/R			
2007		U/R				
2008						
2009			U/R			
2010				U/R	U/R	
2011			U/R			

Year	UHS	CHIP	CHNS	CHFS	CFPS	CLDS
2012				U/R	U/R	
2013		U/R				
2014				U/R	U/R	U/R
2015			U/R			
2016				U/R	U/R	
2017						
2018					U/R	

Note: CHIP: Chinese Household Income Project

UHS: Urban Household Survey

CHNS: China Health and Nutrition Survey

CHFS: China Household Finance Survey

CFPS: China Family Panel Studies

CLDS: China Labor-force Dynamic Survey

Table B.1.1 Summary Statistics: UHS Samples

Year	Variables	Male		Female	
		Mean	**S.D.**	**Mean**	**S.D.**
	inc	1486.532	548.3841	1243.416	446.7642
1986	Sch	10.47865	2.919399	9.764368	2.788257
	Exp	20.47541	11.05743	17.80029	9.503479
1987	inc	1543.903	611.6541	1293.861	495.0336
	Sch	10.60941	2.911555	9.841867	2.710019
	Exp	21.04009	10.88748	18.42951	9.460324
1988	inc	1978.878	850.5979	1641.855	714.4136
	Sch	10.77356	2.931209	9.940273	2.766294
	Exp	20.67055	10.90293	17.99023	9.373456
1989	inc	2265.281	1012.228	1896.05	867.0767
	Sch	10.92746	2.965865	10.11012	2.690659
	Exp	20.8418	10.94331	18.31607	9.332533

1990	inc	2492.834	1087.999	2095.215	926.8817
	Sch	11.09685	2.925453	10.2875	2.701699
	Exp	21.2045	10.79883	18.541	9.304266
1991	inc	2739.452	1165.517	2329.817	1008.187
	Sch	11.26714	2.945501	10.50215	2.65431
	Exp	20.72	10.51704	18.24979	9.01576
1992	inc	3227	1682.20	2715.65	1298.94
	Sch	11.41	2.76	10.72	2.56
	Exp	21.05	10.55	18.69	9.00
1993	inc	4293.68	2777.62	3623.46	2299.25
	Sch	11.39	2.72	10.75	2.55
	Exp	21.41	10.55	19.12	9.07
1994	inc	5934.77	4036.38	4935.77	3391.77
	Sch	11.51	2.77	10.93	2.49
	Exp	21.25	10.54	18.96	9.07
1995	inc	7187.35	4701.14	6033.56	4018.84
	Sch	11.61	2.72	10.97	2.48
	Exp	21.49	10.26	19.23	8.94
1996	inc	7969.58	5466.77	6683.32	4888.78
	Sch	11.64	2.69	11.07	2.43
	Exp	21.80	10.28	19.58	8.96
1997	inc	8554.39	6037.77	7107.18	5311.87
	Sch	11.64	2.69	11.12	2.42
	Exp	22.03	10.10	19.75	8.96

Table B.1.2 Summary Statistics: CHNS samples

Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1989	inc					1398.24	1259.78	1199.39	1074.94
	Sch					6.30	4.04	4.64	4.34
	Exp					17.88	11.47	16.19	10.32
1991	inc					1468.11	1306.13	1260.93	1139.13
	Sch					6.72	3.92	4.86	4.32
	Exp					18.41	11.51	17.09	10.45
1993	inc					2104.87	1911.41	1752.71	1491.15
	Sch					7.11	3.71	5.26	4.29
	Exp					19.28	11.55	17.99	10.32
1997	inc					4517.69	3818.30	3588.66	2958.12
	Sch					7.37	3.51	5.51	4.20
	Exp					20.60	11.57	19.33	10.58
2000	inc	10112.61	10832.57	8216.76	8367.89	5332.65	4511.72	4166.85	3346.32
	Sch	11.41	2.98	11.23	2.95	7.99	3.24	6.42	4.11
	Exp	21.06	10.28	18.49	9.26	21.32	11.60	20.46	10.49
2004	inc	14440.98	11543.27	13080.04	10584.54	7254.25	6479.61	5722.63	4963.01
	Sch	11.48	2.81	11.52	2.57	8.29	3.17	6.67	4.09
	Exp	23.21	9.97	20.48	8.84	25.08	10.90	23.20	9.70
2006	inc	19009.48	21177.45	15916.35	16025.81	10173.17	8371.42	7480.72	6806.45
	Sch	11.92	2.82	12.07	2.85	8.43	3.57	6.82	4.36
	Exp	24.82	9.50	20.92	8.72	25.71	10.81	23.66	9.50
2009	inc	26775.71	27500.44	21608.55	20930.16	14634.10	11684.12	12023.12	9507.12
	Sch	11.69	2.88	12.00	2.76	8.32	3.33	7.31	4.11
	Exp	25.64	9.96	21.36	9.43	26.31	10.93	23.91	9.71
2011	inc	39813.88	38432.37	36982.66	36946.27	21927.65	17409.49	16949.41	13000.58
	Sch	12.74	3.16	13.26	3.10	8.74	3.50	7.65	4.15
	Exp	24.01	11.11	18.80	9.76	27.05	10.73	24.55	9.42

2015	inc	60266.71	77971.86	56864.46	92045.41	34861.94	24164.65	29325.26	21387.12
	Sch	13.42	2.95	13.78	2.92	10.13	2.77	10.12	3.13
	Exp	24.24	10.82	19.90	9.33	25.06	11.70	21.57	10.59

Table B.1.3 Summary Statistics: CHIP samples

Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1988	inc	1933.25	947.00	1632.07	834.47	953.01	880.75	852.15	761.52
	Sch	10.70	2.92	10.00	2.75	7.16	3.28	5.02	3.88
	Exp	20.96	10.97	18.25	9.43	18.33	12.39	15.41	10.88
1995	inc	6661.15	3771.24	5440.83	3059.29	4536.05	3533.31	4293.76	3115.17
	Sch	11.58	2.85	10.85	2.72	7.95	2.82	6.27	3.41
	Exp	22.46	10.80	20.59	9.65	21.26	11.92	20.05	11.17
1999	inc	9431.35	5666.40	7757.61	5112.18				
	Sch	12.05	2.74	11.74	2.57				
	Exp	22.72	10.09	20.74	9.18				
2002	inc	12428.98	7905.79	10016.43	7252.22	5250.24	5049.25	3694.44	3794.98
	Sch	12.19	2.81	11.98	2.59	8.52	2.76	6.88	3.68
	Exp	23.80	10.06	21.25	9.22	21.82	12.07	19.84	11.05
2007	inc	31521.57	29229.78	23380.43	17992.01	13677.31	9934.99	10136.26	7731.68
	Sch	12.78	3.03	12.86	2.87	10.54	2.38	7.55	2.52
	Exp	21.49	11.07	17.62	9.74	22.37	12.81	19.39	11.36
2013	inc	46024.87	33002.89	35958.59	25805.72	21041.66	16491.36	19709.65	15149.22
	Sch	12.65	3.06	12.84	3.05	9.16	2.60	8.66	3.11
	Exp	21.96	10.89	18.75	9.61	22.70	12.34	20.95	11.02

Table B.1.4 Summary Statistics: CFPS samples

Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
2010	inc	31478.54	32080.28	23329.77	20280.96	11807.60	12406.63	7294.23	7956.00
	Sch	11.16	3.76	11.39	3.95	6.80	4.14	5.01	4.43
	Exp	21.52	11.36	17.75	10.00	25.58	11.14	23.56	9.59
2012	Inc	32218.61	32512.06	23076.81	23047.57	18987.82	16528.45	11354.48	11942.87
	Sch	10.47	3.72	10.69	3.97	8.17	3.68	6.46	4.45
	Exp	22.28	11.67	19.32	10.37	23.63	12.05	22.23	10.47
2014	Inc	39021.10	30071.84	29781.15	32905.47	21970.64	20413.34	13408.08	14837.86
	Sch	10.47	4.01	10.69	4.30	7.08	4.18	5.60	4.63
	Exp	21.47	11.92	18.84	10.46	24.64	11.95	23.53	10.36
2016	Inc	45882.20	43892.81	34634.79	36429.07	26768.87	23875.00	18950.96	18700.14
	Sch	9.31	4.23	9.58	4.48	6.43	3.97	6.33	4.76
	Exp	19.27	12.37	16.89	11.09	24.86	12.20	21.78	12.07
2018	Inc	55012.92	42880.99	41629.23	33770.06	26697.59	21397.82	16266.97	16007.60
	Sch	11.00	3.36	11.43	3.53	8.22	2.75	7.27	3.31
	Exp	21.19	11.66	18.98	10.35	26.74	11.63	25.50	10.46

Table B.1.5 Summary Statistics: CHFS samples

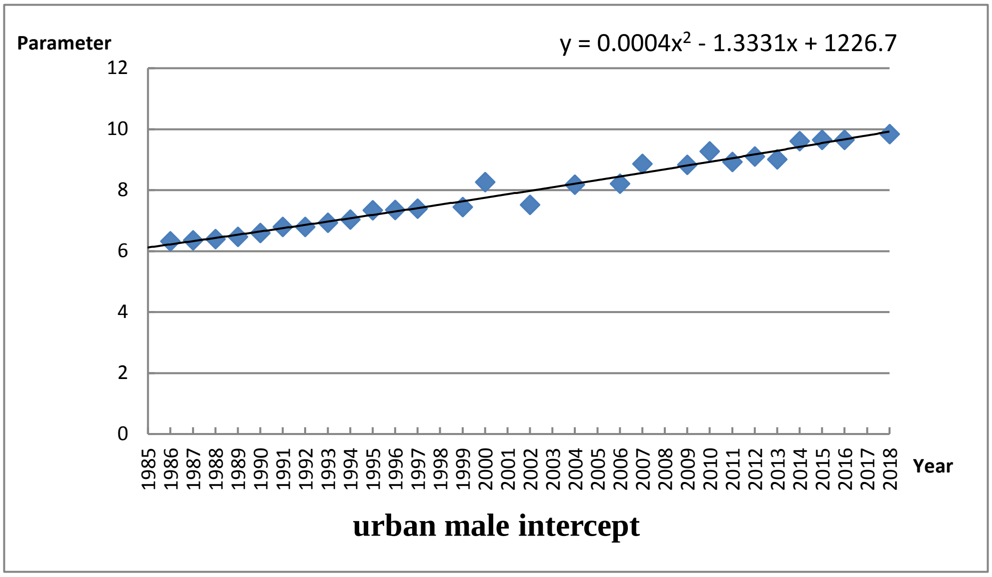
Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
2010	inc	38350.09	50580.68	30434.63	31834.97	9876.40	12050.69	6545.16	9460.94
	Sch	11.85	3.50	11.96	3.57	8.02	3.02	6.67	3.54
	Exp	21.70	10.26	18.50	8.91	28.05	10.30	25.07	9.44
2012	inc	46309.61	50884.25	37000.66	38612.57	17501.20	16639.32	12178.25	12480.30
	Sch	12.44	3.38	12.72	3.48	8.59	3.09	7.57	3.71
	Exp	19.52	11.24	16.07	9.97	22.72	12.40	20.85	11.27

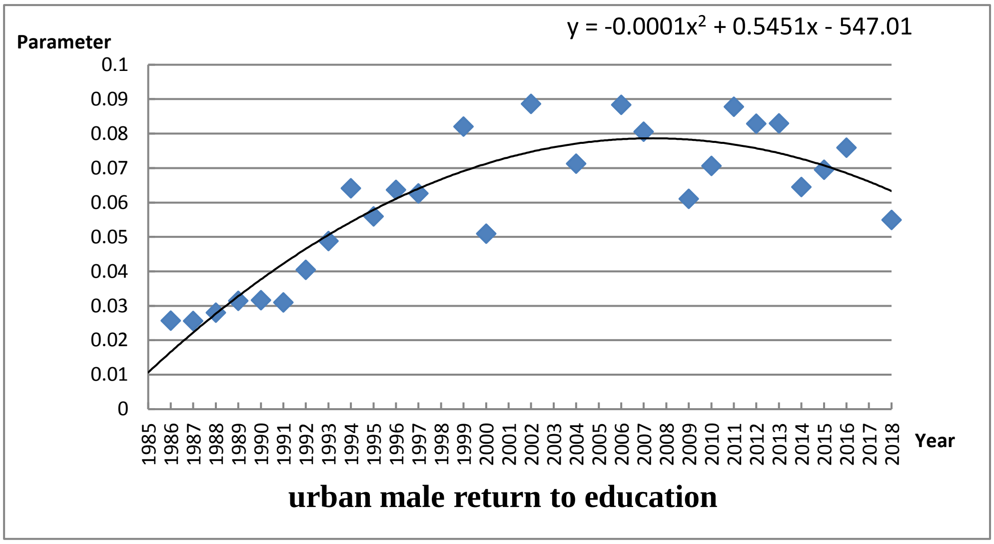
Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
2014	inc	53131.18	35959.70	45585.92	31525.14	25846.90	19064.36	21018.34	15456.64
	Sch	12.36	3.43	12.82	3.47	9.18	2.99	8.58	3.61
	Exp	20.25	11.19	16.67	9.84	21.99	12.46	19.85	11.64
2016	inc	62335.44	57570.01	52939.53	46608.30	27777.48	21441.46	21866.89	18427.60
	Sch	12.19	3.45	12.68	3.60	8.89	2.99	8.14	3.77
	Exp	21.47	11.45	18.08	10.09	23.90	12.26	22.48	11.42

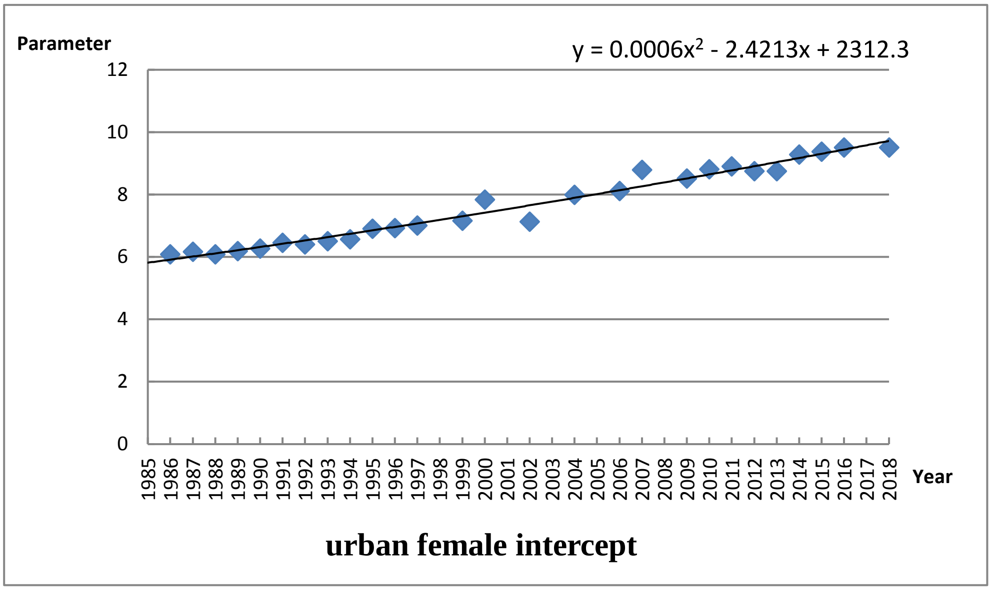
Table B.1.6 Summary Statistics: CLDS samples

Year	Variables	Urban				Rural			
		Male		Female		Male		Female	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
2014	inc	49140.28	46818.38	39476.19	41543.86	26174.77	33250.29	18752.97	31854.3
	Sch	13.04	2.93	13.35	2.94	8.98	2.46	8.56	2.58
	Exp	21.87	11.30	17.72	9.87	24.78	11.85	21.701	10.48

Figures B.1-B.4 Parameter Estimates Against Time: Urban sample



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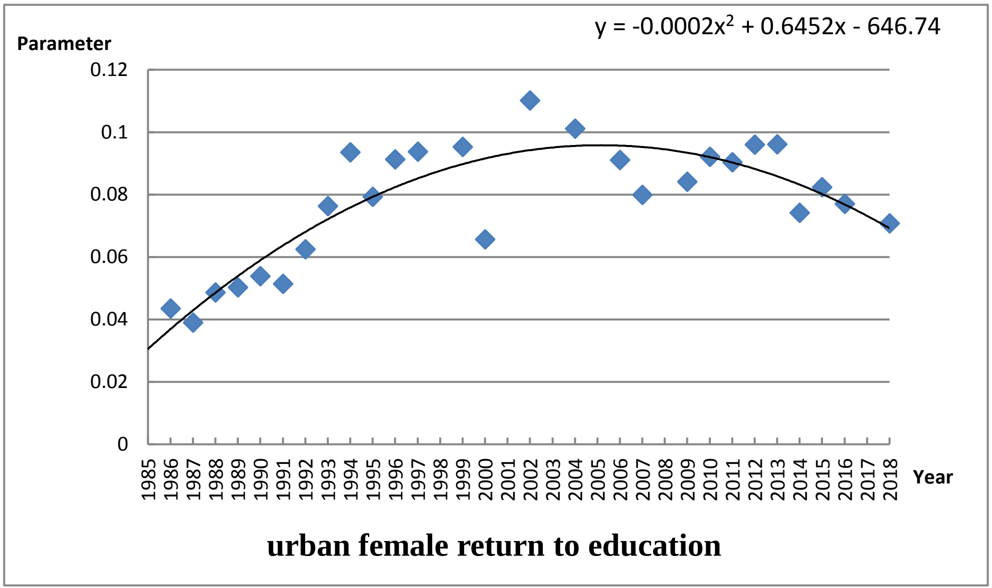
12
10
8
6
4
2
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
urban female intercept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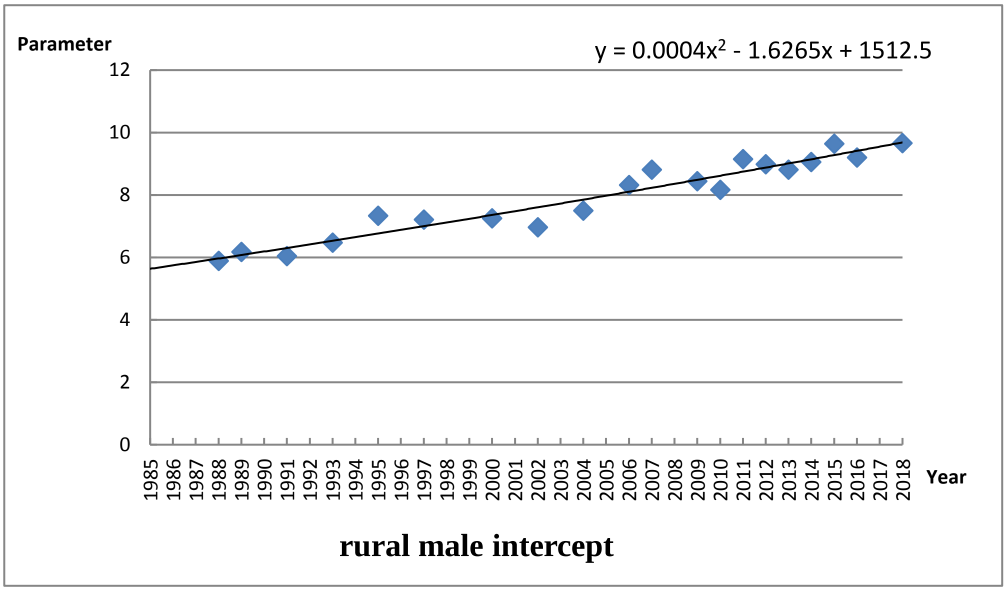
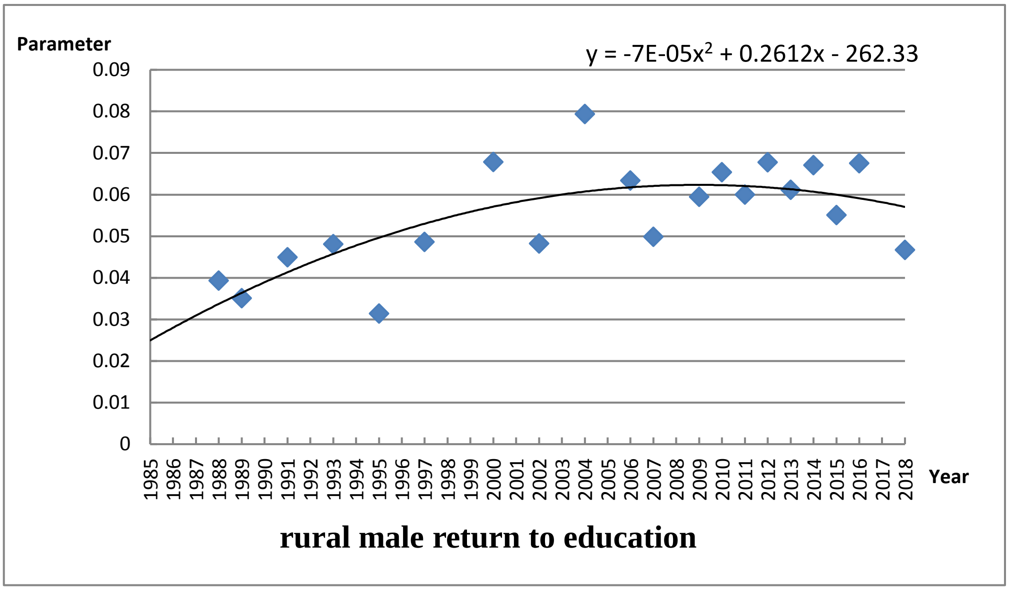
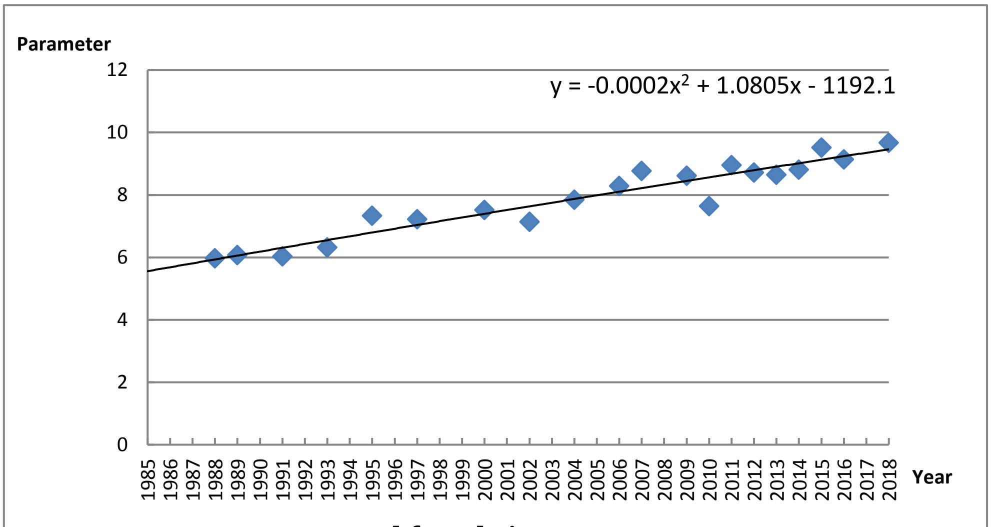
Parameter
0.12
0.1
0.08
0.06
0.04
0.02
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
urban female return to education

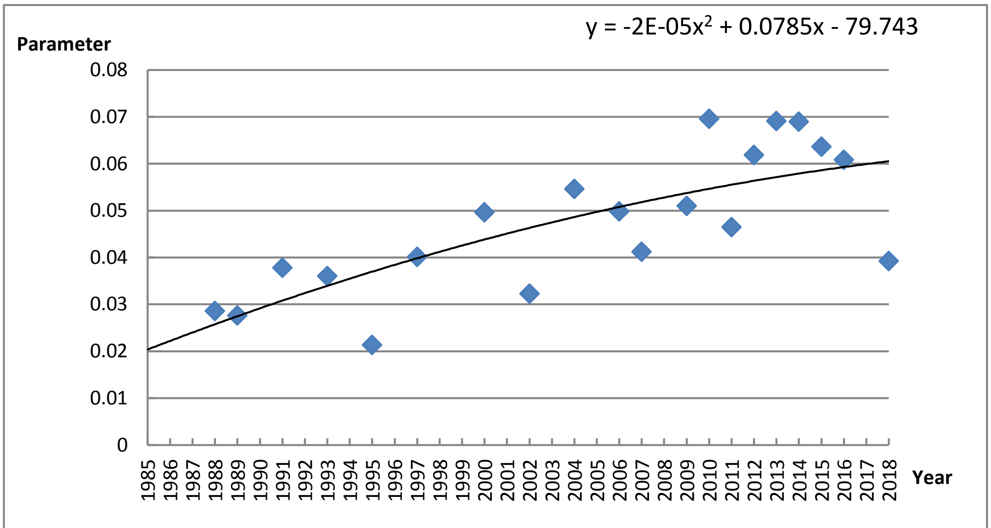
Figures B.5-B.8 Parameter Estimates Against Time: Rural Samples







rural female intercept



rural female return to education

Appendix C Human Capital Stock Calculation

This section summarizes the basic methods and procedures for estimating China's human capital stock from 1985 to 2018 based on the J-F approach. In particular, it explains estimations on some of the variables necessary for the J-F approach based on China's data. We use the following notations:

y indicates calendar years from 1980 to 2018. s indicates sex equaling to one and two for males and females, respectively. a indicates age ranging from 0 to 60 years. e indicates the levels of education as five categories for the years 1985-2000 including no schooling (ns), primary school (pri), junior middle school (jm), senior middle school (sm), and college (col). For the years 2000-2018, the levels of education (e) are classified as six categories including no schooling (ns), primary school (pri), junior middle school (jm), senior middle school (sm), college (col) and university (uni).

Variables used for measuring the human capital stock:

whrs(y,s,a,e): annual market hours worked per employed person in year y with sex s, age a , and education level e;

empr(y,s,a,e): employment rate in year y for persons with sex s, age a, and education level e;

mhrs(y,s,a,e): market labor time per capita in year y for persons with sex s, age a, and education level e;

com(y,s,a,e): hourly compensation net of taxes on labor income for persons with sex s, age a, and education level e;

yinc(y,s,a,e): annual income of the employed in year y with sex s, age a, and education level e;

ymi(y,s,a,e): annual market income per capita net of tax on labor compensation in year y for persons with sex s, age a , and education level e;

sr(y,s,a): survival rate in year y for persons with sex s and age a;

employed(y,s,a,e): population employed in year y with sex s, age a, and education level e;

pop(y,s,a,e): population in year y with sex s, age a, and education level e;

newEnroll(y,s,a,e): population enrolled in education level e in year y, with sex s and age a;

pop_inschool(y,s,a,e-n): number of people in school in year y with sex s, age a, education level e, and grade n+1;

where e-n represents students in grade n+1 of education level e

senr(y,s,a,e+1,e-n): share of people enrolled in the next education level e+1 and in school in year y with sex s, age a , education level e, and grade n+1;

mi(y,s,a,e): human capital of the population not in school in year y with sex s, age a , and education level e;

R = (1+real growth rate of income)/(1+discount rate);

pop_inschool(y,s,a,e): number of people in school in year y with sex s, age a, and education level e;

pop_nischool(y,s,a,e): number of people not in school in year y with sex s, age a, and education level e;

Le(y): total population with education level e in year y;

Ls(y): total population with sex s;

Mi(s): human capital for both sexes (nominal income);

v_e: share of the present value of human capital for the population with education level e;

$\overline{v}_e$: average share of the present value of human capital for the population with education level e;

$\overline{V}_s$: average share of the present value of human capital for the population with sex s;

ΔlnK: growth rate of the aggregate human capital stock;

Poplog(y,s): logarithmic growth rate of the population for sex s in year y;

Mitg (y): cumulative growth rate of the aggregate human capital stock;

MiQ(y): total human capital in year y measured in the base year's prices.

1. Schooling and work status by age for calculating human capital using the J-F approach

no school or work	0-6
school only	7-15
work and school	16-a
work only	a-59
Retirement	male：60+；female：55+

(1) When calculate human capital using the J-F approach, the retirement age is 60 for males and 55 for females. The legal retirement ages were set by the second meeting of the fifth NPC Standing Committee on May 24, 1978. Detailed regulations are described in "The Temporary Method of Settling the Old, Weak, Ill, and Disabled Cadre by the State Council" and "The Temporary Method of Settling the Retired Workers by the State Council" (1978, No.104). In general, the legal retirement age is 60 for males, 50 for female workers and 55 for female cadres. However, for workers who work in high temperature, high elevation, highly exhausting conditions, or harmful conditions, the legal retirement age is 55 for males and 45 for females. For people who become disabled due to illnesses approved by the Labor Ability

Appraisal Committee, the legal retirement age is 50 for males and 45 for females.

(2) *a* in the table is the upper bound of "work and school", and the lower bound of "work only". This is determined according to the calculation of the lower bound of people in school in each year. The method of calculating people in school is discussed in section 3.2.

2. Estimation of annual market income ymi(y,s,a,e)

2.1 Estimation of annual income of the employed

2.1.1 Estimation of annual income of the employed using Mincer equation

Using data from CHIP (Chinese Household Income Project), CHNS (China Health and Nutrition Survey), UHS (Urban Household Survey), CHFS(China Household Finance Survey) and CFPS(Chinese Family Panel Studies), we regress the logarithm of annual income *ln yinc* on years of schooling *sch*, work experience *exp* and work experience squared exp^2 by OLS.

$$\ln(inc) = \alpha + \beta \cdot Sch + \gamma \cdot Exp + \delta \cdot Exp^2 + u$$

We use the fitted value of ln yinc from the equation above to obtain $m_i = e^{\ln yinc}$. We regress the annual income observed in the survey data on m_i using the OLS (without the intercept) to obtain the coefficient on m_i, α.[46] Finally, we estimate the annual income of the employed as yinc=$\alpha \times e^{\ln yinc}$.

[46] Jeffrey M. Wooldridge (2005), Introductory Econometrics: A Modern Approach, 3rd edition.

Note that the annual income used for estimating the Mincer equation is in real terms with 1985 as the base year.

2.1.2 Coding of schooling and work experience in the Mincer equation

(1) Coding of years of schooling:

	No schooling	**Primary school**	**Junior middle school**	**Senior middle school**	**College**	**University**
1985-1999	0	6	9	12	15	-
2000-2018	0	6	9	12	15	16

(2) Coding of work experience:

For people younger than age 16, work experience is *exp*=0;

For people older than age 16, if s<10, work experience is *exp*=*age*-6;

For people older than age 16, if s≥10, work experience is *exp*=*age*-*sch*-6

2.2 Estimation of annual market income

After estimating the annual income of the employed using the Mincer equation, we obtain $\mathrm{yinc}_{y,s,a,e} = \mathrm{whrs}_{y,s,a,e} \times \mathrm{com}_{y,s,a,e}$.

Given that

$$\mathrm{mhrs}_{y,s,a,e} = \mathrm{whrs}_{y,s,a,e} \times \mathrm{empr}_{y,s,a,e}\ ,\quad \mathrm{ymi}_{y,s,a,e} = \mathrm{whrs}_{y,s,a,e} \times \mathrm{empr}_{y,s,a,e} \times \mathrm{com}_{y,s,a,e}$$

the annual market income is given by:

$$\mathrm{ymi}_{y,s,a,e} = \mathrm{yinc}_{y,s,a,e} \times \mathrm{empr}_{y,s,a,e}\ .$$

2.2.1 Calculation of employment rate empr(y,s,a,e)

To calculate the employment rate, empr(y,s,a,e), by age, sex and educational for individuals older than 16, we use the data from census years of 1987, 1995, 2000, 2005 and 2010 and replace middle years' employment rates by the average of these years.

We assume that the employment rate of college graduates is the same as that of university graduates.

The formula used to calculate the employment rate is:

$$empr(y,s,a,e)=[employed(y,s,a,e)]/pop(y,s,a,e)$$

The data sources of employment rates are listed in the table below:

Data	**Sources**
The employed by age, sex and education Level in 1987	"China Population Census 1987"
Population by age, sex and education level in 1987	"China Population Census 1987"
The employed by age, sex and education level in 1995	"China Population Census 1995"
Population by age, sex and education level in 1995	"China Population Census 1995"
The employed by age, sex and education level in 2000	"China Population Census 2000"
Population by age, sex and education level in 2000	"China Population Census 2000"
The employed by age, sex and group in 2005	"China Population Census 2005"
The employed by age, sex and education level in 2005	"China Population Census 2005"
Population by age, sex and education level in 2005	"China Population Census 2005"
The employed by age group, sex and education in 2005	"China Population and Employment Statistics Yearbook 2006"
The employed by age group, sex in 2010	"China Population and Employment Statistics Yearbook 2010"
The employed by age group, sex and education in 2010	"China Population and Employment Statistics Yearbook 2010"
Population by age, sex and education in 2010	"China Population Census 2010"
The employed by age group, sex and education in 2010	"China Population and Employment Statistics Yearbook 2011"
The employed by age group, sex in 2015	"China Population and Employment Statistics Yearbook 2015"
The employed by age group, sex and education in 2015	"China Population and Employment Statistics Yearbook 2015"

Population by age, sex and education in 2015	"China Population Census 2015"
The employed by age group, sex and education in 2015	"China Population and Employment Statistics Yearbook 2016"

Note: The 1% sample population in 1995 is converted to the total population by the actual sampling percentage of 1.03%.

The employed in "China Population Census 2000" for each province, autonomous region and municipality is aggregated to get the total population employed by the actual sampling percentage of 9.5%. To divide the age group data in 2005 and 2010 we assume that the employment rate in each age in the same age group has the same increasing rate. For example, the employment rate of a 25-year-old individual in 2005 equals to the employment rate of a 25-year-old individual in 2000 times the growth rate of the employment rate of the individual's corresponding age group (25-29) between 2000 and 2005.

3. Calculation of enrollment rate

Enrollment rate is the share of people with education level *e* enrolled in a higher level of education *e*+1.

3.1 Calculation of enrollment by sex, age and education level

Based on the age distribution of the enrollment number for a certain education level and sex, the enrollment number in each year by sex, age and education level is given by:

$$\text{NewEnroll}(y,s,a,e) = \text{NewEnroll}(y,s,e)*\lambda(y,s,a,e)$$

$$\sum_a \lambda(y,s,a,e) = 1$$

Note that λ(y,s,a,e) refers to the age distribution of the enrollment number for each education level and sex.

There is no college or university in rural areas, so the enrollment number of college and university in rural areas is assigned to be 0.

3.2 In-school population of each education level and each grade

The in-school population of age *a*, sex *s*, education level *e*, and grade *n*+1 in year *y* is the enrolled population of age a-n, sex s, and education level e in year y-n:

pop_inschool(y,s,a,e-n)= NewEnroll (y-n,s,a-n,e)

3.3 Enrollment rate of each education level and each grade

The probability of advancing to the next higher level of education is estimated as the average ratio of the sum of all students of any age in a year initially enrolled to the sum of all students of any age initially enrolled in the next higher level of education *X* years later, where *X* is the number of years it takes to complete an education level.

3.3.1 Enrollment rate from no schooling to primary school

The formula of the enrollment rate from no schooling to primary school is:

senr(y,s,a,pri-ns) = Newenroll(y+1,s, pri)/ pop(y,s,ns)

The upper(lower) bound of people out of school in year y and enrolled into primary school in year y+1 is determined by the upper(lower) bound of the age distribution for enrollment of primary school in year y+1.

3.3.2 Enrollment rate from primary school to junior middle school

The steps of calculating this enrollment rate by sex and age in year y are as follows:

(1) The enrollment rate of the first grade of primary school in year y by age and sex is the average enrollment rate that the group in this grade can be enrolled in the first grade of junior middle school six years later, and the formula is:

senr(y,s,a,jm-pri) = newEnroll (y+6, s, jm)/ newEnroll (y, s, pri)

(2) The population of the second grade of primary school in year y by age and sex is the enrolled population of primary school in year y-1 by age and sex. The probability that the group in this grade can be enrolled in junior middle school 5 years later is the average enrollment rate that the group in this grade can be enrolled in the first grade of junior middle school five years later, and the formula is:

senr(y,s,a,jm-pri-1) = newEnroll (y+5,s,jm)/ newEnroll (y-1,s,pri)

(3) The population of the third grade of primary school in year y by age and sex is the enrolled population of primary school in year y-2 by age and sex. The probability that the group in this grade can be enrolled in junior middle school 4 years later is the average enrollment rate that the group in this grade can be enrolled in the first grade of junior middle school four years later, and the formula is:

senr(y,s,a,jm-pri-2) = newEnroll (y+4,s,jm)/ newEnroll (y-2,s,pri)

(4) Similarly, we can calculate the probability of the group of each grade in primary school being enrolled in junior middle school in year y.

3.3.3 Enrollment rate from junior middle school to senior middle school

The steps of calculating this enrollment rate by sex and age in year *y* are as follows:

(1) The enrollment rate of the first grade of junior middle school in year y by age is the average enrollment rate that the group in this grade can be enrolled in the first grade of senior middle school three years later, and the formula is:

senr(y,s,a,sm-jm) = newEnroll (y+3,s,sm)/ newEnroll (y,s,jm)

(2) The population of the second grade of junior middle school in year y by age and sex is the enrolled population of junior school in year y-1 by age and sex. The probability that the group in this grade can be enrolled in senior middle school two years later is the average enrollment rate that the group in this grade can be enrolled in the first grade of senior middle school two years later, and the formula is:

senr(y,s,a,sm-jm-1) = newEnroll (y+2,s,sm)/ newEnroll (y-1,s,jm)

(3) Similarly, we can calculate the probability of the group of each grade in junior middle school being enrolled in senior middle school in year y.

3.3.4 Enrollment rate from senior middle school to college or university

The steps of calculating the enrollment rate from senior middle school to college by sex and age in year *y* are as follows:

(1) The enrollment rate of the first grade of senior middle school in year *y* by age is the average enrollment rate that the group in this grade can be enrolled in the first grade of college three years later, and the formula is:

senr(y,s,a,col-sm) = newEnroll (y+3,s,col)/ newEnroll (y,s,sm)

(2) The population of the second grade of senior middle school in year y by age and sex is the enrolled population of senior school in year y-1 by age and sex. The probability that the group in this grade can be enrolled in college two years later is the average enrollment rate that individuals in this grade can be enrolled in the first grade of college two years later, and the formula is:

senr(y,s,a,col-sm-1) = newEnroll (y+2,s,col)/ newEnroll (y-1,s,sm)

(3) Similarly, we can calculate the probability of the group of each grade in senior middle school being enrolled in college in year *y*.

The steps of calculating the enrollment rate from senior middle school to university by sex and age in year *y* are as follows:

(1) The enrollment rate of the first grade of senior middle school in year y by age is the average enrollment rate that the group in this grade can be enrolled in the first grade of university three years later, and the formula is:

senr(y,s,a,col-uni) =newEnroll (y+3,s,uni)/ newEnroll (y,s,sm)

(2) The population of the second grade of senior middle school in year y by age and sex is the enrolled population of senior school in year y-1 by age and sex. The probability that the group in this grade can be enrolled in university two years later is the average enrollment rate that the group in this grade can be enrolled in the first grade of university two years later, and the formula is:

senr(y,s,a,uni -sm-1) = newEnroll (y+2,s,uni)/ newEnroll (y-1,s,sm)

(3) Similarly, we can calculate the probability of the group of each grade in senior middle school being enrolled in university in year *y*.

Two points are worth noting:

(1) By using the enrolled population in different years for calculating enrollment rates, an adjustment has already been made for the survival rate. Therefore, the survival rate is not included in the formula. We also assume that no one drops out, skips a grade, repeats a grade, or suspends for a year or more within a certain education category.

(2) We could only calculate the enrollment rate of primary school till 2007 for lack of data. We use 2007 enrollment rates for years after 2007. Likewise, for enrollment rates of junior middle school and high school, we fix the enrollment rates for 2012 and 2013 at the 2011 levels.

4. Growth rate of real wage

The datum used to calculate rural growth rate are rural CPI and average pure income of rural residents. Calculation method: rural real income is equal to average pure income of rural residents divided by rural CPI. Rural growth rate in T-1 period is equal to the income gap between rural real income in T and T-1 periods divided by rural real income in T-1 period. The datum used to calculate urban growth rate are urban CPI and average wage of urban employees. Calculation method: urban real wage is equal to the average wage of urban employees divided by urban CPI. Urban growth rate in T-1 period is equal to the income gap between urban real wage in T and T-1 periods divided by urban real wage in T-1 period. Results show that, for the 32-year period, 1985-2018, annual growth rates on average are 6.19% and 8.17% in the rural and urban sectors, respectively.

5. Discount rate

The discount rate we use is 4.58%, following Jorgenson and Yun (1990) and Jorgenson and Fraumeni (1992a). It is based on the rate of return on long-term investments in the private sector of the U.S. economy and also adopted by the OECD consortium (OECD 2010).

6. Calculation of human capital

6.1 Human capital of in-school population

The number of years discounted until they accumulate the higher level of human capital depends on the number of years it takes to complete the starting grade level and the current grade of enrollment within the starting grade level.

6.1.1 Human capital of population in primary school by age and sex

(1) If an individual in the first grade of primary school can advance to the next higher level of education, he could get human capital equal to that of

someone who is currently six years older and whose final educational attainment is junior middle school. We discount that income by 6 years to reflect the fact that it takes 6 years for him to reach junior middle school: senr(y,s,a,jm-pri)*mi(y,s,a+6,jm)*R^6

(2) If an individual in the second grade of primary school can advance to the next higher level of education, his human capital is calculated as: senr(y,s,a,jm-pri-1)*mi(y,s,a+5,jm)*R^5, discounted by 5 years as it takes him 5 years to reach junior middle school.

(3) Similarly, we can calculate the human capital of the group in each grade of primary school.

6.1.2 Human capital of the group in junior middle school and above by age and sex

Take junior middle school as an example.

(1) If an individual in the first grade of junior middle school can advance to the next higher level of education, he could get human capital equal to that of someone who is currently three years older and whose final educational attainment is senior middle school. We discount that income by 3 years as it takes 3 years for him to reach senior middle school: senr(y,s,a,sm-jm)*mi(y,s,a+3,sm)*R^3

(2) If an individual in the second grade of junior middle school can advance to the next higher level of education, his human capital is calculated as:

senr(y,s,a,sm-jm-1)*mi(y,s,a+2,sm)*R^2, discounted by 2 years as it takes 2 years for him to reach senior middle school.

(3) Similarly, we can calculate the human capital of the group in each grade of junior middle school.

For the years that we do not observe separate enrollments for university and college (there are five categories for education level, and the last level is college and above), we get the human capital of the group in the first grade of senior middle school as:

$senr(y,s,a,col\text{-}sm)*mi(y,s,a+3,col)*R^3$

For grade 2 and 3 students, the human capital is given by:

$$senr(y,s,a,col\text{-}sm\text{-}1)*mi(y,s,a+2,col)*R^2$$

and

$$senr(y,s,a,col\text{-}sm\text{-}1)*mi(y,s,a+2,col)*R,$$

respectively.

For the years that separate university and college enrollments are available (there are six categories for education level, and the last level is university and above), we should use the human capital equation:

$$senr(y,s,a,col\text{-}sm)*mi(y,s,a+3,col)*R^3+senr(y,s,a,uni\text{-}sm)*mi(y,s,a+3,uni)*R^3,$$

as for senior middle school students, they can go to college or university after their graduation.

For grade 2 students, the human capital is calculated as:

$senr(y,s,a,col\text{-}sm\text{-}1)*mi(y,s,a+2,col)*R^2+senr(y,s,a,uni\text{-}sm\text{-}1)*mi(y,s,a+2,uni)*R^2$. Similarly, we can calculate the human capital of the group in each grade of senior middle school.

Note that by using the average ratio of the sum of all students of any age in a year initially enrolled to the sum of all students of any age initially enrolled in the next higher education level X years later, an adjustment has already been made for age-specific survival rates. Accordingly, the survival rate does not appear in the formula.

6.2 Human capital of out-of-school population

6.2.1 Calculation of out-of-school population

In-school population of age a, sex s, and education level e in year y, pop_inschool(y,s,a,e), is the sum of population of each grade:

$$\text{pop\_inschool(y,s,a,e)} = \sum_{n=0}^{y(e)} \text{pop\_inschool}(y, s, a, e)$$

where y(e) is the number of years to achieve education level e. The formula for calculating out-of-school population of age a, sex s, and education level e in year y is:

$$\text{pop\_noschool(y,s,a,e) = pop(y, s, a,e) - pop\_inschool(y,s,a,e)}$$

Note that following adjustment is made for negative values in the out-of-school population.

(1) Rewrite the negative numbers of the out-of-school population for certain gender, age and education level as 0. The negative out-of-school population mainly appears in primary school for students aged 5-10.

(2) Add the weighted negative out-of-school population for certain gender, age and education level to the in-school population by grades, where the weights are the proportion of population in each grade by gender, age, and education level.

6.2.2 Human capital of out-of-school population

The out-of-school population only consists of people who are working. For people below the age of 60, the formula for human capital is:

$$\text{mi(y,s,a,e) = ymi(y,s,a,e) + sr(y,s)*mi((y,s,a+1,e)*R}$$

For those who are over 60, human capital is zero, i.e. ymi = 0.

7. Human capital stock in China: 1985-2018

The income estimated by the Mincer equation is the real yearly income (using 1985 as the base). We use CPI and real income to obtain the nominal yearly income.

Tables C.1- C.2 report the real human capital in China with 1985 as the baseline year. Tables C.3-C.4 show the labor force human capital.

In all these tables, we report the results based on six education categories from 1985-2018. Due to data limits, initially when we do the imputation, we do not differentiate college and university before 2000; when we do human capital calculation, we separate college and university before 2000 by using China Population Census 1990 and 2000. China Population Census 1990 record the population of university by age, sex and region. It is convenient for us to use China Population Census 1990 and 2000 to separate “university and above” from “college and above” before 2000. We use data from the China Educational Statistical Yearbook before 2000 to calculate the national university share in college and university enrollment. Then we assume that the ratio of university to college enrollment is the same in all provinces. We also assume that the ratio of university to college enrollment is the same across gender.

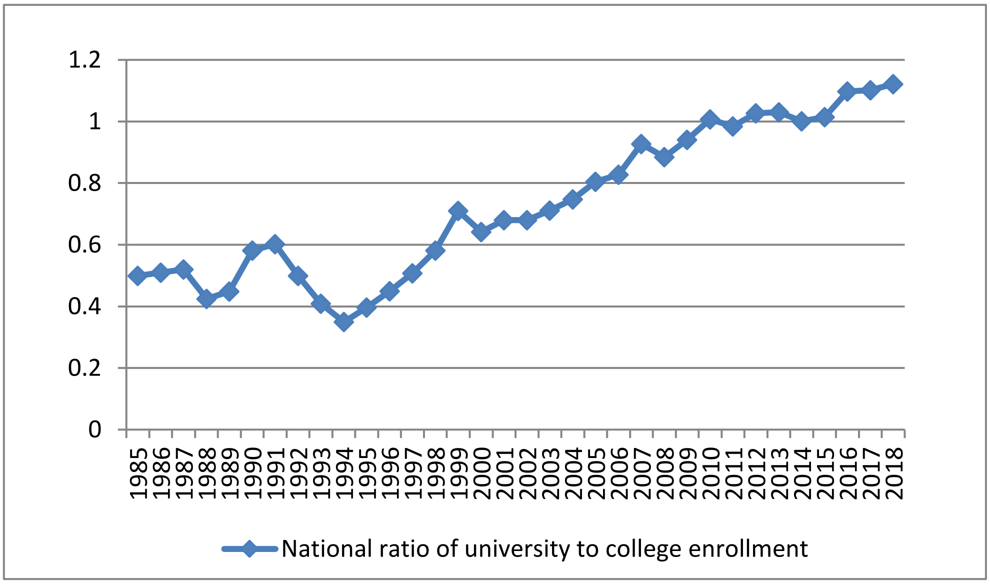


Figure C.7.1 National ratio of university to college enrollment, 1985-2018

Tables and figures of appendix C

Table C.1 Real Human Capital by Region and Gender, 1985-2018

Unit: Billion Yuan

Year	Urban Male	Urban Female	Rural Male	Rural Female
1985	11226	5775	11810	13310
1986	13711	6459	13090	13350
1987	14729	7159	14410	13480
1988	14329	6960	14280	12430
1989	14411	6988	13850	11280
1990	16644	8301	15410	11800
1991	18741	9737	17520	12480
1992	20248	10902	19280	12890
1993	20248	10902	19280	12890
1994	20392	11252	19420	12260
1995	18823	10683	17870	10780
1996	18417	10676	17110	10010
1997	20692	11935	17460	9732
1998	29141	16954	20920	10680
1999	34996	20847	23300	11440
2000	40379	24506	25840	12030
2001	46205	28578	27680	12670
2002	53670	32529	29200	13340
2003	60309	36085	30970	13830
2004	65694	39703	31530	14070
2005	71925	43643	32560	14650
2006	83716	49732	35760	16070
2007	93361	55166	37020	16930
2008	101521	59632	37730	17770
2009	117762	68552	41480	19980
2010	131600	75107	43140	21440
2011	146140	83632	41190	20940

Year	Urban Male	Urban Female	Rural Male	Rural Female
2012	165051	93423	40630	21110
2013	190104	105680	39850	21240
2014	210043	113503	40070	21940
2015	228232	119506	40570	22930
2016	250427	128779	40160	24100
2017	275152	138081	40060	25670
2018	299427	146845	39450	27150

Note: The results are based on six education categories.

Table C.2 Per Capita Real Human Capital by Region and Gender, 1985-2018

Unit: Thousand Yuan

Year	Urban Male	Urban Female	Rural Male	Rural Female
1985	94.09	57.18	29.92	37.38
1986	109.47	61.66	33.16	37.68
1987	112.57	65.98	36.57	38.05
1988	103.66	60.68	35.98	35.22
1989	99.42	57.83	34.74	32.05
1990	110.16	65.34	38.35	33.28
1991	120.44	73.62	43.57	35.20
1992	126.52	79.12	48.12	36.41
1993	124.23	78.55	48.77	34.75
1994	112.54	72.08	45.22	30.61
1995	108.05	69.56	43.57	28.40
1996	113.51	73.20	45.38	28.29
1997	125.27	81.38	49.78	29.74
1998	142.08	92.72	56.47	32.45
1999	162.12	108.42	63.96	35.52

Year	Urban Male	Urban Female	Rural Male	Rural Female
2000	178.84	121.84	72.46	38.27
2001	195.80	134.90	79.64	41.14
2002	217.74	145.97	86.78	44.54
2003	235.21	154.54	95.20	47.58
2004	247.37	163.13	99.92	49.72
2005	261.70	172.19	106.53	53.21
2006	291.61	189.92	117.54	59.10
2007	313.62	205.17	123.01	63.49
2008	331.31	217.09	126.71	67.90
2009	371.26	242.46	140.45	77.53
2010	401.37	258.27	147.72	84.72
2011	425.40	275.16	146.61	86.30
2012	462.74	296.58	150.77	90.94
2013	522.87	327.03	154.39	95.50
2014	567.54	347.00	160.81	101.74
2015	611.01	360.97	168.45	109.70
2016	660.60	381.50	171.86	117.92
2017	716.96	404.84	176.49	129.33
2018	771.01	428.48	178.52	141.84

Note: The results are based on six education categories.

Table C.3 Real Labor Force Human Capital by Region and Gender, 1985-2018

Unit: Billion Yuan

Year	Urban Male	Urban Female	Rural Male	Rural Female
1985	4929	2156	4960	5825
1986	5608	2447	5622	6027
1987	6249	2746	6348	6253
1988	6020	2636	6405	5816
1989	6023	2647	6368	5386

Year	Urban Male	Urban Female	Rural Male	Rural Female
1990	6902	3031	7257	5759
1991	7565	3426	8284	6070
1992	7902	3721	9137	6252
1993	7637	3748	9206	5933
1994	6807	3485	8546	5230
1995	6569	3493	8230	4840
1996	7367	3816	8541	4725
1997	8682	4431	9297	4881
1998	10467	5284	10480	5246
1999	12441	6267	11830	5677
2000	14453	7241	13070	6078
2001	16095	8133	13860	6360
2002	18346	9267	14630	6686
2003	20405	10372	15330	6961
2004	22332	11383	15430	7057
2005	24925	12781	15850	7356
2006	29804	14976	17650	8143
2007	33369	16611	18660	8719
2008	36258	17911	19330	9224
2009	42979	20952	21510	10480
2010	49411	23507	22580	11350
2011	54152	25840	21830	11260
2012	60806	28468	21870	11520
2013	67596	31639	21750	11800
2014	74371	33022	22090	12360
2015	81085	34942	22420	12950
2016	88518	37708	22510	13810
2017	96630	40409	22650	14810
2018	104412	42922	22440	15720

Note: The results are based on six education categories.

Table C.4 Per Capita Real Labor Force Human Capital by Region and Gender, 1985-2018

Unit: Thousand Yuan

Year	Urban Male	Urban Female	Rural Male	Rural Female
1985	65.58	33.49	21.44	27.68
1986	70.01	35.99	23.93	27.98
1987	73.01	38.08	26.59	28.32
1988	66.52	34.54	26.35	26.32
1989	62.88	32.61	25.67	24.18
1990	68.18	35.13	28.57	25.47
1991	72.70	38.21	32.31	26.60
1992	74.51	40.04	35.46	27.18
1993	71.18	39.09	35.70	25.62
1994	62.93	35.29	33.03	22.34
1995	59.85	34.19	31.80	20.50
1996	62.34	35.22	33.28	20.35
1997	68.29	38.38	36.61	21.37
1998	76.74	42.79	41.66	23.29
1999	85.49	47.70	47.28	25.55
2000	93.46	51.87	52.80	27.76
2001	100.34	55.55	57.31	29.51
2002	110.36	60.48	62.12	31.62
2003	118.25	64.65	66.93	33.59
2004	124.55	67.88	69.37	34.80
2005	133.42	72.79	73.41	37.10
2006	152.03	82.82	81.60	41.46
2007	164.11	90.25	86.29	44.95
2008	172.84	95.79	89.57	48.18
2009	196.55	108.76	99.79	55.34
2010	216.40	117.88	105.29	60.76

Year	Urban Male	Urban Female	Rural Male	Rural Female
2011	228.65	125.37	104.47	62.16
2012	249.40	134.73	107.73	65.72
2013	273.81	146.85	110.45	69.37
2014	295.45	151.86	115.24	74.24
2015	317.81	158.04	120.60	79.92
2016	343.78	168.06	123.12	85.91
2017	372.94	179.71	126.37	94.26
2018	400.34	192.14	127.42	103.33

Note: The results are based on six education categories.

Appendix D Physical Capital Estimation

1. Two measurements of physical capital

For each province, we calculate variations of two measures of physical capital stock:

(1) Wealth capital stock (or: net capital stock): measures the monetary value of the physical capital stock. To be used in this report for the purpose of comparing the value of physical capital with that of human capital.

(2) Productive capital stock: measures the volume (or productive capacity) of physical capital. To be used, for example, in productivity analysis.

Note that when geometric depreciation is adopted, the wealth capital and productive capital stocks are identical.

In productivity analysis, what are of interest are the services rendered in a particular period by capital as an input to the production process. It is assumed that the services rendered by the productive capital stock in a particular period are in fixed proportion to the productive capital stock. In calculating aggregate growth of productive physical capital we therefore also refer to growth in capital services. (In productivity analysis, an analogue of capital services is labor services, with the services rendered by labor in the production of a particular volume of output in a particular period being assumed to be in constant proportion to the number of laborers or number of laborer-hours worked in that period.)

Our capital measures closely follow the OECD Manual (2009) on *Measuring Capital* and the physical capital chapter in the OECD Manual (2001) on *Measuring Productivity*. For the case of a hyperbolic age-efficiency function, the methods used by the U.S. Bureau of Labor Statistics and the Australian Bureau of Statistics are consulted.

We calculate the two measures of physical capital stock in five variations:

(1) Wealth capital stock at the end of the year in (mid-year) 1985 prices, based on geometric depreciation.

(2) Wealth capital stock at the end of the year in current prices, based on a geometric age-price profile.

(3) An index of real growth in end-year wealth capital stock, based on a geometric age-price profile and with the 1985 value set equal to one.

(4) An index of real growth in capital services, based on a geometric depreciation and with the 1985 value set equal to one.

(5) An index of real growth in capital services, based on hyperbolic depreciation using parameters adopted by the U.S. Bureau of Labor Statistics and the Australian Bureau of Statistics and with the 1985 value set equal to one.

The first four variations of capital stock (and services) measures are derived using a modified version of an OECD-provided model spreadsheet. The fifth variation follows from more elaborate, own calculations. (Own calculations for the first four variations confirm the results obtained via the modified OECD-provided spreadsheet.)

2. Data and data sources

For each province, the following data are needed:

(1) Investment values in the form of gross fixed capital formation, with a breakdown by type of asset adopted from the investment statistics;

(2) Investment in fixed assets price index, with a breakdown by type of asset;

(3) CPI;

(4) Aggregate income accounts with a breakdown into labor remuneration, operating surplus, depreciation, and net taxes on production.

The source of the data for the most recent years is the statistical database on the NBS website. Historical data are obtained from *GDP 1952-1995* and *Sixty Years*. Occasionally the *China Statistical Yearbook* and provincial statistical yearbooks are consulted. All constant-price values are in 1985 prices, and real growth indices use 1985 as the base year (with value one).

Provincial values of gross fixed capital formation (GFCF) are obtained from the NBS website and *Sixty Years*. These are the most up-to-date values that incorporate all benchmark revisions, up to and including the benchmark revision following the 2013 economic census. GFCF values do not come with a breakdown by type of asset.

The investment statistics provide a breakdown of total investment by type of asset: structures, equipment, and "others." These province- and year-specific proportions of structures, equipment, and "others" in total investment are applied to the provincial annual GFCF values. Investment data by type of asset are available since 2003 (NBS website). For each province, values for 1951-2002 are estimated by establishing the 1950 proportions, and then connecting these 1950 proportions linearly to the average 2003-2005 proportions. Approximate 1950 proportions of the three types of assets in total economy-wide (national) investment are uniformly used for all provinces (structures 75%, equipment 20%, and "others" 5%).

Data on the investment in fixed assets price index are available for the years since 1991, including by type of asset (NBS website). For earlier years, price changes are obtained from nominal GFCF values together with GFCF real growth rates, both published in *GDP 1952-1995*. This GFCF deflator is applied to all three types of assets (structures, equipment, "others"). In the case of provinces (or years) with missing nominal GFCF values and/or missing GFCF real growth rates, the deflator of industry value-added is used as proxy (with values from *Sixty Years*).

CPI data are obtained from the NBS website.

Income accounts data are obtained in two steps in order to address statistical breaks and to ensure that income accounts data and aggregate expenditure data (including GFCF) are consistent. First, the share of each income component in aggregate income is calculated. The underlying income data for the years since 1993 are from the NBS website and for the years 1978 through 1992 from *GDP 1952-1995*. Shares for the years 1950-1977 are set equal to the average 1978-1982 shares. In a second step, absolute values are obtained by multiplying the share values by aggregate expenditures (using data from the same sources as reported above for GFCF, one of the components of aggregate expenditures).

Missing data are addressed through appropriate approximations. For example, (early) Chongqing GFCF data are constructed as

$$\text{Chongqing GFCF} = \frac{Sichuan\ GFCF}{\text{Sichuan GCF}} * Chongqing\ GCF \quad (1)$$

With the data taken from *Sixty Years* (and GCF denoting gross capital formation, i.e., GFCF plus inventory investment). A very occasional unreasonably extreme data point may be replaced by the mean of the previous and following years' values. A list of all special adjustments has been compiled.

3. Initial capital stock

The initial year of our capital stock series is 1952. The (province-specific) capital stock value W_{1952} is obtained equally for all our measures of capital as

$$W_{1952} = \frac{GFCF_{1953}}{\delta+\theta} - GFCF_{1953} \quad (2)$$

$GFCF_{1953}$ is GFCF of the year 1953, θ is the asset-specific average annual (geometric) real growth rate of GFCF between 1953 and 1957, and δ is the asset-specific depreciation rate (using the double-declining balance method). For some but not all provinces, GFCF value would have been available for 1950-1952, and a judgment was made that the first somewhat reliable (non-erratic) post-war GFCF value is probably the 1953 value.

4. Methodology

We follow the method outlined in the OECD Manual (2009) on *Measuring Capital* and the physical capital chapter in the OECD Manual (2001) on *Measuring Productivity*. Following other countries' experiences as reported in the first manual, and our evaluation of the circumstances in China, average service lives of physical assets are taken to be 40 years for structures, 16 years for equipment, and 25 years for all "others."

The procedure comprises two stages. First, constant-price GFCF of a particular type of asset is subjected to a survival function and age-efficiency profile to obtain productive capital stock, or to a survival function and age-price profile to obtain wealth capital stock.

Second, to obtain the growth rate of aggregate capital services, the growth rates of different types of productive capital stock (structures, equipment, "others") are combined using a Tornqvist index with user costs as weights. Aggregate (nominal or constant-price) wealth capital stock is obtained by summing the asset-specific wealth capital stock, while the real growth rate of the aggregate wealth capital stock is obtained by combining the real growth rates of asset-specific wealth capital using a Tornqvist index, with current-price wealth capital values used in constructing the weights.

4.1 Geometric age-efficiency profile, single type of asset

We follow common practice in the case of a geometric age-efficiency profile, of not separately including a survival function in deriving asset-specific productive or wealth capital stock. With a geometric age-efficiency profile, age-efficiency and age-price profile are identical, and thereby asset-specific productive capital stock and wealth capital stock are identical. The formula for geometric age-efficiency is

$$g_n = (1 - \delta)^n \qquad (3)$$

where n denotes age and δ denotes the rate of efficiency decline or the depreciation rate. The rate of efficiency decline (depreciation rate) is obtained using the double-declining balance method, as 2 divided by the average service life. Starting at twice the average service life, efficiency (as well as the price) is set equal to zero.

4.2 Hyperbolic age-efficiency profile, single type of asset

The survival function is 1 minus the asset-specific cumulative normal distribution, with asset-specific average service lives given above, and a standard deviation equal to one-quarter of the average service life.

The age-efficiency profile is described by the hyperbolic function

$$g_n = \frac{(T-n)}{(T-b*n)} \qquad (4)$$

In this report, parameters for the hyperbolic function are set to those used by the U.S. Bureau of Labor Statistics and the Australian Bureau of Statistics. Specifically, with n denoting age, T is twice the average service life, and b is a shape parameter that takes the value 0.75 in the case of structures, and 0.5 otherwise.

In the case of a non-geometric age-efficiency profile, the age-price profile is not identical to the age-efficiency profile. But the two are connected: following the asset market equilibrium condition, the current year's price of an asset equals the discounted stream of future rental income from the asset, where each future period's rental income depends on the productive capacity (efficiency) of the asset at that point in time, and the current year's price of the asset thereby on the age-efficiency profile of the asset. A series of current year prices constitutes the age-price profile of an asset. Following the procedures employed by the U.S. Bureau of Labor Statistics and by the Australian Bureau of Statistics, a discount rate of 4% as a long-run average rate of return is assumed in deriving the age-price profile from the age-efficiency profile.

4.3 Aggregate capital values and growth rates

To obtain the real growth rate of aggregate productive capital stock or of capital services (assumed to be a fixed proportion of the productive capital stock), the growth rates of the different types of assets—structures, equipment, and "others"—at a particular point in time t are aggregated using the Tornqvist index T:

$$T_t = \prod_{i=1}^{3} Z_{it}^{(Share_{it}+Share_{it-1})/2} \quad (5)$$

where Z denotes the growth rate of constant-price productive capital stock K.

The asset-specific weight in the Tornqvist index is the arithmetic mean of a previous-year and a current-year value denoting the share of this asset's user cost U_i in aggregate user costs U:

$$Share_{it} = U_{it} / \sum_{i=1}^{3} U_{it} \quad (6)$$

The user cost of a particular type of asset (type of productive capital) is defined as the rental rate times the current-price productive capital stock (q*K), with the rental rate covering depreciation and a rate of return, less appreciation of the asset during the period:

$$U_{it} = \left(\delta_{it} + r_t - \frac{q_{it} - q_{it-1}}{q_{it}}\right) * q_{it} K_{it}^{P} \quad (7)$$

The rate of depreciation follows from the age-price profile, and the rate of appreciation is obtained from the investment in fixed assets price index. The rate of return is unknown and the asset-specific user costs, thus, are unknown.

To solve equation (7), the rate of return is assumed to be identical across all types of assets. An economy-wide (province-specific) value of user costs is obtained from the income accounts data as the sum of operating surplus, depreciation and a proportion of net taxes on production. The proportion of net taxes to include is “operating surplus plus depreciation” as a share of “operating surplus plus depreciation plus labor remuneration;” i.e., total income is attributed to labor (labor remuneration) and capital (operating surplus plus depreciation), and the final income component of net taxes on production is split proportionally between labor and capital. This economy-wide value of user costs equals the sum of the user costs of the three types of assets, which allows one to solve for the rate of return r_t in:

$$U_t = \sum_{i=1}^{3} U_{it} = \sum_{i=1}^{3} \left(\delta_{it} + r_t - \frac{q_{it} - q_{it-1}}{q_{it}}\right) * q_{it} K_{it}^{P} \qquad (8)$$

Once r_t is known, the asset-specific user costs (7) can be calculated, providing the shares (6) used in the Tornqvist index to obtain the real growth rate of capital services (5).

One shortcoming of this procedure is that in the first step, the age-price profile is derived using an assumed long-run rate of return, only to obtain a depreciation rate which then allows one to, in equation (8) solve for the current-year rate of return. Alternatively, one could not calculate an age-price profile and assume a depreciation rate in equations (7) and (8), thereby abandoning the consistency between age-efficiency and age-price profile. The advantage of this procedure is that one is not limited to the use of a rather unrealistic geometric age-efficiency profile.

The absolute value of the aggregate wealth capital stock, in constant or current prices, is simply the sum of the asset-specific wealth capital stock. To obtain a real growth rate for aggregate wealth capital stock, asset-specific constant-price wealth capital stock is aggregated using the Tornqvist index, with current-price asset values used to calculate the shares that enter the weights.

Tables of appendix D

Table D.1 Wealth Capital Stock at Constant Prices, 1985-2018（hyperbolic）

Unit: 1 billion of 1985 Yuan

Province	1985	1990	1995	2000	2005	2017
Beijing	51	116	228	436	862	3181
Tianjin	38	67	115	202	376	2574
Hebei	95	147	244	483	870	4239
Shanxi	54	80	109	167	308	1590
Inner Mongolia	31	50	92	150	390	3422
Liaoning	102	163	253	358	628	2810
Jilin	40	63	99	151	275	2148
Heilongjiang	68	106	151	240	381	1764
Shanghai	71	132	253	502	850	2486
Jiangsu	99	220	481	954	1914	9169
Zhejiang	15	31	151	448	1097	4622
Anhui	46	80	130	222	382	2042
Fujian	31	50	93	196	363	2115
Jiangxi	43	64	104	180	371	1850
Shandong	122	213	351	618	1243	6071
Henan	99	162	259	478	892	6429
Hubei	70	106	176	352	615	3285
Hunan	48	73	103	165	284	1587
Guangdong	94	163	388	811	1592	7652
Guangxi	45	57	87	144	258	1918
Hainan	8	17	41	61	92	438
Chongqing	47	61	96	180	389	2081
Sichuan	73	109	160	283	517	2416
Guizhou	29	40	53	86	164	892
Yunnan	75	89	135	215	345	2078
Tibet	8	10	15	20	40	270
Shaanxi	41	70	99	149	257	1547
Gansu	34	51	63	90	161	712
Qinghai	14	20	27	48	97	700

Province	1985	1990	1995	2000	2005	2017
Ningxia	13	19	25	34	65	475
Xinjiang	32	52	103	172	298	1504
National	**2082**	**3237**	**5268**	**8781**	**15570**	**67548**

Table D.2 Wealth Capital Stock at Constant Prices, 1985-2018（geometric）

Province	1985	1990	1995	2000	2005	2017
Beijing	43	98	192	363	720	2596
Tianjin	31	55	95	166	312	2136
Hebei	76	118	199	401	721	3480
Shanxi	43	64	87	134	255	1300
Inner Mongolia	25	40	76	122	336	2811
Liaoning	79	131	206	288	520	2251
Jilin	32	51	80	122	228	1753
Heilongjiang	56	86	122	194	309	1452
Shanghai	59	109	212	417	697	2003
Jiangsu	83	186	407	797	1602	7486
Zhejiang	12	26	136	388	940	3774
Anhui	37	66	107	182	315	1697
Fujian	25	41	78	165	302	1761
Jiangxi	34	51	85	148	311	1518
Shandong	100	175	286	508	1038	4963
Henan	80	131	211	395	742	5339
Hubei	56	85	144	293	508	2743
Hunan	39	58	82	133	233	1312
Guangdong	78	134	331	684	1333	6333
Guangxi	35	44	70	119	215	1583
Hainan	6	14	35	50	74	365
Chongqing	36	47	77	149	329	1735
Sichuan	60	88	128	232	427	1993
Guizhou	23	32	42	70	135	753

Province	1985	1990	1995	2000	2005	2017
Yunnan	56	68	109	176	283	1764
Tibet	6	8	12	16	33	228
Shaanxi	33	57	79	119	210	1285
Gansu	27	40	49	72	132	588
Qinghai	11	16	21	39	81	596
Ningxia	11	15	19	27	54	400
Xinjiang	26	42	86	141	245	1255
National	**1672**	**2604**	**4290**	**7165**	**12825**	**55386**

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