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Human Capital in China

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I. Introduction[1]

Since the concept of human capital was introduced to modern economic analysis by Schultz (1961) and Becker (1964), it has been widely used in academic studies and policy analysis. The latest definition of human capital from the Organization for Economic Co-operation and Development (OECD) is “The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being” (OECD, 2001, page 18). In most countries, human capital accounts for more than 60% of the nation’s wealth, which includes natural resources, physical capital and human capital (World Bank, 1997).

It is generally believed that human capital is an important source of economic growth and innovation, an important factor for sustainable development, and for reducing poverty and inequality (see, for example, Stroombergen et al., 2002, and Keeley, 2007). In China, since the start of economic reforms, the economy has grown at a dramatic rate. It is believed that human capital has played a significant role in the Chinese economic miracle (see, for example, Fleisher and Chen, 1997, and Démurger, 2001). Additionally, studies show that human capital also has an important effect on productivity growth and on reducing regional inequality in China (Fleisher, Li and Zhao, 2009).

Despite the important role of human capital in the Chinese economy, however, until now, there has been no systematic effort to construct comprehensive measures of the total human

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capital stock in China. There are a few studies on human capital measurement published in Chinese journals. For example, Zhang (2000) and Qian and Liu (2004) calculated China's human capital stock based on total investment (cost-side); others, such as Zhu and Xu (2007), Wang and Xiang (2006), estimated human capital from the income side. Zhou (2005) and Yue (2008) used some weighted average of human capital attributes to construct a measurement. In most cases, these studies, including Cai (1999), Hu (2002), Zhou (2004), Hou (2000), and Hu (2005), measure human capital based on some education characteristics such as average years of schooling. While the above studies represent significant efforts to measure human capital in China, there are major limitations. First, they cover only limited time period. There has been no comprehensive and systematic measurement of the total human capital stock in China from the 1980s through recent years. Second, they do not construct separate human capital measures for the rural and urban population and by gender. Third, the methodologies used have been limited by data availability, feasibility of parameter estimation, and some technical treatment difficulties. Thus, there has been no serious attempt at estimating human capital in China using the state-of-art methods that have been implemented for numerous countries.

Human capital measures for China are central to the understanding of the global importance of human capital for a number of reasons. First, China is the most populous country in the world. It is important to understand the dynamics of human capital related to demographic changes (for example, due to one-child policy, migration, and urbanization) and the rapid expansion of education during the course of economic development. Second, such measures would allow for a better assessment of the contribution of human capital to growth, development, and social well-being through empirical and theoretical research. Additional benefits from human capital measures include the provision of useful information for policy makers, such as assessing how education policies of the central and local governments affect the accumulation of human capital. This is especially important, given the long-term nature of human capital investment. Developing comprehensive measures of human capital in China provides the necessary early work for constructing China's human capital account and for eventually incorporating human capital into the national accounting.

We attempt to construct a comprehensive measurement of human capital in China by applying the methods used in other countries after modifying them to fit China's special cases. We estimate total human capital at the national level, for male and female, for urban and rural areas for the period 1985 to 2007. Our estimates include nominal values, real values, and decompositions using Divisia indices. We mostly adopted the Jorgenson-Fraumeni (J-F) lifetime income based approach, which has been widely used in other countries (Jorgenson and Fraumeni 1989, 1992a, and 1992b).

In implementing the J-F approach for China, we overcome the paucity of earnings data by using Mincer equation estimation. In particular, we apply the Mincer equation to estimate earnings using various household survey data. Thus, it is possible to integrate the changes in returns to education and experience (on-the-job-training) over the course of economic transition into our estimates.

Moreover, constructing separate human capital measures for urban and rural areas, allows us to capture the changes caused by rapid urbanization as well as by the large scale rural-urban migration since the start of economic reforms in China. This framework is particularly suitable for transitional economies because it shows the changes in human capital due to structural changes and migration. Migration, as a form of human capital investment, helps realize higher value of one's human capital.

The rest of this report is arranged as follows. Section II discusses the methodology we use to construct human capital measures. Section III describes our data and method used for estimating incomes. The estimated human capital stocks are reported in Section IV. Section V concludes.

II. Methodology

In general, human capital can be produced by education and training (child bearing and rearing are investments that increase future human capital), as well as by job turnover and migration that help to realize the potential value of human capital. Like physical capital stock, human capital can be valued using two methods: i) it can be valued as the sum of investment, minus depreciation, added over time to the initial stock; ii) it can be valued as the net present value of the income flow it will be able to produce over an assumed lifetime. The first method, the perpetual inventory method, is used in the cost approach; while the second method is the income-based approach (this method is used to estimate the value of most natural resources).

Kendrick is an early pioneer in the construction of human capital accounts using the cost approach. Kendrick (1976) estimates both tangible and intangible human capital. Tangible human capital includes child rearing costs. Intangible human capital includes education, training, medical, health and safety expenditures, and mobility costs. Human capital stocks are created using a perpetual inventory method where investment expenditures are cumulated and existing stocks are depreciated. The Kendrick approach covers detailed aspects of human capital formation from the cost side and provides a very complete menu for summing up all related costs to estimate the value of human capital. Yet, the data requirement is enormous. For example, we may need to get government statistics before the founding of the People's Republic of China in 1949. Additionally, it does not provide a clear guideline on some critical technical issues. For these reasons, we do not adopt the cost approach in this study.

The Lisbon Council has constructed European Human Capital Index for the 13 European Union (EU) states and 12 Central and Eastern European states (Ederer, 2006 and Ederer et. al., 2007). As it has cost components and index components, it is best viewed as a blend of a cost approach and an indicator approach. Since the technique details for a revised methodology for this approach have not been released, we do not apply it here in our calculation.

The World Bank (2006) uses a residual approach to estimate human capital for 120 countries. Due to data and methodological limitations, total wealth in the year 2000 is measured as the net present value of an assumed future consumption stream. Intangible capital is equal to total wealth minus produced and natural capital. Intangible capital is an aggregate which includes human capital, the infrastructure of the country, social capital, and the returns from net foreign financial assets. It would be preferred if the components of intangible capital could be separated out.

In addition to those approaches, previous empirical studies have used a large number of proxy measures of human capital, including educational attainment, average years of schooling, and literacy scores (e.g. Barro and Lee, (1996), among others). These proxies are measures which neglect expected future benefits and the possibility of individuals becoming more educated. But they are appealing because they are simple to implement and rely on data that are readily available.

The Jorgenson-Fraumeni income-based approach, which is the most widely used method[2], has been adopted by a number of countries in constructing human capital accounts and by the OECD human capital consortium (OECD, 2010). The advantages of this approach are that it has a sound theoretical foundation and that the data and parameters are relatively easier to obtain than they are for other approaches. The J-F method estimates human capital stock as the expected future lifetime income of all individuals. If human capital could be traded in the market like physical capital, the asset price would be the net present value of the individuals' lifetime labor income. The lifetime income can reflect the importance of long-term investments, such as education and health, in human capital accumulation.

The J-F approach imputes expected future lifetime incomes from the currently observed incomes of the cross-section individuals who are older than a given cohort at the time of observation. Future incomes are augmented with a projected labor income growth rate and discounted to the present with a constant interest rate. Estimation is conducted in a backward recursive fashion, from those oldest aged 75, 74, 73, and so forth to those aged 0.[3] The life cycle is divided into five stages, and the equations used for calculating the lifetime expected incomes are as follows:

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[2] See Australia (Wei, 2008) Canada (Gu and Wang, 2008), New Zealand (Le, Gibson and Oxley, 2005), Norway (Greaker and Liu 2008), Sweden (Alroth, 1997), and the United States (Jorgenson and Fraumeni 1989, 1992a, 1992b), and Christian 2009).

[3] China Labor Law regulates that the male's retirement age should be 60 years old and female's 55 years old, so in our calculation, the oldest age will be 60 for male and 55 for female.

The fifth and final stage is retirement or no school or work (males older than 60 years old, females older than 55 years old):

$$mi_{y,s,a,e} = 0 \tag{1}$$

where the subscripts *y*, *s, a,* and *e* denote respectively year, sex, age and educational attainment, and *mi* stands for lifetime market labor income per capita.

The fourth stage is work but no school (male 25-59 or female 25-54 years old):

$$mi_{y,s,a,e} = ymi_{y,s,a,e} + sr_{y+1,s,a+1} \times mi_{y,s,a+1,e} \times \frac{1+G}{1+R} \tag{2}$$

where *sr* is the survival rate, defined as the probability of becoming one year older, *ymi* denotes annual market income per capita, *G* is the real income growth rate, and *R* is the discount rate.

The third stage is school and work (16-24 years old):

$$mi_{y,s,a,e} = ymi_{y,s,a,e} + \left[senr_{y+1,s,a+1,e+1} \times sr_{y+1,s,a+1} \times mi_{y,s,a+1,e+1} + (1-senr_{y+1,s,a+1,e+1}) \times sr_{y+1,s,a+1} \times mi_{y,s,a+1,e}\right] \times \frac{1+G}{1+R} \tag{3}$$

where *senr* is school enrollment rate--the probability of an individual with educational attainment *e* to enroll in education level *e*+1.

The second stage is school but no work (6-15 years old):

$$mi_{y,s,a,e} = \left[senr_{y+1,s,a+1,e+1} \times sr_{y+1,s,a+1} \times mi_{y,s,a+1,e+1} + (1-senr_{y+1,s,a+1,e+1}) \times sr_{y+1,s,a+1} \times mi_{y,s,a+1,e}\right] \times \frac{1+G}{1+R} \tag{4}$$

The first stage is no school and no work (0-5 years old):

$$mi_{y,s,a,e} = sr_{y+1,s,a+1} \times mi_{y,s,a+1,e} \times \frac{1+G}{1+R} \tag{5}$$

Let $L_{y,s,a,e}$ stand for the population, the expected lifetime income in a country, i.e., the total human capital stock, can be written as:

$$MI(y) = \sum_s \sum_a \sum_e mi_{y,s,a,e} L_{y,s,a,e} \tag{6}$$

Similar equations can be applied to estimate lifetime nonmarket labor income[4], which can be added to lifetime market labor income to obtain total lifetime labor income:

$$LIFE(y) = \sum_s \sum_a \sum_e (mi_{y,s,a,e} + nmi_{y,s,a,e}) \cdot L_{y,s,a,e} \qquad (7)$$

III. Data

III.1 Estimating the income by cohort

One important component of the income approach is the estimation of earnings for all individuals in the population. Using the J-F method, we divide the population into five educational categories, 61 age groups (from 0 to 59 (54) by age and 60 (55) and over), urban and rural residents, male and female categories. This results in a total of 1170 cohorts for which we need to estimate the annual income from 1986 to 2007. When Jorgenson and Fraumeni measured the US's human capital, they derived income from government data, using labor force information such as number of employees, wages, and hours worked, . However, China does not have such data for each cohort, nor are estimates available. As a result, estimating income by cohort with Mincer equation estimation is the key to implementing the J-F method in China.

We conduct estimation based on the basic Mincer (1974) equation:

$$\ln(inc) = \alpha + \beta \cdot e + \gamma \cdot exp + \delta \cdot exp^2 + u \qquad (8)$$

where *ln (inc)* is the logarithm of earnings, *e* is years of schooling, e*xp* and e*xp*^{2} are, respectively, years of work experience and experience squared, and *u* is a random error. The coefficient α is an estimate of the average log earnings of individuals with zero years of

[4] Nonmarket activities include household production, e.g., cooking, cleaning etc. In our calculation we exclude the nonmarket lifetime income because it is difficult to quantify.

schooling and work experience, β is an estimate of the return to an extra year of schooling, and γ and δ measure the return to investment in on-the-job training. Following the convention of a large body of empirical literature, we estimate equation (8) by ordinary least squares.[5]

The data used for estimating the parameters of the earnings equation come from two well-known household surveys in China. The first is the annual Urban Household Survey (UHS) conducted by the National Bureau of Statistics of China over the period 1986-1997. We use this data set to estimate the parameters of equation (8) for each gender of the urban population by year, and then extract fitted estimates by applying linear or exponential time trends. We use the fitted time trends to generate the imputed parameters of the earnings equation for the urban population for the period 1985 through 2007.

The second data set we use is the China Health and Nutrition Survey (CHNS) for the years of 1989, 1991, 1993, 1997, and 2000. This survey covers both the urban and rural population. We use CHNS to obtain earnings-equation parameter estimates by year for each gender and separately for the rural and urban population. We calculate the urban-to-rural ratio for each of these parameters. We then use the ratio to fit a time trend model (i.e. interpolate and extrapolate), which is used to generate fitted values of the urban-to-rural ratio over the period 1985 to 2007. We use the fitted ratios along with the imputed parameters for the urban population to derive the imputed parameters for the rural population over the period 1985 to 2007.[6]

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[5] Griliches (1977) finds that accounting for the endogeneity of schooling and ability bias does not alter the estimates of earnings equation. Ashenfelter and Krueger (1994) also conclude that omitted ability variables do not cause an upward bias in the estimated parameters of equation (8).

[6] If the reader is interested in more details, please contact the authors.

We can obtain the fitted value of *ln(inc)* using equation (8), and define $m_i=e^{ln(inc)}$. We then regress the reported income on m_i using OLS without the constant term to obtain the estimated coefficient on mi, the adjustment factor. Finally, we estimate the income as $y(inc)=a \cdot e^{ln(inc)}$.

III.2 Imputing the population by cohort

In order to implement the J-F method, we need annual population data by age, sex, and educational attainment in urban and rural areas. Data are available for the years 1982, 1987, 1990, 1995, 2000, and 2005. For all other years, we use a perpetual inventory method along with birth rate, mortality rate by age and sex, and enrollment rate (including new enrollment and graduation) at different levels of education to impute population by age, sex, educational attainment, location (urban and rural), and year.

There are five levels of educational attainment: illiterate (no schooling), primary school (Grade 1-6), junior middle school (Grade 7-9), senior middle school (Grade 10-12), and college and above. From 2000 onward, additional information makes it possible to separate the population at the level of college and above into two: one is college, and the other is university and above. Specifically, we use the following perpetual inventory formula to impute urban and rural population by age, sex and educational attainment for years that data are not available:

$$L(y,e,a,s) = L(y-1,e,a,s)\cdot(1-\delta(y,a,s)) + IF(y,e,a,s) - OF(y,e,a,s) + EX(e,a,s), \qquad (9)$$

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 age and gender specific mortality rate in year y. $IF(y,e,a,s)$ and $OF(y,e,a,s)$ are inflow and outflow of this particular group. For example, inflow would include individuals just achieved this level of education, while outflow would include those who just achieved the next level of education. $EX(e,a,s)$ is a discrepancy term. Moreover,

$$IF(y,e,a,s) = \lambda(y,e,a,s) \cdot ERS(y,e,s) \tag{10}$$

$$OF(y,e,a,s) = \lambda(y,e+1,a,s) \cdot ERS(y,e+1,s) \tag{11}$$

$$\sum_a \lambda(y,e,a,s) = 1 \tag{12}$$

where ERS is the matriculation at education level e, λ is the age distribution at education level e. In order to obtain accurate estimates for λ, we use both microeconomic data sets (China Health and Nutrition Survey and China Household Income Project) and macroeconomic data sets (China Education Statistical Yearbook).[7]

Next we discuss several salient features of China's population growth, especially the educational attainment by age, sex, and location. First of all, during our sample period, China's total population increased from 1.02 billion in 1982 to 1.32 billion in 2007. The urban population increased by 379 million, while the rural population decreased by 74 million (Figure III.1.1).

Figure III.1.3 shows population by educational attainment from 1982 to 2007. The illiterate population was cut in half from 402 million in 1982 to 201 million in 2000, but was relatively stable from 2000 to 2007. The number of primary school graduates increased from 359 million in 1982 to the peak of 466 million in 1997, then declined gradually to 399 million in 2007. This decline is expected as more primary school graduates continue on to higher education level instead of terminating formal education. This is also evident in the rapid growth of junior middle school graduates. Junior middle school students registered the largest

[7] The details are available from authors.

growth among all education levels: the number of junior middle school graduates increased from 181 million in 1982 to 471 million in 2007. This might be related to the implementation of 9-Year Compulsory Schooling Law since 1994 (9-year schooling amounts to completing junior middle school). However, the growth slowed after 2001. Senior middle school and college and above started from very low numbers and have grown significantly. Senior middle school graduates increased from 68 million in 1982 to 166 million in 2007, while college and above increased from only 6 million in 1982 to 76 million in 2007.

III.3 Estimating the real income growth rate and the discount rate

To measure lifetime earnings for all individuals in the population, we need to project incomes for future years, discount these incomes back to the present. We use the following method to estimate the real income growth rate for urban and rural, respectively.

Assuming that the technology is labor-augmenting, we specify the aggregate production function as:

$$Y = (AL)^a K^b \tag{13}$$

where Y is output, A denotes a technology factor, L denotes labor input, and K physical capital input. The average product of labor or labor productivity is proportional to the marginal product of labor.[8] Because the marginal product of labor equals the real wage when the labor market is in equilibrium, labor productivity and the real wage are expected to grow at the same rate. This suggests that the growth rate of real output per employed worker can serve as a reasonable estimate for the growth rate of the real wage.

[8] The marginal product of labor is given by $\beta Q/L$, where Q/L is the average product of labor.

The labor productivity in the rural sector is defined as real GDP of the primary industry divided by the number of persons employed in the primary industry. The labor productivity in the urban sector is the ratio of real GDP of the secondary and tertiary industries to the number of persons employed in these industries. Our calculation indicate that in the past 30 years labor productivity grew on average 4.11% and 6% per annum in the rural and urban sectors, respectively. We assume labor productivities (and hence the real income) continue to grow annually at these average rates.[9]

The discount rate that is used to value future incomes in present terms should reflect the rate of return one expects from investments over a long time horizon. We adopt the discount rate , 4.58%, used by Jorgenson and Fraumeni (1992a). This discount rate was derived by Jorgenson and Yun (1990) based on the long-run rate of return for the private sector of the U.S. economy.

We also use alternative discount rates for the purpose of comparison (see IV.6.1). The first is 3.14%, which is the average interest rate on the 10-year government bonds issued to individual investors over the period 1996 to 2007, net of the average rate of inflation over the same period. The second is 5.43%, which is the average lending rate in China. The third is 8.14%, which is the social discount rate estimated using a method from the World Bank.

[9] One obvious concern is how fast these rates will converge to the long-run steady-state rates, and what are the long-run steady-state rates. Our future research will address these issues.

IV. Results and discussions

IV.1 Total human capital stock, GDP, and physical capital stock

Our results are based on the J-F approach. The estimated total human capital stock at the national level for 1985-2007 is reported in Table IV.1.1. Column 1 contains the total human capital measured in nominal terms and columns 2, 3 and 4 present the ratios of human capital to GDP and physical capital.

In order to get a sense of the magnitude of the estimated total human capital in China, we reported the ratio of nominal human capital to nominal GDP. The ratio of estimated (market) human capital to GDP generally declines over time until 2005-7, when it is between 13 and 14. Jorgenson and Fraumeni (1992a)'s estimates of the ratio of total market human capital to GDP in the U.S. from 1947 to 1986 is between 18 and 22. The ratio of nominal human capital to GDP in 2007 in our alternative scenarios varies from a high of 17.54 to a low of 6.56 depending upon which real discount rate is used.[10]

We also compare our human capital estimates with the estimated total physical capital stock in China. There are a few estimates of China's capital stock. In columns 3 of Table IV.1.1, the estimated capital stock was estimated by Zhang et. al. (2004) in an article published in *Economic Research*, a leading academic journal in China. In column 4 of Table IV.1.4, we use the capital stock estimates reported in Holz (2006).

[10] In one alternative, a real income growth rate of 1.32% is used along with a discount rate of 4.58% following Jorgenson and Fraumeni (1992a). These are also the rates being used by the OECD consortium (OECD 2010). When this altenative is estimated beginning with individuals who are 16 (as opposed to age 0) to increase comparability with the OECD consortium estimates, in 2006, the year used in the OECD paper country comparisons, the ratio of nominal human capital to GDP is 5.1.

As can be seen in Figure IV.1.1, in both cases, the total human capital is much higher than total physical capital. More specifically, human capital is about 7-14 times of the amount of physical capital. This is not surprising, given that in most countries human capital accounts for over 60% of national wealth (which also include natural resources). On the other hand, the ratio of human capital to physical capital appears to be declining continuously, based on both estimates of physical capital. It is unclear whether such a trend indicates that the Chinese government has overly weighted toward physical capital investment relative to human capital investment.[11]

IV. 2. The trend of total human capital stock

In order to discuss the trend of the total human capital in China, we use CPI as the deflator to calculate human capital in real terms[12]One reason is that other published deflators are not available for later years; and the other reason is that the results based on CPI are smaller than those based on deflators used in Zhang et. al. (2004) and Holz (2006) to derive real physical capital stocks. Therefore, our human capital estimates tend to be more conservative.

Table IV.2.1 shows that from 1985 to 2007, the total human capital increased from RMB 19.30 trillion to 83.48 trillion, an increase of more than three-fold. The average annual growth rate for this period is 6.66% per year, considerably lower than the growth rate of the

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[11] Heckman (2005) and Liu (2007) also find suggestive evidence that China over-invested in physical capital and under-invested in human capital during the reform period.

[12] An alternative approach is to construct real human capital by using Divisia quantity indices. In this paper we are beginning a transition to use of Divisia indices by presenting Divisia quantity index growth rates for real human capital and contributions to growth in human capital in Table IV.4.1 and IV.4.2.

overall economy.[13] Over the same period, the Chinese economy grew at an annual rate of 9.33%.[14] This helps explain the declining ratio of human capital to GDP. However, this growth rate is much higher than those observed in other countries. For example, for 1970-2000, the growth of human capital in Canada was 1.7% per year (Gu and Wong, 2009). Moreover, the growth of human capital accelerated after 1994. The average annual growth rates are 5.24% for 1985-1994 and 7.64% for 1995-2007.

Figure IV.2.2 shows the total human capital estimates for urban and rural China separately.[15] Before 1995, the amount of total human capital in both areas was very close. In fact, rural human capital was even larger than that in the urban area until 1994. Since 1995, however, human capital stock in the urban area has been rising much more rapidly. The total human capital for the rural area was RMB 11.58 trillion in 1985 and rose to 30.77 trillion in 2007; and the corresponding figures for the urban area were RMB 7.72 trillion and 52.71 trillion, respectively. In this period, the annual growth rates of human capital were 4.44% (5.28% after 1995) and 8.73% (9.45% after 1995) for rural and urban areas, respectively. The urban-rural gap in the estimated human capital stock increased from 0.35 trillion in 1995 to 21.95 trillion in 2007, growing at an annual rate of 34.60%.

There are several reasons for this trend. First, in early years, the rural population dominated, and thus had larger amount of human capital. For example, in 1985, there were

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[13] In calculating annual average growth rate in this report, we calculate annual growth rates using the difference of logarithm for every year, and then take average across years.

[14] The data come from "China Statistical Yearbook 2008", Table 2-4.

[15] However, our estimates for the rural area are rather conservative because we assume the same male retirement age of 60 and female retirement age of 55 as in the urban area. In fact, many rural residents continue to work after these ages.

733 million people in rural areas, which were more than three times the urban population of 229 million. By 2007, however, the population in rural China reduced to 608 million, much closer to the urban population of 507 million (Figure III.1.1). This change was, to a large extent, a result of the rapid urbanization during the course of economic transition as well as a large scale rural-urban migration.

The second reason is the widening gap in educational attainment between the urban and rural population. In urban areas, the population with education at college or above accounted for 2.47% of the total population in 1985. This proportion increased to 13.01% by 2007. While in rural areas, the corresponding figures were 0.07% in 1985 and 0.93% in 2007.

Figures IV.2.1, IV.2.3 and IV.2.4 show the trends of male and female human capital estimates for the whole population, urban and rural population, respectively. Male and female human capital estimates in the urban area exhibit similar trend. But the gender gap seems to be widening. The gender-based human capital estimates for the rural population painted a somewhat different picture. In the later part of the period, the growth of human capital of males seems to have slowed down while that of females seems to have sped up. Therefore the gender gap became narrower over time. This result is probably caused by two factors: i) a disproportionate number of rural-to-urban migrants are men; and ii) an increase in education for women in rural areas. The reduction of the gender gap in the rural area is consistent with the rising gender disparity in the urban area.

Finally, we construct a human capital index using 1985 as the base year and set its value at 100. The results for each group are reported in Table IV.2.1. Figure IV.2.5 shows the growth trend.

IV.3 Per capita human capital

The increase in the total human capital can be caused by population growth, demographic changes (e.g., the size of retirement group), rural-urban migration or urbanization (e.g., an individual can achieve higher value of human capital by moving from rural to urban area), higher educational attainment, higher rates of return to education, higher rates of return to on-the-job training, etc. In order to get further information on the dynamics of human capital in China, we calculate per capita human capital, i.e., the ratio of total human capital to the non-retired population (Table IV.3.1).

The per capita human capital was RMB 20,059 in 1985, RMB 30,073 in 1995, and RMB 74,840 in 2007. From 1985 to 2007, per capita human capital increased 2.7 times; while over the same period, per capita real GDP increased 6.68 times, much faster than the growth of per capita human capital. Per capita human capital has been increasing since 1985 and at an accelerated rate since1995. The average annual growth rate was 4.1% from 1985 to 1994, and 7.3% from 1995 to 2007. The growth rate in the later period is almost twice as high as that in the earlier period. Figure IV.3.1 and IV.3.2 show the growth trend of human capital per capita by gender and location, respectively.

These growth rates are very high compared to those for Canada and the United States. Per capita human capital for Canada basically remained constant during 1980-2000 and even declined at an annual rate of 0.2% during 2000-2007 (Gu and Wong, 2009). Per capita human capital in the United States also basically remained constant during 1994-2006 (Christian, 2009). Higher per capita human capital growth rates in China are probably attributable to the dramatic economic growth since 1978, rapid expansion of education, transition toward market-oriented system (so that human capital can realize much higher value), rapid urbanization, and massive rural-urban migration.

Per capita human capital growth rates for both males and females substantially increased in the post-1994 period. Specifically, the average annual growth rate for 1985-1994 was 5.0% for males and 2.6% for females; the average annual growth rate for 1995-2007 was 7.0% for males and 7.8% for females. Clearly, the increase in the rates of growth between the two periods is substantially greater for females than for males. In fact, from 1996 onward, the growth rate was lower for males than for females.

In 1985, per capita human capital is RMB 33,742 in the urban area and RMB 15,789 in the rural area; the corresponding numbers become RMB 103,946 and RMB 50,577, respectively, in 2007. The absolute size of the urban-rural gap has been on the rise. The annual growth rate was 5.11% for the urban area (4.57% for 1985-1994 and 5.49% for 1995-2007), and 5.29% for the rural area (2.75% for 1985-1994 and 7.05% for 1995-2007). Therefore, the urban-rural gap was widening in 1985-1994, while it has narrowed since 1995. The wide urban-rural gap raises concern for the increasing disparity between these two areas. Based on Fleisher, Li and Zhao (2009), human capital is a significant contributing factor to economic growth (total factor productivity). Therefore, such a trend in human capital can worsen the urban-rural inequality in China.

Figure IV.3.3 and IV.3.4 show the gender differences for urban and rural areas, respectively. The patterns are similar to that of total human capital. In particular, per capita human capital for males and females show similar trend in the urban area, but per capita human capital grew faster for females than males in the rural area in recent years. From 1985 to 2002, rural per capita human capital grew at an annual rate of 5.21% for males, compared to 3.03% for females; from 2003 to 2007, however, the growth rates were 6.87% and 11.31% for males and females, respectively. Although growth rates for both males and females have increased, the growth rate has increased much more for females than for males.

We also construct per capita human capital index with its corresponding value in 1985 set at 100 (Table IV.3.1). Figure IV.3.5 shows various per capita human capital indices.

IV.4 Divisia indices

As mentioned earlier, we construct Divisia quantity indices to measure real human capital and the contributions of human capital subcomponents to growth in human capital. Following the methodology outlined in Jorgenson, Ho and Stiroh (2005) the growth rate of aggregate human capital stock is calculated as a weighted sum of the growth rates of the number of individuals across different educational, age, gender and location categories:

$$dlnK = \sum_s \sum_e \sum_a \sum_l \bar{v}_{s,e,a,l}\, dlnL_{s,e,a,l} \qquad (14)$$

where *K* denotes the volume indices of aggregate human capital stock, $L_{s,e,a,l}$ the number of individuals with gender s, educational level e, age a, and location l, and d denotes a first difference, or change between two consecutive periods, for example:

$$dlnK = lnK(t) - lnK(t-1) \qquad (15)$$

The weights are given by the average share of each category of population in the nominal value of aggregate human capital stock:

$$\bar{v}_{s.e,a,l} = \frac{1}{2}\left[v_{s.e,a,l}(t) + v_{s,e,a,l}(t-1)\right], v_{s,e,a,l} = \frac{Mi_{s,e,a,l}}{\sum_s \sum_e \sum_a \sum_l Mi_{s,e,a,l}} \qquad (16)$$

where $Mi_{s,e,a,l}$ is the lifetime income of different types of the individuals, cross-classified by gender, education, age and location.

Then we set the base year b, accumulate the annual human capital growth rate, and get the growth rate relative to the base year:

$$MItg(t) = \sum_b^t dlnK \quad (17)$$

We get the human capital quantity of t year:

$$MIQ(t) = \frac{exp[MItg(t)] \cdot MI(b)}{exp[MItg(b)]} \quad (18)$$

Further, to examine the contribution to the compositional change of aggregate human capital stock from population characteristics such as gender, education, age, and location separately, we construct the partial indices of aggregate human capital stock corresponding to those characteristics. There are four orders partial indices based on our classification by gender, education, age, and location[16].

The first order partial index of the volume of aggregate human capital stock corresponding to one characteristic (e.g. education) is defined as follows:

$$dlnK^e = \sum_e \overline{v_e}\, dlnL_e \quad (19)$$

$$\overline{v_e} = \frac{1}{2}[v_e(y) + v_e(y-1)], v_e = \frac{Mi_e}{\sum_e Mi_e} \quad (20)$$

The second order partial index of the volume of aggregate human capital stock corresponding to two characteristics (e.g. education and age) is defined as follows:

$$dlnK^{e,a} = \sum_e \sum_a \overline{v}_{e,a}\, dlnL_{e,a} \quad (21)$$

$$\bar{v}_{e,a} = \frac{1}{2}\left[v_{e,a}(y) + v_{e,a}(y-1)\right], v_{e,a} = \frac{Mi_{e,a}}{\sum_e \sum_a Mi_{e,a}} \quad (22)$$

The third order indices are similarly defined. There are four first order indices, six second order indices and four third order indices.

[16] We also can call the aggregate index the fourth order index.

To identify contributions to the growth of human capital, we define the each order contribution of characteristics as follows:

For the first order contribution like education to the human capital growth, Q^e, is the difference between the growth rates of the first-order partial index of human capital and total population:

$$dln\ Q^e = dlnK^e - dlnL \quad (23)$$

For the second order contribution like education and age to the human capital growth, $Q^{e,a}$, is the difference between the growth rates of the corresponding second-order partial index of human capital and total population, less the sum of the growth rates of the two first-order contributions:

$$dln\ Q^{e,a} = dlnK^{e,a} - dlnL - dln\ Q^e - dln\ Q^a \quad (24)$$

The other contribution of each order indices can be constructed similarly.

$$dlnQ^{s,a,e,l} = dlnK - dlnL - dlnQ^{s,a,e} - dlnQ^{s,a,l} - \ldots - dlnQ^{s,a} - dlnQ^{s,e} - \ldots - dlnQ^s - dlnQ^a - dlnQ^e - dlnQ^l \quad (25)$$

so,

$$dlnK - dlnL = dlnQ^{s,a,e,l} + dlnQ^{s,a,e} + dlnQ^{s,a,l} + \ldots + dlnQ^{s,a} + dlnQ^{s,e} + \ldots + dlnQ^s + dlnQ^a + dlnQ^e + dlnQ^l \quad (26)$$

then, we can decompose the growth rate of aggregate human capital per capita and identify the contribution of each partial index.

In the following part we will present growth rates for our estimates of real, or the quantity of, aggregate human capital and for the contribution of human capital for subgroups of persons by gender, age, education and location. Table IV.4.1 report the estimates of the annual growth rates of aggregate and per capita human capital, population, and the first order indices. Figure IV.4.1 plots the growth rates for the first order indices. We are not reporting details for the second and third order indices. From 1986 to 2007, the annual average growth rate of human capital is 1.47%, and 0.67 percentage point is due to the growth in the population, the remainder 0.8 percentage point is due to the effect of the compositional shift or the growth in human capital per capita. During the two periods 1986 to 1994 and 1995 to 2007, these three numbers are 1.53%, 1.17, 0.36 and 1.42%, 0.33, 1.09, respectively. The sub-period average growth rates for human capital are relatively similar; however, the percentage of growth in human capital accounted for by population growth versus growth in human capital per capita flipped in the two sub-periods. In 1986-1994, population growth represented 76% of growth in human capital and growth in human capital per capita represented 24% of growth in human capital. In 1995-2007, population growth represented 23% of growth in human capital and growth in human capital per capita represented 77% of growth in human capital. From Figure IV.4.1, we can see that the education and location indices increase much faster than the age and gender indices in China, which may be caused by the educational level improvement, rural-urban immigration and urbanization, and the aging of population. Gu and Wong (2009) also find the similar story in Canada.

Table IV.4.2 provides a more clear description for the contribution of different indices to the human capital per capita growth. From 1986-2007, the growth rate 0.8% of human capital per capita is contributed by -0.70 percentage points of first-order age index, 0.86 percentage points of first-order education index, -0.0006 percentage points of first-order gender index, 1.05 percentage points of first-order location index, -0.38 percentage points of all second-order indices, -0.03 percentage points of all third-order indices, 0.0005 percentage points of fourth-order index.[17] Education and location make a positive contribution, while the age contribution is negative, and gender almost makes no contribution. Looking at the 1986-1994 and 1995-2007 sub-periods, we see that the positive education and location contributions increase significantly, also the negative contribution of aging becomes larger. The significant role of urbanization and rural-urban migration in human capital accumulation in China is shown by the fact that the location contribution is larger than education's contribution.

Table IV.4.3 decomposes the growth of aggregate human capital into contributions from persons of each gender, from rural and urban, from persons of five education levels and from persons of five age groups. During 1986-2007, on average 61% of the gender-attributed contribution to growth in aggregate human capital is due to the growth in male human capital and 39% due to growth in female human capital. Urban's contribution is much larger than the rural's. It is not a surprise that higher education levels contribute positively to the human capital growth, while the lower education levels contribute negatively, also that over time the higher education levels play a more important role. Human capital increased for all age groups, but the main increase of human capital growth is caused by the 16-45 years old age groups.

IV.5 Active human capital

The above measures of China's human capital can be considered as broader measures of

[17] The sum of the first through the fourth order indices equal the growth rate of human capital per capita (or $dlnK - dlnL$) as shown in the preceding equation in the text.

human capital because they are based on China's population aged 0-60 for males and 0-55 for females. An obvious alternative is to estimate human capital based on the working age population, which consists of males aged 16-60 and females aged 16-55. This represents China's active human capital stock which may provide a better insight into the evolution of human capital stock currently available for market production purposes.

In Figure IV.5.1 we plot against time the ratio of human capital to active human capital for different population groups. The ratios range between 0.5 and 0.7 for the national totals, and display an upward trend during the period 1985-2007. This can be explained by the downward trend of children's share in the population caused by the one-child policy. The ratios for the urban population are lower than the ones for the rural population. It is interesting to note that the difference between the rural and urban ratios is increasing over time even though working age population share is larger for the urban population than for the rural population (see Figure IV.5.3). This suggests that the reason for larger differences between active human capital and total human capital in the urban area is that the 0-15 year old urban children are expected to receive more schooling and more lifetime earnings than their rural counterparts. Similarly, the ratios are lower for females than for males even though the share of the 0-15 years old in male and female population has been fairly stable. This indicates that girls are expected to gain grounds in education and lifetime earnings.

The ratios of active human capital to human capital in per capita terms range between 0.75 and 0.9. The downward trend during the period 1985 to 2007 may suggest that children in the 0-15 age group are expected to obtain, on average, higher lifetime earnings than the current working population.

IV.6 Human capital estimates using alternative discount rates and real income growth rates

Since the J-F approach estimates human capital as the present value of lifetime earnings, human capital estimates are bound to depend on the discount rate and the income growth rate used. In section III.3, we discussed how we chose the discount rate and the income growth rate. For the purpose of comparison, we also calculate human capital estimates (in nominal terms) using alternative rates. The results are reported in table IV.6.1. The estimates reported in columns 1 through 4 are based on the same real income growth rate but different discount rates. The discount rates used are 4.85% in column 1, 3.14% (the average yield on long-term bonds) in column 2, 5.43% (the lending rate) in column 3, and 8.14% (the social discount rate) in column 4. The estimates in the last column are derived using the OECD suggested income growth rate of 1.32% along with our preferred discount rate of 4.85%.

It is obvious that the human capital estimates vary with the discount rate and real income growth rate used. However, figure IV.6.1 (which plots the log of these estimates against time) seems to suggest that the rates of growth of human capital stock (the slopes of the plotted lines) are not sensitive to discount rates and income growth rates used.

IV.7 International comparison

A summary of international comparison of human capital estimates is reported in Table IV.7.1. China’s total human capital is quite large, second only to the United States. However, China’s per capita human capital is still very small. In 2001, the total human capital in China is 18 times of that in Australia and about 170 times of that in New Zealand. In 2006, China’s total human capital is about 80 times of Norway’s, and in 2007, China’s total human capital is 10 times of Canada's. However, per capita human capital in China is one-fourth of that in New Zealand and one-sixth of that in US. The large gap in per capital human capital between China and these selected developed economies may suggest that it is necessary for China to invest more in human capital as it further develops.

V. Conclusions

In this report, we presented our estimates of China's human capital for 1985-2007, using the J-F lifetime income approach. We calculated total human capital at the national level, and separately for the urban and rural population, and for the male and female population. We also reported human capital estimates in per capita basis. We constructed various human capital indices, including partial Divisia quantity indices. Our main findings are summarized below.

First, for 1985-2007, China's total human capital increased more than three times, with an annual growth rate of 6.66%. This growth rate is much higher than the rates experienced by other countries. Moreover, the growth of human capital accelerated after 1994. The average annual rate of growth for the period 1995-2007 is 7.64%.

Second, the total human capital in the urban area increased at a much higher rate than in the rural area over the period 1985-2007. The average annual growth rates are 8.73% and 4.44% respectively for the urban and rural areas. The total human capital in the urban area surpassed that in the rural area in 1993. The urban-rural gap has been widening rapidly, largely because of urbanization, large-scale rural-urban migration, and increase in educational attainment.

Third, per capita human capital also increased rapidly from 1985-2007, with a higher growth rate since 1995. Interestingly, before 1995 total human capital increased faster on average than per capita human capital, while since 1995 both have grown at a similar average annual rate. This result indicates that in recent years, the growth of human capital is mostly driven by factors such as increases in educational attainment, not by population growth.

Fourth, the gender gap in total human capital has been widening at the national level. However, the gender difference in per capita human capital appears to be diminishing.

Fifth, the education-based human capital partial index grew at a much higher rate than the gender-based index. This indicates that education has a greater impact on China’s human capital accumulation.

On the other hand, our results also show that, compared to GDP and physical capital, human capital grew at a slower pace. More specifically, the ratio of human capital to GDP decreased from approximately 21 in 1985 to 13 in 2007; and the ratio of human capital to physical capital also declined from about 11-14 in 1985 to about 8 in 2003, these findings indicates that the Chinese government may have underinvested in human capital compared to physical capital.

Finally, the gap in total human capital and per capita human capital between urban and rural areas has been increasing. Thus, if the object is to reduce urban-rural inequality, more investment in human capital should be directed to the rural area.

Our future work includes: i) finding more data to improve estimates of lifetime earnings and other related variables; ii) refining the estimation of some related parameters and data; iii) completing out construction of Divisia indices; and iv) refining our projections of future incomes and testing the effects of various policy scenarios on human capital accumulation.

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Figures:

Figure III.1.1 Population in China, 1982-2007

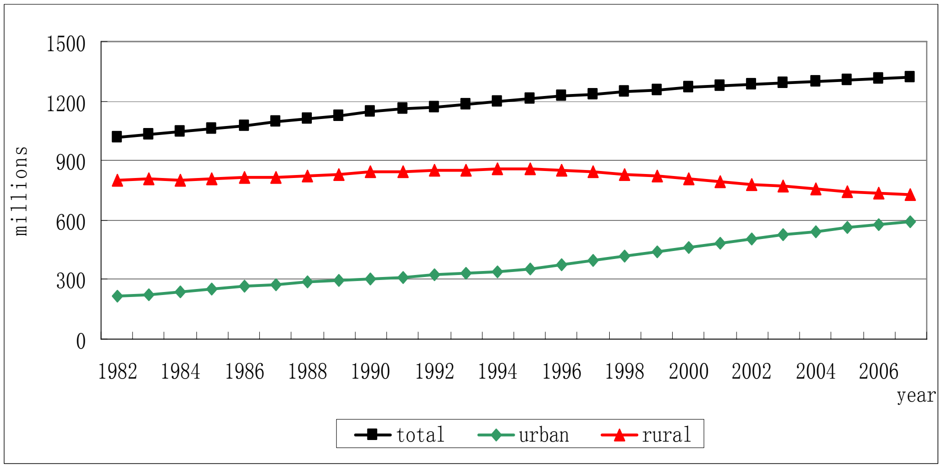


Figure III.1.3 Population by educational attainment, 1982-2007

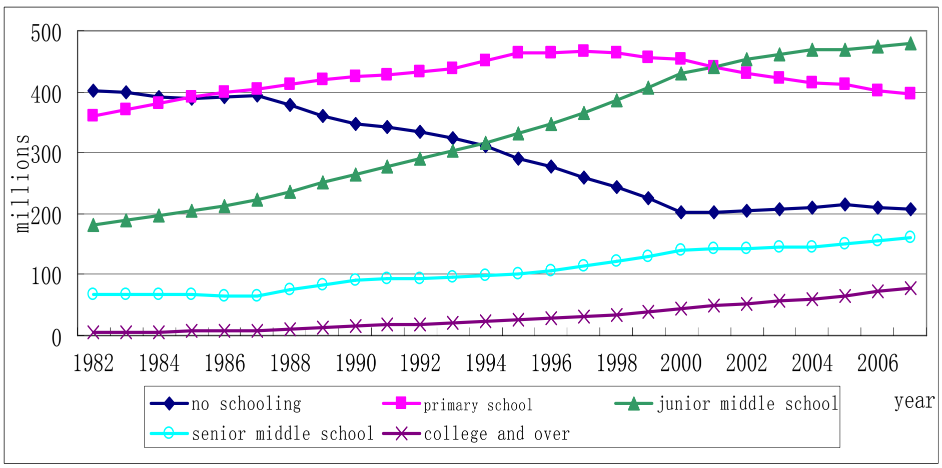


Figure IV.1.1 Nominal and real human capital, 1985-2007

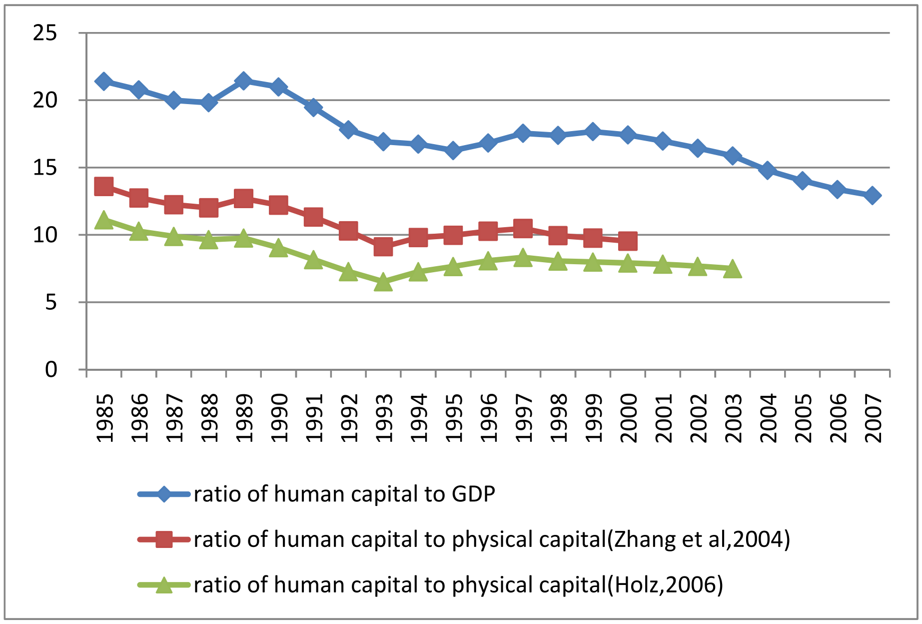


Figure IV.2.1 Total real human capital by gender, 1985-2007

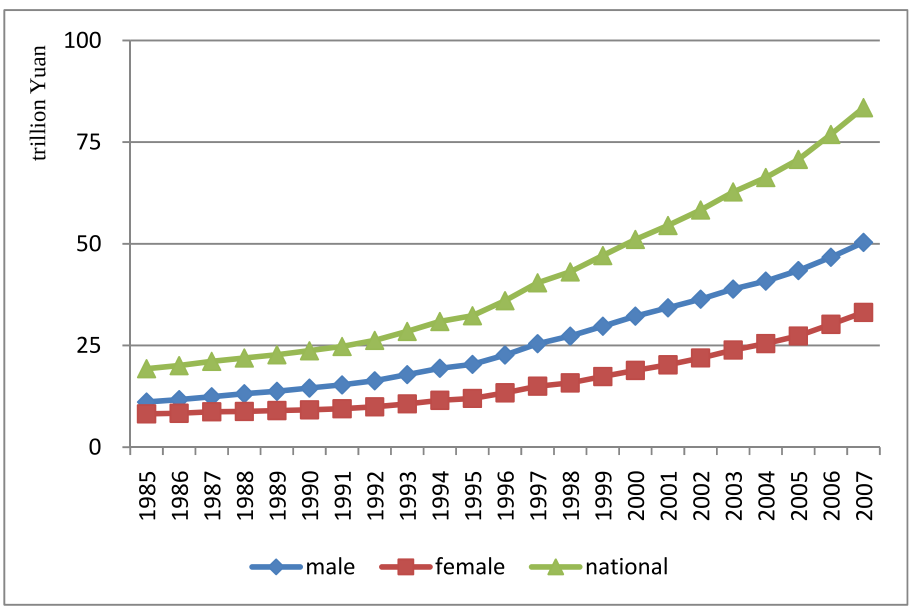


Figure IV.2.2 Total real human capital by urban and rural, 1985-2007

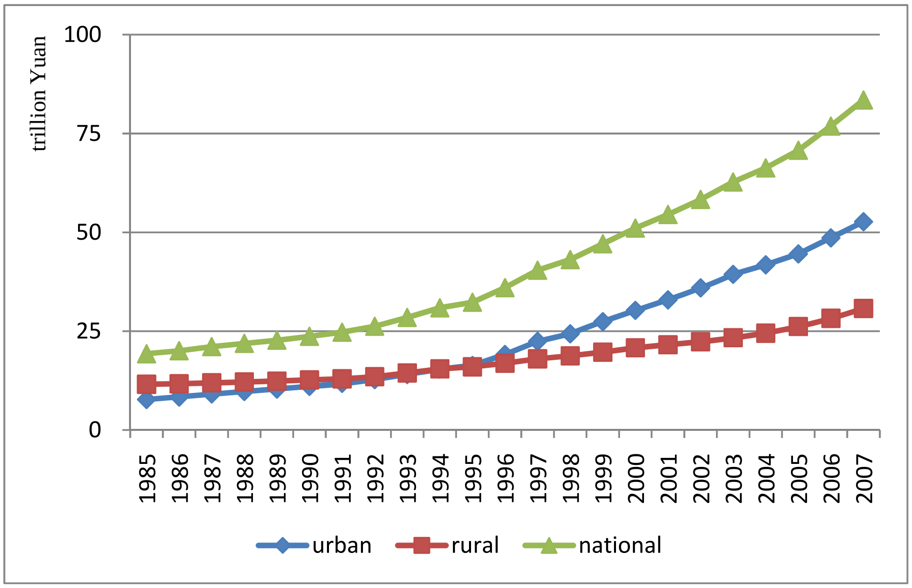


Figure IV.2.3 Total urban human capital by gender, 1985-2007

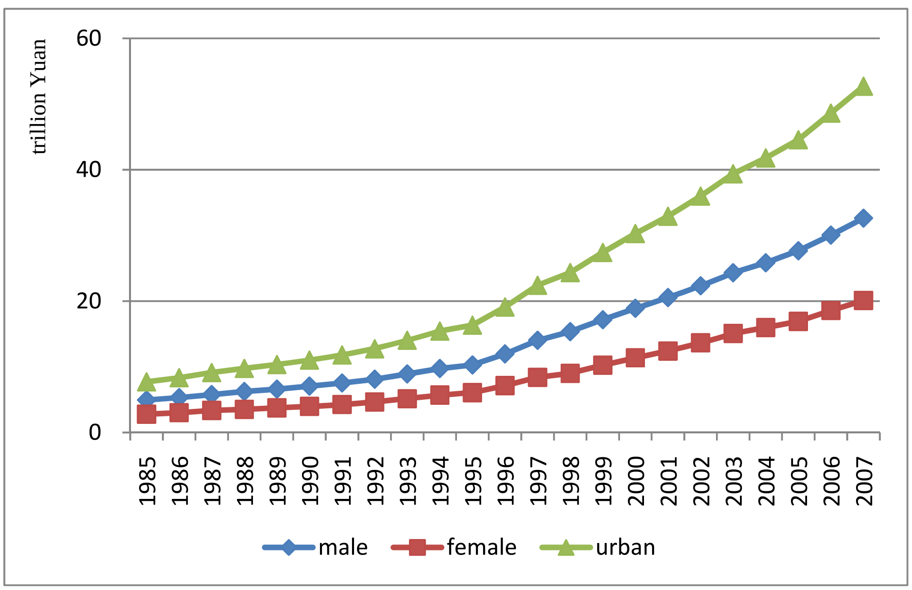


Figure IV.2.4 Total rural human capital by gender, 1985-2007

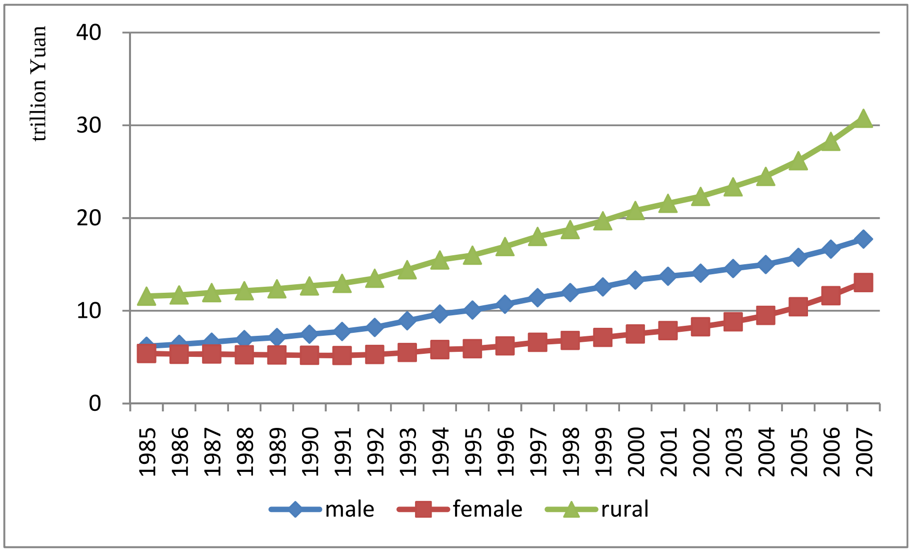


Figure IV.2.5 The index of total human capital, 1985-2007

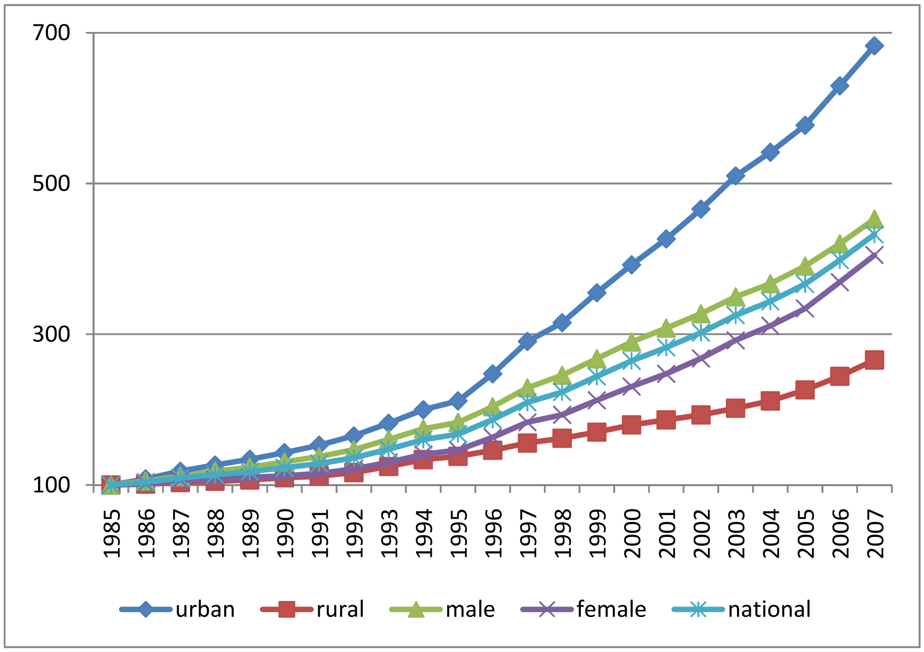


Figure IV.3.1 Real human capital per capita by gender, 1985-2007

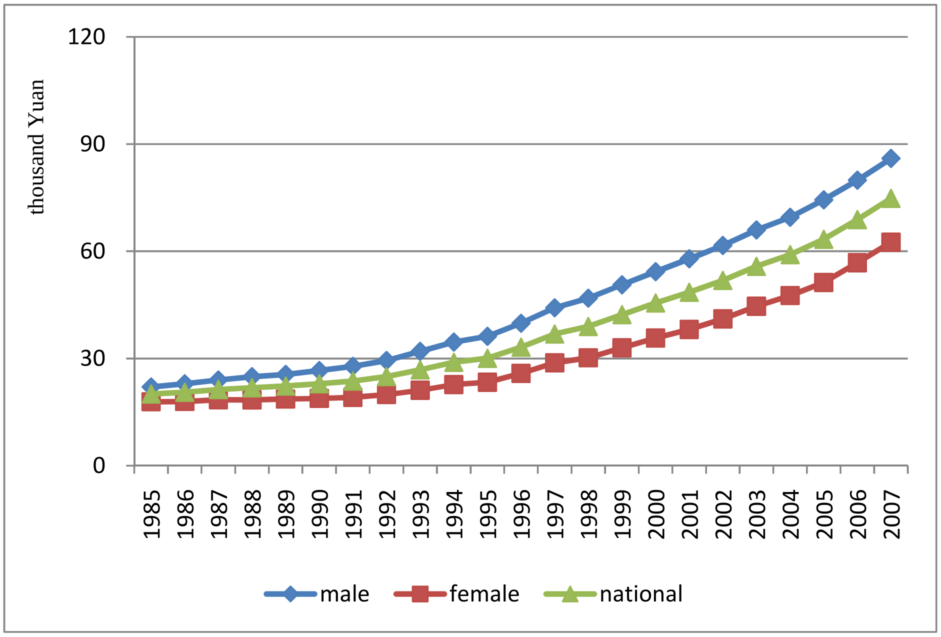


Figure IV.3.2 Real human capital per capita by urban and rural, 1985-2007

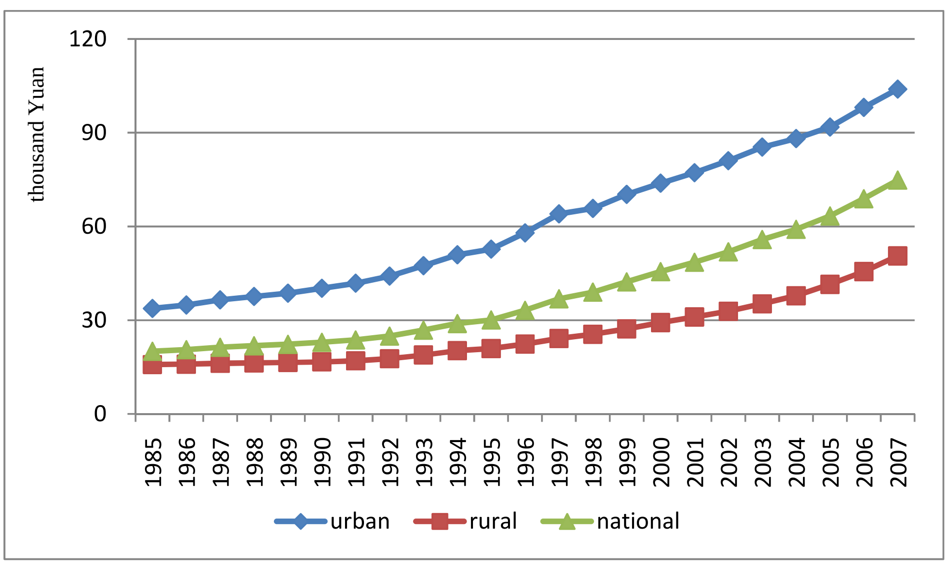


Figure IV.3.3 Urban real human capital per capita, 1985-2007

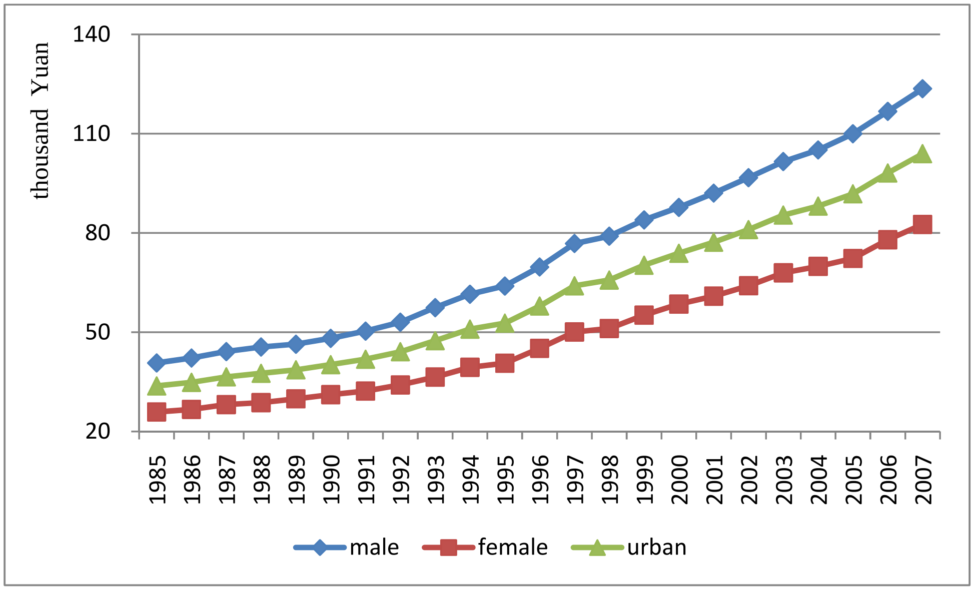


Figure IV.3.4 Rural real human capital per capita, 1985-2007

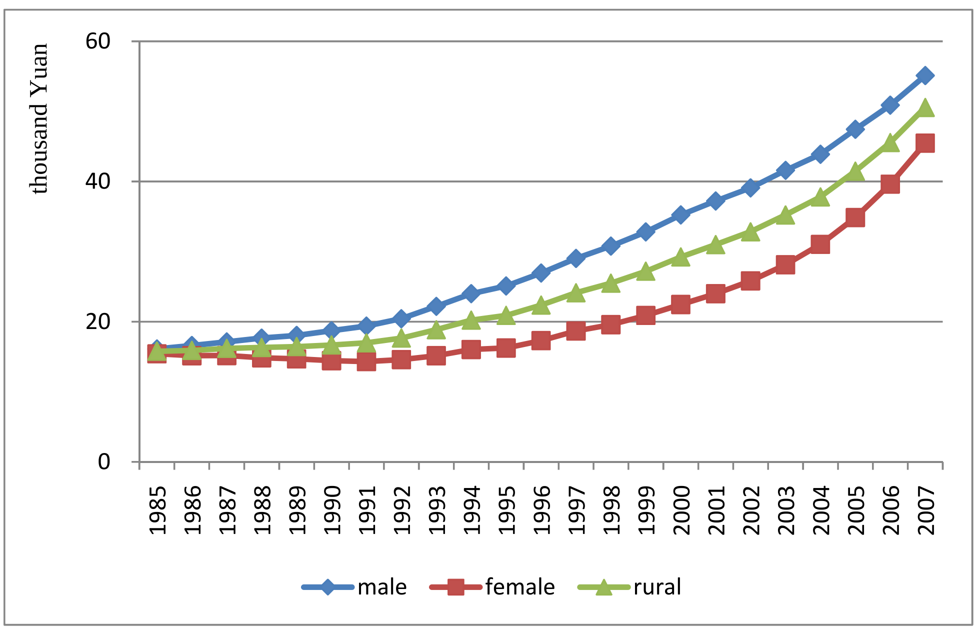


Figure IV.3.5 Indices of real human capital per capita, 1985-2007

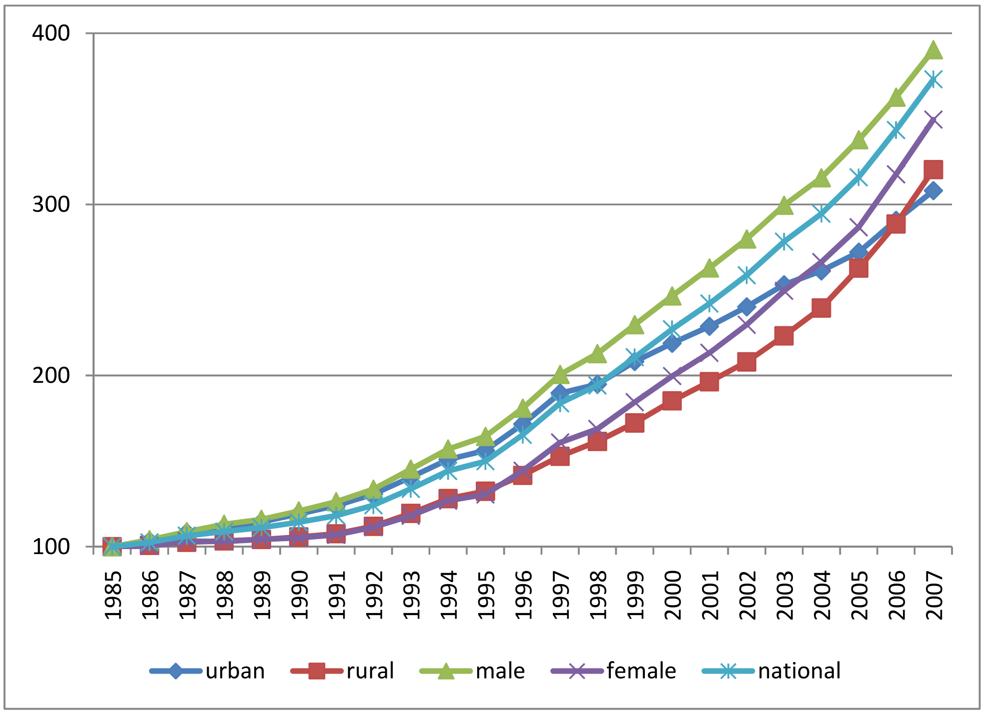


Figure IV.4.1 Growth of human capital Divisia indices

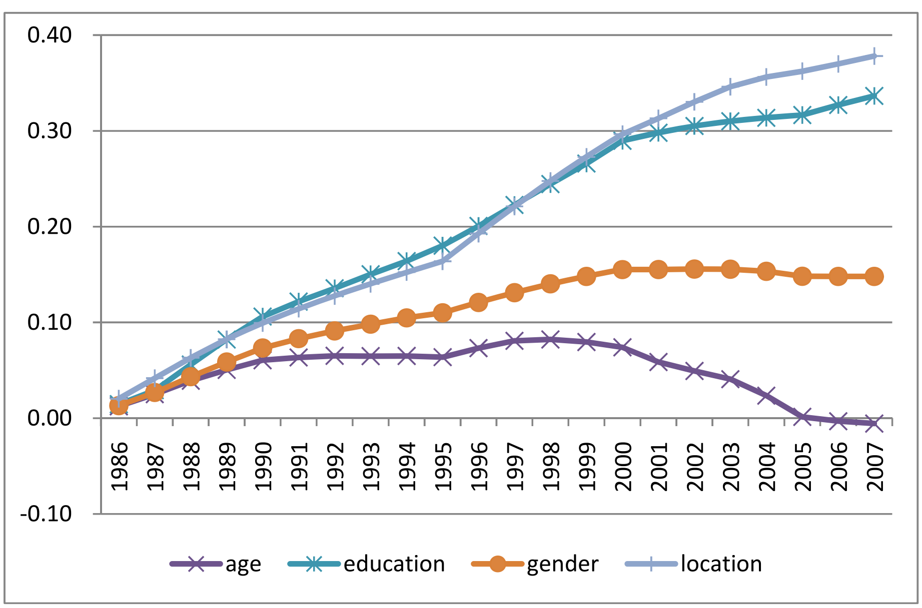


Figure IV.5.1 Ratio of active human capital to total human capital in aggregate level

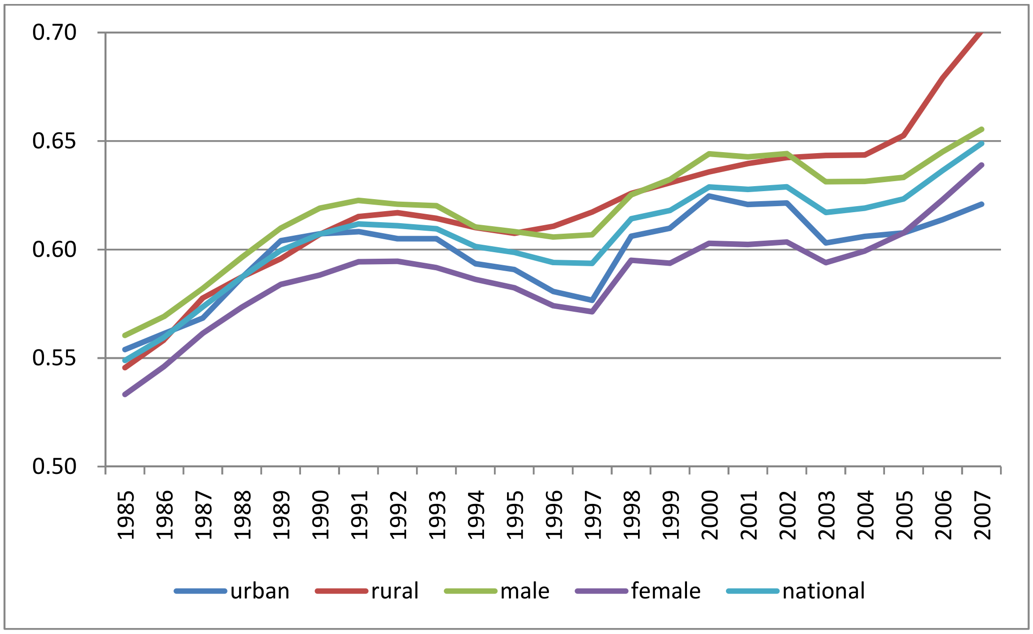


Figure IV.5.2 Ratio of active human capital per capita to human capital per capita

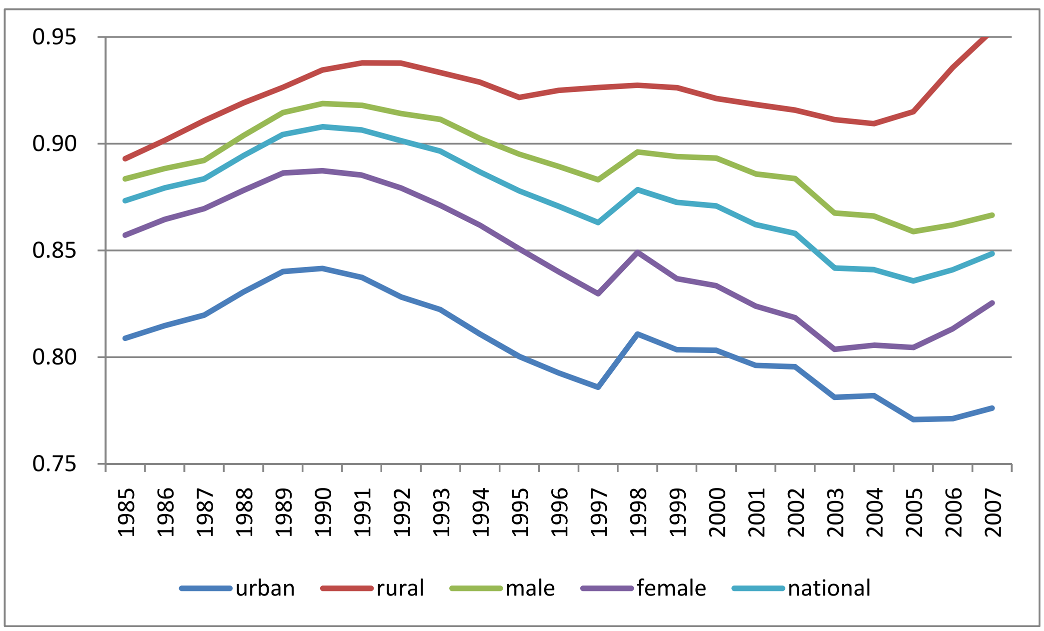


Figure IV.5.3 Ratio of working-age population to population

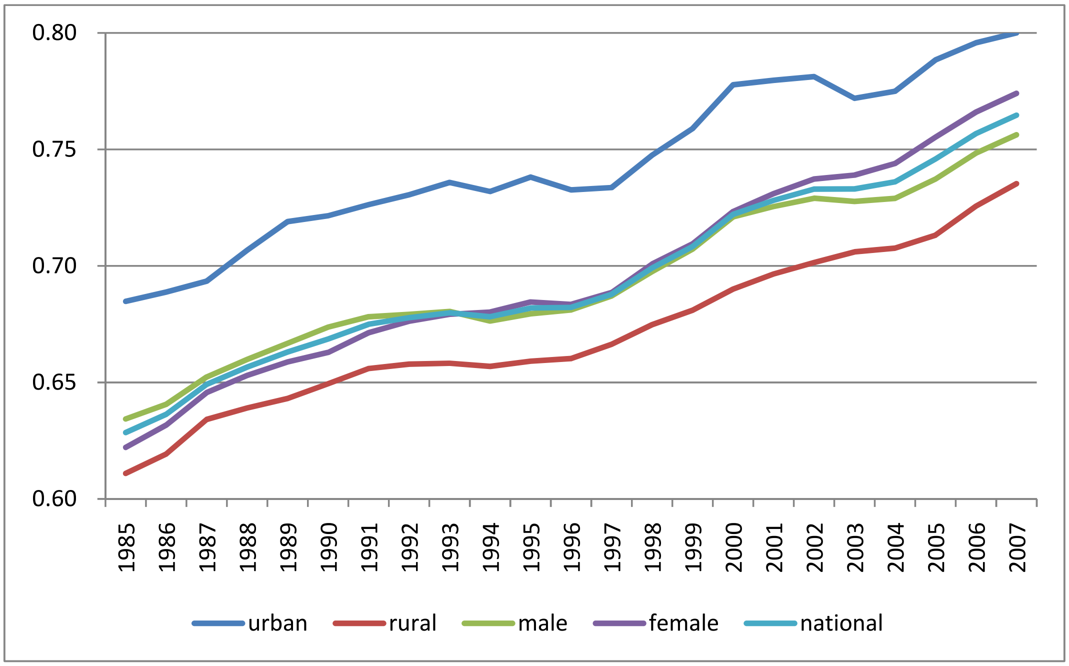
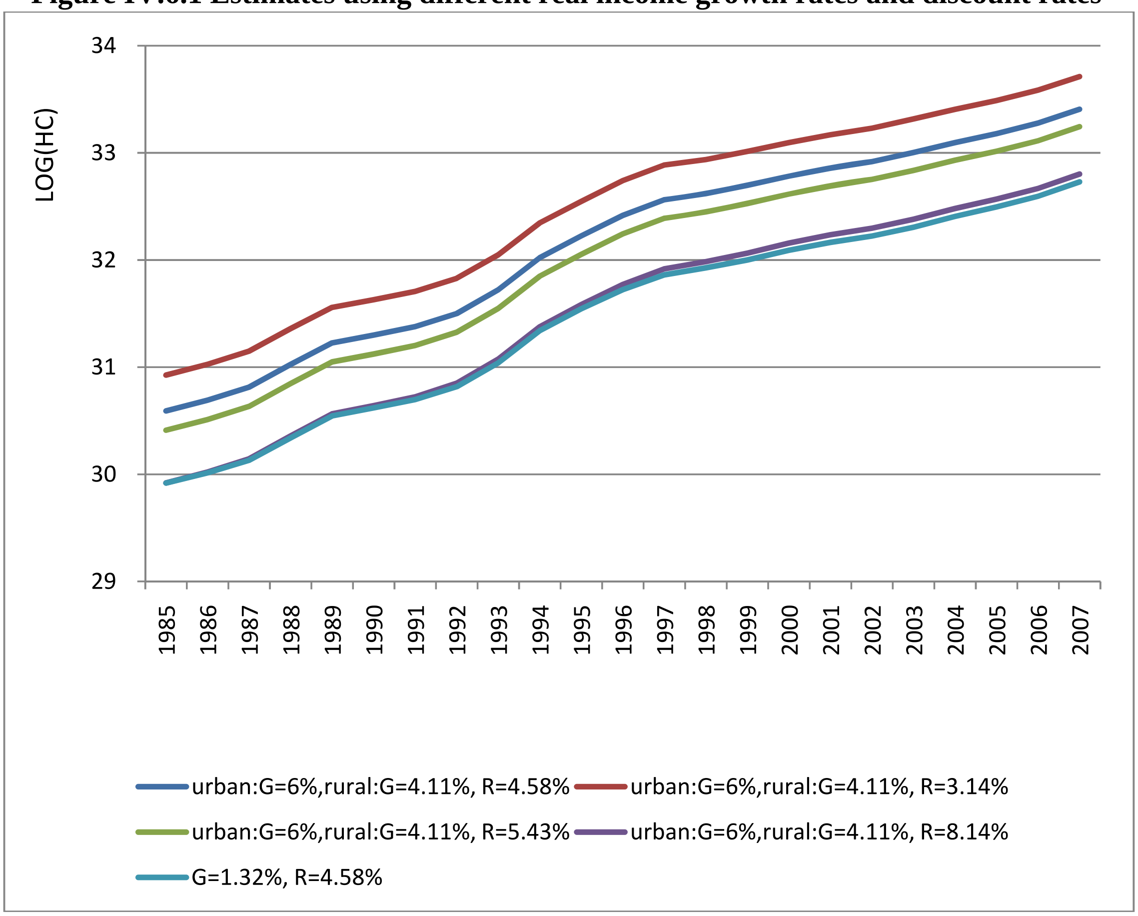


Figure IV.6.1 Estimates using different real income growth rates and discount rates



Tables:

Table IV.1.1 Nominal human capital and the ratio of human capital to GDP and physical capital

Currency unit: RMB Yuan, trillions

year	nominal human capital	ratio of human capital to GDP	ratio of human capital to physical capital	
			Zhang et. al. 2004	Holz, 2006
1985	19.30	21.40	13.60	11.13
1986	21.34	20.77	12.74	10.28
1987	24.11	19.99	12.25	9.89
1988	29.81	19.82	12.01	9.66
1989	36.44	21.44	12.70	9.77
1990	39.19	20.99	12.21	9.06
1991	42.39	19.46	11.33	8.17
1992	47.94	17.81	10.30	7.28
1993	59.80	16.92	9.12	6.53
1994	80.70	16.74	9.81	7.27
1995	98.89	16.27	9.98	7.66
1996	119.75	16.82	10.28	8.09
1997	138.58	17.55	10.47	8.34
1998	146.79	17.39	9.95	8.06
1999	158.50	17.67	9.76	7.99
2000	172.89	17.43	9.54	7.91
2001	186.07	16.97		7.83
2002	197.78	16.44		7.67
2003	215.52	15.87		7.51
2004	236.47	14.79		
2005	256.90	14.02		
2006	283.38	13.37		
2007	322.48	12.92		

Table IV.2.1 Total human capital and indices, 1985-2007

Currency unit: RMB Yuan, trillions

Year	total human capital (in 1985 price)					total human capital indices (1985=100)				
	urban	rural	male	female	national	urban	rural	male	female	national
1985	7.72	11.58	11.12	8.18	19.30	100	100	100	100	100
1986	8.34	11.70	11.71	8.34	20.05	108.1	101.1	105.3	101.9	103.9
1987	9.14	11.96	12.39	8.70	21.09	118.4	103.3	111.5	106.4	109.3
1988	9.77	12.16	13.14	8.78	21.92	126.5	105.0	118.2	107.4	113.6
1989	10.36	12.36	13.73	8.99	22.72	134.2	106.8	123.5	109.9	117.7
1990	11.04	12.67	14.53	9.18	23.71	143.0	109.5	130.7	112.2	122.9
1991	11.81	12.95	15.31	9.44	24.75	152.9	111.8	137.8	115.4	128.3
1992	12.75	13.50	16.32	9.93	26.25	165.2	116.6	146.8	121.4	136.0
1993	14.05	14.43	17.84	10.64	28.48	182.0	124.6	160.5	130.0	147.6
1994	15.44	15.48	19.40	11.52	30.92	200.0	133.7	174.5	140.8	160.2
1995	16.34	15.99	20.35	11.97	32.33	211.6	138.1	183.1	146.3	167.5
1996	19.11	16.92	22.67	13.36	36.03	247.5	146.1	203.9	163.3	186.7
1997	22.42	18.02	25.44	15.00	40.44	290.4	155.6	228.9	183.3	209.6
1998	24.35	18.76	27.31	15.80	43.11	315.4	162.1	245.7	193.2	223.4
1999	27.41	19.70	29.74	17.37	47.11	355.1	170.2	267.5	212.3	244.1
2000	30.28	20.82	32.21	18.88	51.09	392.2	179.8	289.8	230.7	264.8
2001	32.93	21.58	34.26	20.25	54.51	426.5	186.4	308.2	247.5	282.5
2002	35.98	22.34	36.39	21.93	58.32	466.0	192.9	327.3	268.1	302.2
2003	39.39	23.37	38.87	23.88	62.75	510.2	201.8	349.7	291.9	325.2
2004	41.80	24.50	40.82	25.48	66.30	541.4	211.6	367.3	311.4	343.6
2005	44.57	26.19	43.42	27.34	70.75	577.3	226.2	390.6	334.2	366.6
2006	48.61	28.27	46.69	30.20	76.88	629.7	244.2	420.0	369.1	398.4
2007	52.71	30.77	50.34	33.14	83.48	682.8	265.8	452.9	405.0	432.6

Table IV.3.1 Per capita human capital and per capita GDP

Currency unit: RMB Yuan

Year	human capital per capita (in 1985 price)					human capital per capita indices (1985=100)					real per capita GDP
	urban	rural	male	female	national	urban	rural	male	female	national	
1985	33742	15789	22027	17887	20059	100	100	100	100	100	858
1986	34842	15913	22921	17967	20563	103.3	100.8	104.1	100.4	102.5	934
1987	36491	16196	23961	18458	21337	108.1	102.6	108.8	103.2	106.4	1,042
1988	37581	16329	24902	18424	21827	111.4	103.4	113.0	103.0	108.8	1,160
1989	38627	16456	25551	18651	22288	114.5	104.2	116.0	104.3	111.1	1,207
1990	40197	16689	26611	18816	22932	119.1	105.7	120.8	105.2	114.3	1,253
1991	41829	16983	27804	19116	23697	124.0	107.6	126.2	106.9	118.1	1,368
1992	44088	17668	29421	19920	24924	130.7	111.9	133.6	111.4	124.3	1,563
1993	47427	18861	32000	21120	26835	140.6	119.5	145.3	118.1	133.8	1,781
1994	50927	20228	34592	22693	28939	150.9	128.1	157.0	126.9	144.3	2,014
1995	52724	20900	36210	23346	30073	156.3	132.4	164.4	130.5	149.9	2,234
1996	57911	22369	39850	25820	33165	171.6	141.7	180.9	144.4	165.3	2,458
1997	64020	24128	44189	28774	36865	189.7	152.8	200.6	160.9	183.8	2,686
1998	65762	25496	46872	30186	38975	194.9	161.5	212.8	168.8	194.3	2,897
1999	70244	27204	50602	32985	42276	208.2	172.3	229.7	184.4	210.8	3,117
2000	73845	29243	54301	35717	45545	218.9	185.2	246.5	199.7	227.1	3,380
2001	77193	31008	57899	38145	48557	228.8	196.4	262.9	213.3	242.1	3,661
2002	81032	32842	61628	41090	51876	240.2	208.0	279.8	229.7	258.6	3,993
2003	85393	35236	65961	44631	55811	253.1	223.2	299.5	249.5	278.2	4,394
2004	88121	37812	69505	47627	59077	261.2	239.5	315.5	266.3	294.5	4,837
2005	91813	41482	74402	51278	63362	272.1	262.7	337.8	286.7	315.9	5,341
2006	98104	45563	79886	56806	68892	290.7	288.6	362.7	317.6	343.5	5,964
2007	103946	50577	85991	62522	74840	308.1	320.3	390.4	349.5	373.1	6,675

Table IV.4.1 The growth rates of aggregate and per capita human capital and the first order partial Divisia indices

Year	Growth rates (%)						
	aggregate human capital	population	human capital per capita	first order indices			
				age	education	gender	location
1986	1.95	1.32	0.63	1.25	1.46	1.31	2.03
1987	1.98	1.40	0.58	1.26	1.46	1.38	2.14
1988	2.36	1.58	0.78	1.41	2.69	1.65	2.14
1989	1.91	1.48	0.43	1.12	2.61	1.53	1.93
1990	1.64	1.43	0.20	1.02	2.40	1.46	1.69
1991	0.84	1.01	-0.16	0.29	1.56	0.98	1.50
1992	0.80	0.83	-0.03	0.17	1.39	0.81	1.32
1993	0.78	0.75	0.03	-0.03	1.46	0.70	1.27
1994	1.50	0.68	0.82	0.02	1.38	0.66	1.22
1995	1.17	0.61	0.56	-0.12	1.61	0.53	1.14
1996	3.82	1.06	2.76	0.93	2.05	1.08	2.89
1997	3.84	0.97	2.87	0.77	2.20	1.02	2.83
1998	2.75	0.84	1.91	0.15	2.18	0.92	2.66
1999	2.20	0.74	1.46	-0.27	2.14	0.77	2.51
2000	1.90	0.66	1.24	-0.55	2.38	0.72	2.38
2001	0.10	0.08	0.03	-1.54	0.84	0.00	1.65
2002	0.72	0.13	0.59	-0.94	0.72	0.05	1.71
2003	1.73	0.03	1.70	-0.86	0.49	-0.02	1.58
2004	-0.11	-0.19	0.08	-1.71	0.35	-0.22	1.02
2005	-1.05	-0.50	-0.56	-2.22	0.29	-0.52	0.60
2006	0.47	-0.06	0.51	-0.45	1.05	-0.01	0.76
2007	0.95	-0.05	0.99	-0.25	0.96	0.00	0.83

Table IV.4.2 Contribution to the annual growth rate of human capital per capita

Percentage points

Year	first order				second order	third order	fourth order
	age	education	gender	location			
1986	-0.073	0.136	-0.013	0.712	-0.204	0.074	0.000
1987	-0.142	0.065	-0.022	0.740	-0.148	0.096	-0.010
1988	-0.169	1.102	0.063	0.552	-0.854	0.098	-0.016
1989	-0.360	1.128	0.053	0.453	-1.018	0.184	-0.010
1990	-0.415	0.970	0.032	0.263	-0.717	0.101	-0.031
1991	-0.722	0.554	-0.029	0.488	-0.513	0.059	0.000
1992	-0.661	0.561	-0.023	0.493	-0.409	0.010	-0.005
1993	-0.784	0.706	-0.053	0.522	-0.260	-0.111	0.011
1994	-0.664	0.697	-0.017	0.542	0.284	-0.011	-0.012
1995	-0.730	1.005	-0.082	0.529	-0.053	-0.107	0.000
1996	-0.126	0.997	0.027	1.835	0.094	-0.072	0.009
1997	-0.201	1.229	0.053	1.860	-0.018	-0.062	0.007
1998	-0.692	1.340	0.079	1.823	-0.624	-0.007	-0.005
1999	-1.007	1.398	0.028	1.772	-0.583	-0.166	0.018
2000	-1.214	1.716	0.060	1.718	-0.855	-0.193	0.006
2001	-1.610	0.763	-0.071	1.579	-0.459	-0.190	0.015
2002	-1.065	0.592	-0.075	1.587	-0.291	-0.174	0.016
2003	-0.884	0.469	-0.042	1.556	0.584	0.030	-0.010
2004	-1.519	0.546	-0.028	1.213	0.035	-0.164	0.000
2005	-1.729	0.779	-0.031	1.092	-0.419	-0.254	0.004
2006	-0.406	1.091	0.037	0.801	-1.051	0.027	0.013
2007	-0.209	0.996	0.039	0.866	-0.850	0.140	0.009

Table IV.4.3 Contribution to the annual growth rate of aggregate human capital by types of individuals

Percentage points

	Gender groups		location groups		age groups					education groups				
year	male	female	urban	rural	age0-16	age16-25	age26-35	age36-45	age45-60	noschooling	primaryschl	junmiddleschl	senmiddleschl	college
1986	1.15	0.80	1.76	0.20	0.09	1.53	-0.07	0.37	0.04	0.23	0.86	0.96	-0.12	0.02
1987	1.12	0.86	1.83	0.14	-0.42	2.18	-0.20	0.35	0.07	0.77	0.44	0.91	-0.17	0.03
1988	1.70	0.66	1.77	0.58	-0.22	1.57	0.37	0.56	0.09	-0.97	-0.17	1.50	1.39	0.61
1989	1.32	0.59	1.38	0.53	-0.27	-0.05	1.53	0.62	0.08	-0.89	-0.16	1.21	1.19	0.55
1990	1.06	0.57	1.07	0.56	-0.07	-0.25	1.18	0.67	0.09	-0.02	-0.71	0.95	0.93	0.49
1991	0.45	0.40	0.85	-0.01	-0.07	-0.69	0.74	0.76	0.11	-0.43	-0.28	1.03	0.24	0.27
1992	0.45	0.35	0.82	-0.03	0.24	-0.96	0.80	0.60	0.11	-0.42	-0.25	1.06	0.16	0.24
1993	0.25	0.53	0.77	0.01	0.32	-0.70	0.34	0.67	0.15	-0.79	0.13	0.95	0.16	0.33
1994	0.97	0.53	1.42	0.08	1.53	-1.31	0.62	0.55	0.12	-0.98	1.35	0.86	0.03	0.25
1995	0.45	0.72	0.89	0.28	0.51	-0.89	1.15	0.22	0.18	-1.55	1.06	1.14	0.24	0.29
1996	2.43	1.39	4.26	-0.44	1.69	0.47	1.39	0.15	0.12	-0.11	0.37	1.91	0.97	0.68
1997	2.48	1.36	4.14	-0.30	1.17	0.77	1.76	0.00	0.13	-0.48	0.75	1.68	1.18	0.71
1998	2.03	0.72	3.23	-0.48	-0.33	1.45	0.98	0.45	0.20	-0.37	-0.32	1.52	1.18	0.75
1999	1.30	0.90	2.74	-0.53	-0.25	1.03	0.22	1.00	0.20	-0.34	-0.90	1.59	1.00	0.86
2000	1.34	0.56	2.22	-0.32	-1.04	1.13	0.82	0.71	0.28	-0.74	-1.21	1.67	1.00	1.17
2001	-0.08	0.18	1.43	-1.33	-0.15	-0.52	-0.14	0.61	0.30	-0.02	-2.01	0.93	0.32	0.87
2002	0.25	0.46	1.95	-1.23	0.02	0.50	-0.49	0.44	0.24	0.11	-1.63	1.56	0.06	0.62
2003	0.90	0.83	2.92	-1.19	1.76	0.06	-0.47	0.10	0.28	0.11	0.40	0.84	-0.15	0.53
2004	-0.12	0.01	0.85	-0.96	0.14	-0.55	-0.67	0.68	0.28	0.12	-0.31	-0.14	-0.27	0.50
2005	-0.67	-0.38	-0.16	-0.89	-1.47	-0.46	-0.25	0.90	0.23	0.10	0.10	-2.09	0.04	0.80
2006	0.34	0.13	0.89	-0.42	-1.73	1.96	-0.63	0.72	0.14	0.08	-1.60	-0.18	0.90	1.26
2007	0.63	0.33	1.41	-0.45	-0.98	1.46	-0.36	0.77	0.07	0.12	-0.84	-0.03	0.42	1.28

Table IV.6.1 Nominal total human capital estimates using different discount rate and real income growth rate

Currency unit: RMB Yuan, trillions

Year	urban: G=6%, rural: G=4.11%				G=1.32%
	R=4.58%	R=3.14%	R=5.43%	R=8.14%	R=4.58%
1985	19.30	26.98	16.13	9.86	9.86
1986	21.34	29.85	17.83	10.91	10.84
1987	24.11	33.70	20.15	12.35	12.18
1988	29.81	41.64	24.93	15.30	15.02
1989	36.44	50.76	30.52	18.81	18.44
1990	39.19	54.56	32.83	20.28	19.87
1991	42.39	58.89	35.57	22.05	21.48
1992	47.94	66.55	40.24	24.99	24.22
1993	59.80	82.85	50.25	31.30	30.23
1994	80.70	111.63	67.87	42.37	40.80
1995	98.89	136.55	83.25	52.10	50.10
1996	119.75	165.58	100.72	62.87	59.93
1997	138.58	191.59	116.55	72.69	68.74
1998	146.79	201.81	123.82	77.83	73.41
1999	158.50	217.59	133.78	84.22	79.02
2000	172.89	236.52	146.20	92.48	86.49
2001	186.07	254.24	157.48	99.92	93.19
2002	197.78	270.15	167.42	106.30	98.80
2003	215.52	294.59	182.38	115.68	107.20
2004	236.47	322.27	200.44	127.80	118.58
2005	256.90	349.81	217.92	139.37	129.49
2006	283.38	385.36	240.54	154.10	143.08
2007	322.48	437.55	274.07	176.16	163.74

G: the real income growth rate

R: the discount rate

Table IV.7.1 International comparison of human capital estimates

Currency unit: USD Dollars

	Canada	Norway	New Zealand	U.S.	Australia	China		
	2007	**2006**	**2001**	**2006**	**2001**	**2001**	**2006**	**2007**
Age Range	15-74	15-67	25-65	0-80	18-65	male 0-60, female 0-55		
Per capita human capital	548,494	-	323,150	about 700,000	355,590	78,352	115,483	130,549
Total human capital (trillions)	13.61	1.66	0.51	212	4.86	87.96	128.88	145.62
Ratio of human capital to GDP	11	8	6	over 15	10	17	13.4	13

Note: the PPP exchange rates are from http://pwt.econ.upenn.edu/php_site/pwt_index.php