

Chapter 3

Demography and Higher Education: The Impact on the Age Structure of Staff and Human Capital Formation

by

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This chapter first highlights major demographic trends in the OECD area and compares them to trends in other major areas of the world. It then presents a simulation to show how the ageing of staff in higher education is an outcome of two processes – ageing in place and evolution of the student population – demonstrating the importance of a cohort perspective in investigating the relation between demography and the future of higher education. The paper then looks at human capital produced by higher education in terms of the contribution to the labour market of tertiary education graduates in person-years. It concludes by speculating on the role of demographics as a driver of change in higher education.

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3.1. Introduction

Demography affects the future of higher education in two important ways. The first is the demand for education. A decline in fertility has an immediate effect on the number of births and, with a certain delay, on the recruitment base for higher education. The second is the ageing of lecturers and researchers in institutions of higher education, which is only partly due to the ageing of the population. In fact, more people than ever survive to the age of retirement, but a major reason for the ageing of staff is past patterns of recruitment and replacement (turnover). The rapid growth of institutions of higher education in the 1960s and 1970s to accommodate the baby boom generation and the increase in participation rates led to extensive recruitment of personnel. The baby boom was then followed by a baby bust, and the need for new personnel was minimal because the necessary staff was already in place and was ageing.

This paper first highlights major demographic trends in the OECD area and compares them to trends in other major areas of the world. It then presents a simulation to show how the ageing of staff in higher education is an outcome of two processes: namely, ageing in place and evolution of the student population. The combination of a declining student population and a staff that is ageing in place leaves little room for recruitment, and this has been a problem for many institutions of higher education in the OECD area. What the simulation shows is the importance of a cohort perspective in investigating the relation between demography and the future of higher education. The cohort perspective is addressed in the third of these sections. Education is an investment in human capital and increases future labour productivity and future income. The measurement of human capital and assessment of the impact of human capital on economic growth have been, and continue to be, the subject of many studies. A number of these studies advocate a cohort perspective rather than a period or cross-sectional perspective. The fourth section therefore measures human capital produced by higher education in terms of the contribution to the labour market of graduates from higher education in person-years. This concept of human capital is related to the income-based approach to human capital measurement but is much simpler. A concluding section speculates on the role of demographics as a driver of change in higher education.

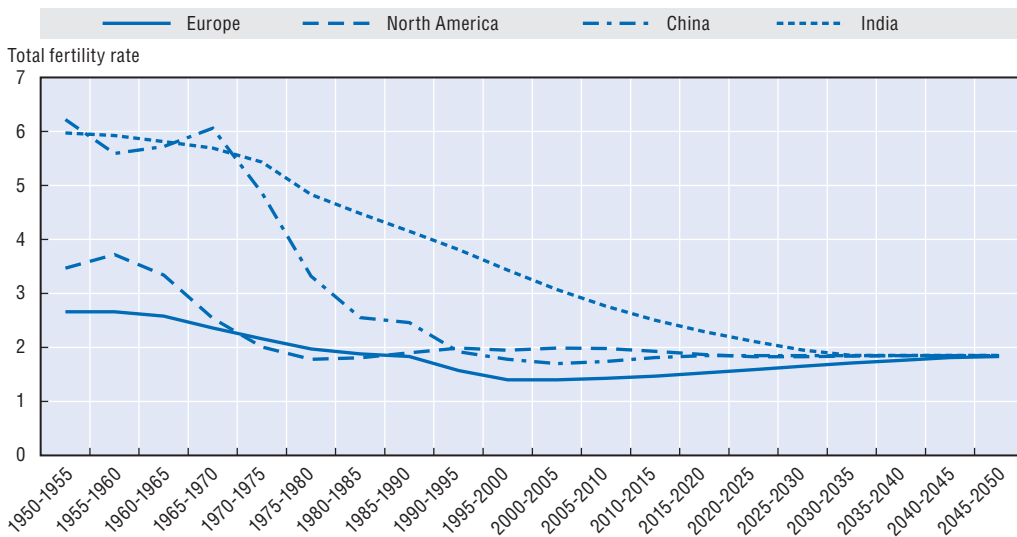
3.2. Major demographic trends in the OECD area

The OECD area is quite heterogeneous. It includes high-fertility countries such as Mexico and Turkey and countries with very low fertility such as Italy and the Czech Republic. Trends in total fertility rates (TFR) have changed dramatically over the last 30 years, declining from an average of 2.4 children per woman in 1970 to 1.6 in 2000. Most of this decline took place between 1970 and 1985. In southern European countries, the decline started later but was much faster. In Central Europe, the decline was also remarkably rapid, dropping from around replacement level in the mid-1980s to a TFR of around 1.3 at the beginning of the 21st century. This very rapid decline can be attributed in

part to postponement of the first birth from about age 24 in 1970 to between 27 and 30 at the turn of the century. When women become mothers at a later age, the decline is temporary and fertility increases after a period of low fertility. In most countries, fertility remains low but some countries, most notably the United States and the Nordic countries, have experienced a recovery. Countries such as Japan and Italy, however, have not seen a recovery and fertility is very low (1.3 or lower). For a description of fertility trends in OECD countries, see Sleebos (2003).

A comparison of the decline in fertility in the OECD area with the decline in two very large non-member countries, China and India, leads to an interesting observation (Figure 3.1): both have experienced a decline in fertility and are converging towards the European fertility rate. In China, the decline has been extremely rapid, owing in part to the one-child policy. In India, the decline has been slower but regional differences are marked. Fertility declined rapidly in southern India and several areas have a TFR of near or below replacement level. In northern India, most states continue to experience high fertility. Overall, by 2025, China, India, North America and Europe are projected to have closer levels of fertility rates.

Figure 3.1. **Total fertility rates, selected regions of the world**

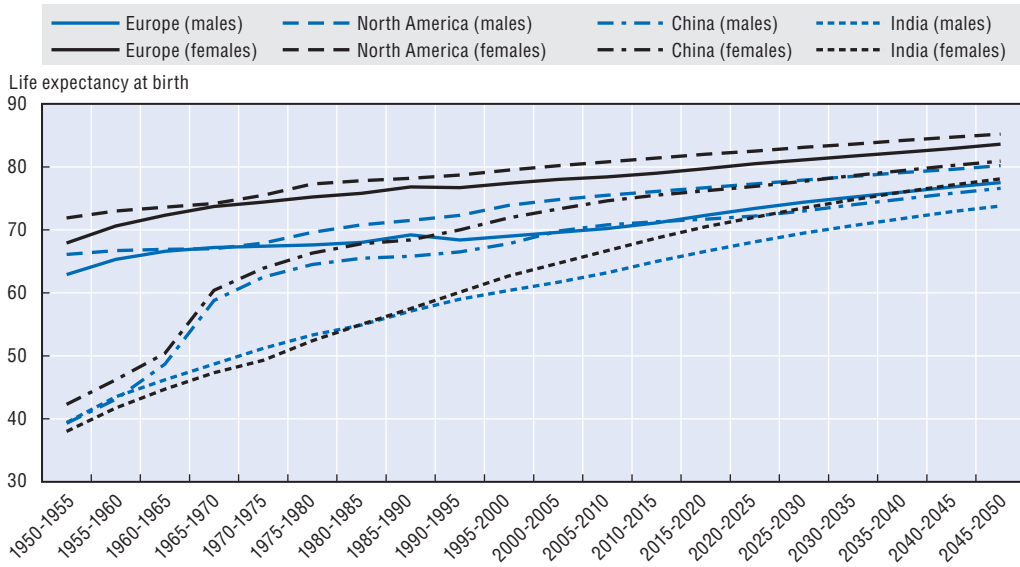


Source: UN Population Division.

In the OECD area, life expectancy has been increasing, from around 65 for males and 70 for females in 1950 to 70-75 for males and 78-80 for females at the turn of the century. Japan enjoys the highest life expectancy, 78.6 for males and 85.6 for females. The United Nations expects life expectancy in OECD countries to increase further to 78-80 for males and 83-85 for females around 2050. Life expectancy at 65 is increasing too. In 2003, average life expectancy for a person 65 years old across OECD countries stood at 15.9 for males and 19.3 for females, an increase of more than three years since 1970. The increase is expected to continue. The OECD projects that in 2040 average life expectancy at 65 in the OECD area will reach 18.1 years for males and 21.6 years for females. China and India are catching up. They started from life expectancy of about 40 for males in 1950 and of 42 (China) and 38 (India) for females. Until the first half of the 1980s, females in India had a shorter expected

lifetime than males. Currently, however, females are living longer than males, in India as in other countries of the world. Figure 3.2 shows the long-term trend in life expectancy for several areas of the world, again a convergence pattern.

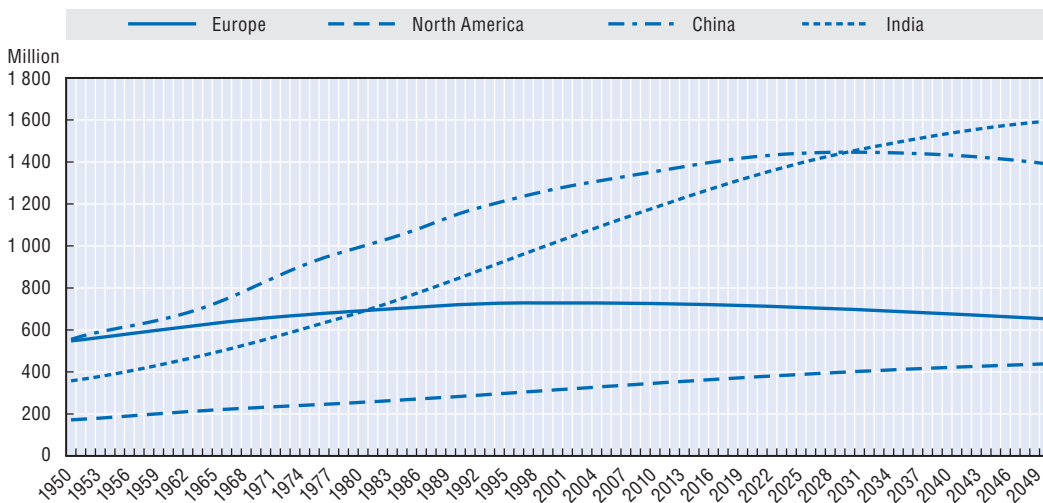
Figure 3.2. **Life expectancy at birth, selected regions of the world**



Source: UN Population Division.

Fertility, mortality and migration underlie changes in population size. High fertility up to 1990 in China and up to 2025 in India, along with the increase in life expectancy, will result in a substantial population increase in these countries compared to Europe and North America. Figure 3.3 shows past changes in the world's population and expected future trends. Around 2030, India will become the country with the world's largest population. The population of North America will continue to grow owing to relatively high

Figure 3.3. **Total population, selected regions of the world**



Source: UN Population Division.

fertility. In Japan, the population was expected to peak in 2006 and then move into a period of decline. According to the United Nations, Europe's population reached a peak in 2003.

The combination of the decline in fertility and the increase in life expectancy results in an ageing population. Today the elderly (65+) account for between 15% and 20% of the population in many OECD countries. The increase in the share of the elderly is most rapid in countries that experienced rapid declines in fertility, such as Japan and Korea. In 2030 the population aged 65+ is projected to reach 30% in Japan and Italy. For a recent account of demographic changes in OECD countries, see Gonand (2005).

Ageing of the population is not restricted to OECD countries. It is occurring in many parts of the world, including China and India. Throughout history, humankind has searched for the secrets of longevity and for ways that allow couples to have the number of children they want. Today, people live longer than ever before, and reliable and safe family planning methods are widely available. However, these major achievements pose new challenges and require society to adjust to the new realities. Smaller families and longer lives imply an increase in the old-age dependency ratio unless pension reform restores the balance between working life and retirement, labour market policies lead to more effective use of human capital, and health policies help to achieve more active ageing. The achievements of the past have enabled people to take more control over their lives. The challenge of the future will be to extend that control while maintaining a balance between individual and social responsibilities.

3.3. Ageing in the higher education sector

The overall population of lecturers, researchers and other personnel in higher education is ageing, a trend that will continue. The main reason is not the ageing of the general population but recruitment associated with the tenure system. This section uses a simple simulation model to demonstrate the effect of: i) declining enrolments in higher education as a result of the decline in fertility; ii) a recruitment policy that links new recruitments to the size of the student population; and iii) the tenure system in higher education which has led to the ageing that characterises the educational sector in general.

Assume an institution of higher education with a ratio of one staff member for 15 students.¹ Recruitment policy seeks to maintain that ratio. A student population of 45 000 means a staff of 3 000. Assume that in the base year the composition of the staff is as follows: about one-quarter (24%) are between 50 and 64; about one-third (32%) are between 40 and 49; and the rest (44%) are under 40. The youngest staff member is 29. Of the employees aged 50-64, one out of six is assumed to be over 60. The staff members of a given age group are distributed uniformly over the ages in the age group. Hence, there are 120 staff members for each year of age for the age group 29-39, 96 for the age group 40-49, 60 for the age group 50-59, and 24 for the age group 60-64. Assume further that no staff member dies, no one leaves before retirement at age 65, and there is no problem for replacing them.

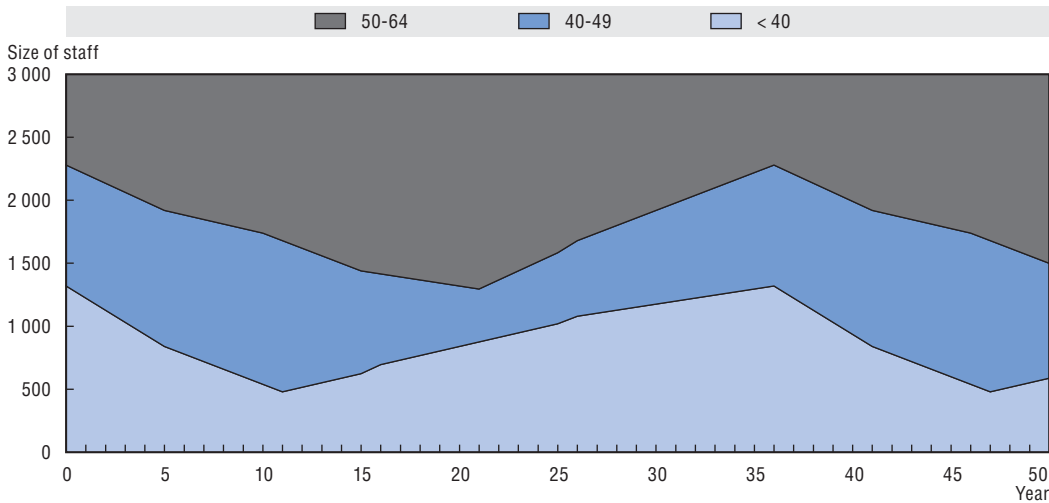
Three scenarios are considered: constant enrolment, declining enrolment and increasing enrolment

First scenario: constant enrolment

When enrolment remains fixed at 45 000, staff size remains constant and retiring staff members are replaced through recruitment. In an attempt to maintain a young workforce,

new recruits are 29 years of age. During the first five years, 24 persons retire each year. After this initial period, the figure increases to 60 retirements a year over the following ten years, to 96 in the subsequent ten years and to 120 in the next period. The age composition of the staff is shown in Figure 3.4.

Figure 3.4. **Number of staff members, by age group: constant enrolment scenario**

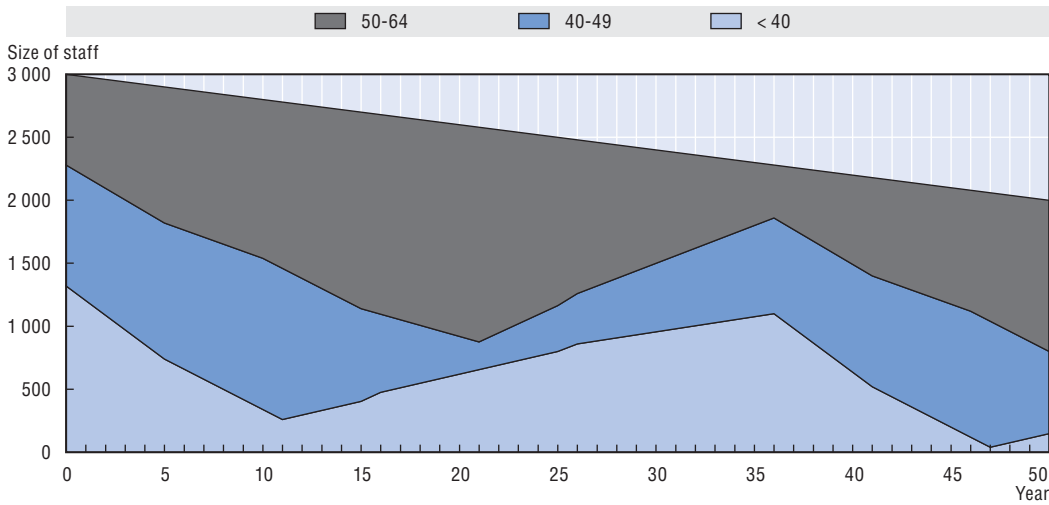


The total number of employees remains fixed but the age structure changes significantly over time. The share of employees less than 40 years of age declines from 44% in the base year to 16% after 11 years. When the large cohorts of employees below 50 start to retire, recruitment of young employees increases substantially and the share of young members of the staff starts to increase. Initially, the increase comes at the cost of the age class 40-49. After 21 years, only 14% of the workforce is in their forties while 57% are 50 or older. Then, 36 years after the introduction of the recruitment policy, the composition of the workforce is the same as in the initial period: 44% are below 40, 32% are between 40 and 49, and 24% are 50 or over. During the years that follow, the pattern observed initially is repeated. The scenario with constant enrolment and a recruitment policy that is fully determined by replacement of retiring staff members by young persons shows that a remarkable change in age structure may result.

Second scenario: declining enrolments

Consider a scenario in which enrolment decreases by 300 each year. After 50 years, enrolment declines from 45 000 initially to 30 000. As a consequence, the staff is reduced from 3 000 to 2 000, or 20 staff members a year. The reduction is obtained by not replacing all retiring employees. The number being replaced in a given year is the number retiring minus 20. As a result of the change in enrolment and the recruitment policy, the share of employees under 40 years of age declines from 44% initially to 9% after 11 years. In that year, those aged 50 or more account for 47%. The proportion of those aged 50+ increases further to 66% after 21 years. In that year, 25% of the staff is under 40 and only 9% are between 40 and 49. Figure 3.5 shows the changing age structure.

Figure 3.5. **Number of staff members, by age group: decreasing enrolment ratio**

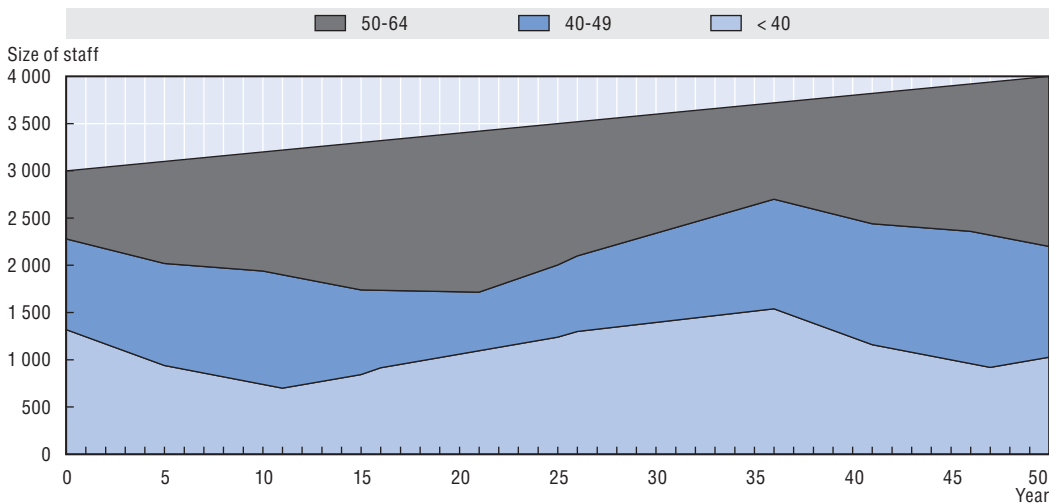


Third scenario: increasing enrolments

In the third scenario, assume that the enrolment increases by 300 students a year. This is a linear increase from 45 000 in the base period to 60 000 after 50 years. After 11 years, the staff under 40 years of age reaches a minimum of 22% which compares favourably with the 16% in the constant enrolment scenario and the 9% in the decreasing enrolment scenario. After 21 years, the proportion of those aged 50+ reaches a maximum of 50% (see Figure 3.6).

These simple simulations illustrate vividly the consequences of student enrolments and recruitment policy on the age structure of the workforce in institutions of higher education. Although the figures are arbitrary, the results of such restrictions on institutions of higher education (student/staff ratio and staff stability) are real. When the staff is stable and ages in place, its age structure varies, even when enrolment remains constant. When

Figure 3.6. **Number of staff members, by age group: increasing enrolment scenario**



enrolment is constant, staff members retire at 65, and retirees are replaced by young persons (aged 29), and the share of senior staff (50-64) varies between 24% and 57%. The variation follows a cycle of 36 years. Since retirement determines recruitment, the entry of young staff varies between 24 persons in the first year of the cycle and 120 persons a year in the last year of a cycle. Thus, between the end of one cycle and the first phase of the next recruitment drops substantially. The variation is entirely determined by the age structure of the staff in the base year and the recruitment and retirement policies.

In sum, enrolment affects recruitment and hence the age structure of the staff. The share of senior staff reaches a maximum of 66% when enrolments decline and of 50% when enrolments increase. To maintain a more or less balanced age structure with a strict staff replacement policy, enrolments must increase. For instance, if enrolments increase by 1 000 a year, the cycle is barely perceptible. The share of the junior staff (those under 40) declines gradually from the initial 44% to 32% after 50 years and the share of senior staff increases from 24% to 39%. Enrolment increases from 45 000 to 95 000 and the staff from 3 000 to 6 333.

An illustration: Japan

The theoretical model is illustrated using data on Japanese universities.² In Japan, university enrolments increased from 1.7 million in 1972 to 3.8 million in 2005. The increase was rapid in the 1970s and levelled off after 1995. The number of staff in higher education increased from 118 000 in 1972 to 171 000 in 1981 and 318 000 in 2005. The staff-student ratio was 14 in 1972, 12 in 2005 and varied between 12 and 15 in the intervening years. Table 3.1 shows the enrolment and staff data for a number of years. Between 6% and 9% of the staff are 65 or older.

Table 3.1. Student enrolments and staff at universities in Japan

	Enrolments	Staff				
		Total	< 40	40-49	50-64	65+
1972	1 684 296	117 799	46 648	32 636	28 706	9 809
1981	2 561 463	171 245	65 333	47 235	45 402	13 275
1987	2 636 489	195 490	65 624	53 346	64 024	12 496
1990	3 243 962	211 261	61 950	65 661	69 653	13 997
1996	3 731 804	259 735	71 253	78 955	87 419	22 108
2002	3 727 519	307 097	73 221	87 563	119 090	27 223
2005	3 764 386	317 641	74 065	93 768	121 930	27 878

The observed age structure of the personnel at universities in Japan may be compared with the age structure that would result under a recruitment policy that limits recruitment to young people. The number of recruitments is determined by the retirement of staff and changes in student enrolments. To obtain annual data on enrolments, a trend model was estimated to describe the enrolment data. Several models were tried and the quadratic model performed best. The model is:

$$\text{Enrolments (t)} = 1\,656\,769 + 103\,964\,t - 1\,145\,t^2 \quad (R^2 = 0.95) \text{ where } t \text{ is the year since 1972.}$$

The model is applied to obtain annual estimates of enrolments. The staff is determined using a constant student/staff ratio of 15. The fixed ratio implies that staff recruitment is fully determined by changes in student enrolments and retirement of personnel. The age at retirement is not known but it is known that about 7% of the staff are 65 or older. For the illustration, it is assumed that retirement occurs at 65.

The baseline age structure (in 1972) was determined from data on personnel by five-year age groups. A uniform distribution of ages within the five-year age groups is assumed. In 1972, 43% of the staff members below 65 years of age were less than 40 years of age; 30% were aged 40-49 and 27% were aged 50-64. About 2% were younger than 25, 10% were older than 25 but less than 30, and 16% were aged 30-34. Recruitment is limited to young people. In the theoretical model, recruits are 29 years old. The recruitment pattern of Japanese universities is assumed to be as follows: 15% of the recruits are below 25, 60% are aged 25-29 and 25% are aged 30-34. Figure 3.7 shows the changing age composition of personnel at Japanese universities predicted by a model incorporating a policy that restricts recruitment to young people. The observed age pattern is shown in Figure 3.8. The predicted age structure of personnel is relatively close to the observed age structure. It implies that, in Japan, staff follows enrolments and the recruitment policy of Japanese universities is not much different from the policy assumed in the theoretical model.

Figure 3.7. **Predicted number of staff members at universities in Japan, by age group**

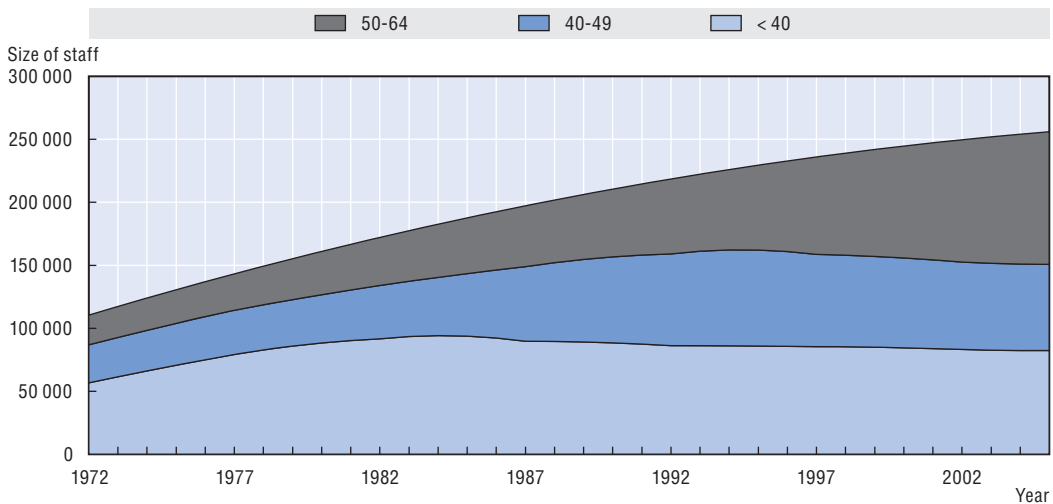
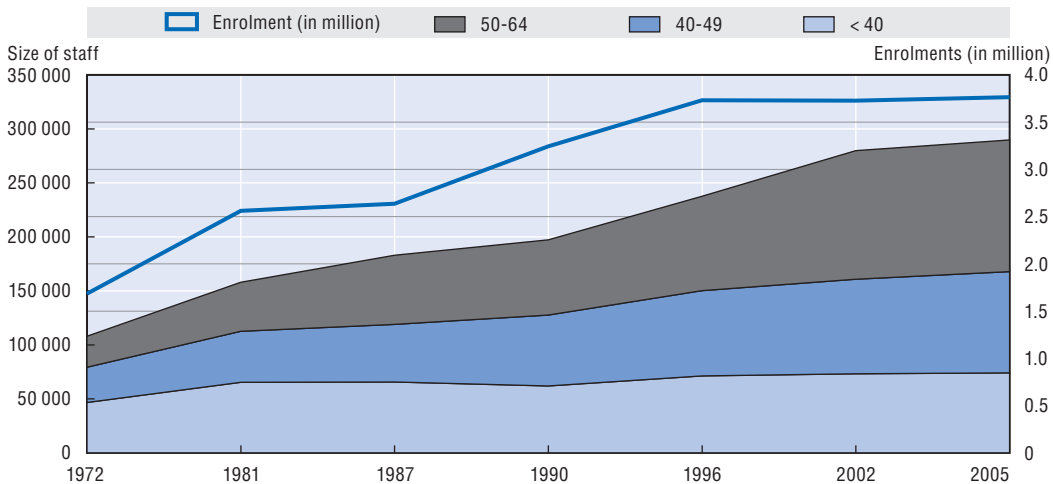


Figure 3.8. **Observed number of staff members and enrolments at universities in Japan, by age group**



Conclusion

Ageing of teachers and researchers in higher education is a fact of life. To avoid the detrimental effects commonly associated with ageing personnel, the focus must shift from the age structure of personnel to the human capital of personnel. Teachers and researchers change over the course of their career and as they age, and institutions need to prepare for an ageing personnel. If, as is generally accepted, productivity declines with age, the decline is not only due to growing older, it is also an effect of the changing portfolio of tasks and responsibilities that constitute a job. What is needed is a life-course paradigm in personnel planning, with programmes designed to maintain knowledge and skills. It is also necessary to identify the jobs that fit persons of a given age and competence. If an optimal match is not feasible, competences and/or jobs must change because ageing is inevitable. If institutions of higher education are unable to introduce the necessary adjustments in human capital and jobs, flexible retirement schemes may help alleviate the negative consequences of an ageing staff.

3.4. Trends in human capital and higher education in the OECD area and in China and India

To many people, higher education is often viewed as an investment in human capital, not an end in itself but a way to secure an adequate income while contributing to society at large. This section looks at the impact of demography on higher education in terms of the human capital generated by institutions of higher education and compares human capital formation in the OECD area, India and China over the coming decades.

The contributions of institutions of higher education to the economy are determined not by how much human capital they produce (capital stock) but also by the number of years in which that human capital is used in productive activities (capital flow). That is, people who graduate from higher education quite late and retire early contribute less than those who graduate early and retire late. This analysis differs from the usual studies of human capital by studying human capital from a *cohort perspective* and considering how much human capital members of a birth cohort contribute to the economy during their entire working life. This contribution is defined in terms of the human capital generated by institutions of higher education. Therefore, the human capital contributed to the economy by a given birth cohort depends on the proportion entering higher education, the age of entry, the proportion graduating and the age of graduation, and the number of years of working life. The human capital a person contributes may vary over time as a result of depreciation and/or continued education (lifelong learning). In this study, such changes are disregarded.

The idea that investment in education has a long-term economic and social payoff for the individual and society at large goes back to Adam Smith. Today, human capital – the skills, capabilities, experience, knowledge and health that people bring to their jobs and that enhance their productivity and permit them to earn a good income – is viewed as a key determinant of international competitiveness. The concept is thus quite broad. There is no single definition of human capital and no unique way to measure it. Measurement of human capital is based on three general approaches. The first is cost-based and estimates human capital by the cost of producing it. The second is income-based and estimates human capital by the expected future income stream from using the human capital. The first approach measures capital retrospectively and the second prospectively. The third

approach is education-based and measures human capital in terms of education output indicators such as literacy rates, enrolment rates, drop-out rates, repetition rates, average years of schooling in the population and test scores. The rationale for this method is that education is a key aspect of human capital formation and that measures of levels of education can be (and are generally) used as proxies for human capital. For a recent overview of conceptual and measurement issues, see Le, Gibson and Oxley (2005) and Wössmann (2005).

This study measures human capital generated by higher education by the number of years graduates of institutions of higher education participate in the labour force. The human capital contributed by graduates of higher education is measured in person-years. If one person contributes an average of 30 years, 100 graduates contribute 3 000 person-years of human capital generated by institutions of higher education. Since each year in the labour force may be associated with an income or wage level, this duration-based approach is related to the income-based approach. Like the latter, it is a prospective measure of human capital.

Assumptions and specifications of the model

A detailed investigation of the impact of demography on the creation of tertiary-level human capital is beyond the scope of this paper. Therefore the following assumptions are made. First, all graduates are gainfully employed and receive an income. In this simple model, unemployment does not exist, although it may easily be introduced. Second, graduates of institutions of higher education remain in the labour force until they retire at the age of 65. Early withdrawal from the labour force, owing to disability or early retirement, for example, is not considered. Taking unemployment, early withdrawal and early retirement into account would provide a way to measure the “waste” of human capital produced by institutions of higher education if the measurement of human capital is restricted to gainful employment.

The impact of demography on higher (or tertiary) education and the human capital it generates is studied here by comparing the OECD area to China and India. To determine the effect of education on the human capital of a birth cohort, four stages of life are distinguished; the period before tertiary education, the period during which young adults engage in tertiary education, the period following drop-out from tertiary education; and the period in the labour market after graduation from tertiary education. These stages are referred to as states, and the four states define the state-space or multistate approach³ that is used here to determine the effects of higher education on human capital. The events (or transitions from one state to another) considered are entry into tertiary education, drop-out and graduation.

The contribution of higher education to human capital formation depends on: i) the size of the population; ii) the recruitment base, i.e. the population that meets the requirements for entering higher education (e.g. completed secondary education); iii) the rate of entry into higher education; iv) the drop-out rate; and v) the graduation rate.

The recruitment base is assumed to consist of all the members of a birth cohort. Hence, the rate of entry into tertiary education is the ratio of the number of persons entering higher education at a given age to the number of persons that have not (or not yet). In technical terms, this is the *population at risk*. A person who has entered higher education leaves either by graduating or by dropping out. These are competing events.

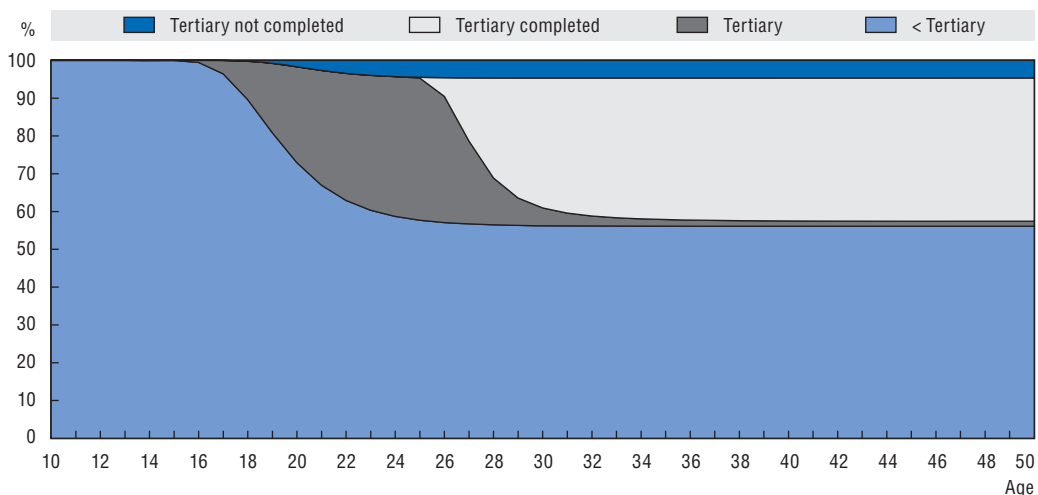
Moreover, mortality is neglected and it is assumed that all members of the birth cohort survive to the highest age considered in the simulation.

The level of entry into higher education and the rate at which young adults leave higher education are indicated by the transition rates. In this study, transition rates differ by age and the age-specific rates differ by region (OECD and China-India). Transition rates are generally estimated from empirical observations on the number of transitions during a given period and the duration at risk of a transition (see Annex 3.A1), but these data are not available for this study. As an alternative, a parameterised approach is followed. Its specification is given in the annex. Parameterisation involves specification of a parametric model of transition rates that adequately captures empirical regularities. Transition rates are plausible if the changes they generate are comparable to observed changes. To compare the model output and the empirical evidence, a few indicators are used. According to OECD data, almost every second person (47%) will enter general higher education programmes during his/her lifetime; the percentage of the population aged 25 to 34 that has attained tertiary education is 28% (OECD average for 2001); and on average, a 17-year-old in OECD countries can expect to receive 2.5 years of tertiary education (OECD, 2004). For China, a 10% rate of entry into tertiary education was assumed. The drop-out rate is assumed to be lower than in the OECD, about 0.5%. India was then assumed to have similar characteristics as China.

Projections under current conditions

The parameters used in the model approximate the real ones. The states occupied by cohort members at different ages are shown in Figure 3.9. In the OECD area, according to the model, 43.3% of the birth cohort enters tertiary education, i.e. fewer than the actual 47%, and 5% of those who enter leave higher education before completion. On average, cohort members spend 2.1 years in tertiary education, close to the observed 2.5 years. Figure 3.9 shows the time spent in the different states up to age 40. Persons graduating from tertiary education spend the period between graduation and age 40 in the labour market. This represents 15.84 years, which implies graduation at age 24. Between age 40 and 65, tertiary education graduates contribute 25 years if they do not die or retire early. Of the members of the birth cohort, 56.5% never enter tertiary education, 2.2% enter and drop out, and 41.1% enter and graduate. This means that, on average, a member of the

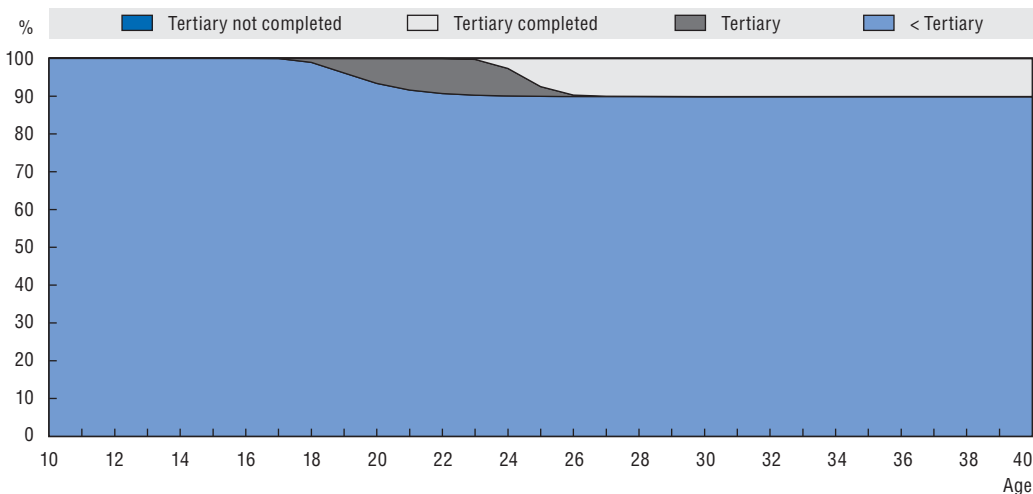
Figure 3.9. States occupied by birth cohort at successive ages, OECD



entire birth cohort contributes 6.4 years to the labour market as a highly educated person before reaching the age of 40 and 10.3 years between age 40 and retirement at age of 65. On average a member of the full cohort spends 0.4 years as a highly educated person between dropping out of tertiary education and the 40th birthday.

In China, as shown in Figure 3.10, the picture is very different. Of the cohort members, only 10.1% enter higher education. The human capital produced by higher education is therefore low if measured in terms of the number of years a member of a birth cohort contributes to the labour market as a highly educated person. In China and India, because an average cohort member is much less likely than in OECD countries to enter tertiary education, the contribution to the labour market after graduation from tertiary education is limited. (It is assumed that the transition rates that apply to China also apply to India.) On average, a member of the birth cohort spends 0.5 years in tertiary education and contributes 1.6 years of skills and knowledge obtained in higher education to the labour market before reaching the age of 40 (Figure 3.10). The average contribution between age 40 and 65 is 2.5 years.⁴ The low value is the consequence of the low probability of enrolment into higher education.

Figure 3.10. **States occupied by birth cohort at successive ages, China-India**



However, the picture changes dramatically when the contribution of an average cohort member is multiplied by the size of the birth cohort. In the period 2000-04, 17.6 million children were born in China annually compared to 4.4 million in North America and 7.4 million in Europe. In India, the annual number of births was 25.8 million. If the transition rates are the same in Europe and North America, the members of a birth cohort in North America who complete tertiary education contribute 73.8 million person-years of human capital before reaching the retirement age of 65.⁵ In Europe the contribution is 123.4 million person-years.⁶ In China, the birth cohort contributes 72.5 million person-years of skills and knowledge obtained in higher education to the labour market.⁷ In India, the contribution is 106.2 million person-years. It is interesting to note that in China a birth cohort contributes about the same human capital to the labour market as in North America. The low entry into higher education is offset by the large size of the birth cohort. This analysis clearly demonstrates that size matters.

Projections under different conditions

If enrolment in tertiary education in China reached 40%, i.e. the level in OECD countries, the birth cohort would contribute 294.7 million person-years.⁸ In India, it would contribute 432 million person-years of knowledge and skills acquired in tertiary education. With enrolment in higher education at 40% in each of the four regions, China would contribute four times more high-level human capital to the economy than North America and 2.4 times more than Europe, and India would contribute close to six times more than North America and 3.5 times more than Europe. These figures demonstrate that in semi-developed countries like China and India, fertility is a very important variable in human capital. Table 3.2 summarises the results.

Table 3.2. **Future contribution of tertiary educated human capital by the cohort born in 2000-04**

	Scenario 1	Scenario 2
	(current conditions)	(current OECD conditions in China and India)
	Million person-years	Million person-years
Europe	123.4	123.4
North America	73.8	73.8
China	72.5	294.7
India	106.2	432.0

The institutions of higher education in China today contribute about the same amount of human capital with tertiary education to its economy as the institutions of higher education in North America. Institutions of higher education in India contribute only 16% less than comparable institutions in Europe.

A slight increase from 10.1% to 11.5% in the rate of entry into higher education in China and India would result in an amount of human capital equivalent to that currently observed in North America and Europe, where more than 40% of a cohort enters higher education. Higher rates of entry would produce tertiary-educated human capital exceeding that in North America and Europe if their rate of entry remains at its current level. With a rate of entry into higher education of slightly over 20%, i.e. half the current rate in major OECD areas, China and India would produce twice the tertiary-educated human capital. This could allow China and India to become poles of innovation if they continue to emphasise engineering and science.

These scenarios are for birth cohorts of sizes observed in 2000-04. A decline in fertility results in smaller birth cohorts and hence a reduction in person-years of tertiary-educated human capital unless smaller cohorts are offset by higher rates of entry into higher education. In China and India, because of the low enrolment rates, fertility decline does not have much effect, however. For instance, a decline of 1% in the number of births is offset by increasing the rate of entry into higher education from 10.1% to 10.2%. A 1% decline in cohort size in China and India combined reduces the number of births by 433 000 and the tertiary educated human capital by 1.8 million person-years, if the rate of entry into tertiary education remains constant. To maintain human capital in China and India at the previous level, at least three policy options are available: i) family policies that increase fertility; ii) educational policies that increase the rate of entry into higher education; and iii) migration policies that attract knowledge workers to China and India. The effect on

human capital of a 1% decline in numbers of births (by 433 000) is offset by immigration of 43 800 graduates of higher education if they are the same age as native graduates of higher education (24 years).

Similarly, OECD countries can choose between family policies that increase fertility, policies that promote entry into higher education, policies that reduce drop-out and immigration policies that are attractive to knowledge workers. Preventing a student from dropping out has the same effect on tertiary-educated human capital as attracting a tertiary-educated immigrant. One less birth reduces the tertiary-educated human capital by 16.8 person-years.⁹ A 1% fertility decline reduces the human capital by 2.0 million person-years. The decline can be offset by immigration of 48 000 persons with tertiary education, provided each immigrant contributes 40.84 years of human capital.

3.5. Conclusion

Demography affects the future of higher education in important ways. In many OECD countries low to very low levels of fertility result in a continued decline in the number of young adults. Institutions of higher education are responding by increasing participation rates and by organising mid-career programmes and higher education for seniors. Demographic change and the increased emphasis on lifelong learning, in view not only of employability but also as part of personal (human) development, represent opportunities for institutions of higher education. Enrolments of young adults in higher education will reach maximum levels and further increases in enrolments will necessitate targeting other age groups, in particular mid-career and senior people.

To demonstrate the effect of enrolment levels on the staff size and the age composition of staff in institutions of higher education, a simulation study was carried out. The study shows important cycles in the age structure of the personnel as a result of recruitment and retirement policies. The extent of the variation in age structure depends on changes in enrolments. The cycles are less marked when enrolments increase rapidly. The simulation illustrates the problems associated with maintaining an optimal age composition of the workforce in institutions that are characterised by the tenure system as it exists today. The simulation model is able to replicate current trends in the age structure of personnel at institutions of higher education, as demonstrated by Japan where ageing of higher education personnel was very low in periods of rapid expansion of enrolments and high in periods when the growth in enrolments levelled off.

Ageing of teachers and researchers in higher education is here to stay. Institutions can respond by adopting a life-course paradigm in personnel planning with much greater attention to matching competences and job requirements. Jobs need to fit the age and competence of individuals. If matching is not successful and training programmes or greater flexibility in job requirements cannot remedy the situation, flexible retirement schemes may help alleviate the negative consequences of an ageing staff. The life-course paradigm provides a holistic framework that integrates many current labour market policies and points to new policies that affect time use, activity patterns, personal development and human capital development throughout the life cycle.

The contribution of higher education to the economy may be measured by the human capital contributed to the labour market by graduates of institutions of higher education. Education is a most important element of labour quality. Ho and Jorgenson (1999) found that in North America almost all of the trend in labour quality improvement during the

period 1948-95 can be attributed to the rise in average levels of educational attainment. They expect this trend to continue well into the 21st century. This study measures human capital not only in terms of educational attainment but also in terms of the time spent in employment before retirement. It measures the person-years of skills and knowledge obtained in higher education contributed to the economy. In the OECD area, an average person is estimated to contribute 16.9 years of tertiary education-based human capital to the labour market before retirement at the age of 65. In China, the average is 4.1 years. The difference is largely attributable to differences in participation in higher education (above 40% in the OECD area and 10% in China). A graduate of an institution of higher education contributes about the same number of years of tertiary education-based human capital (about 40 years), irrespective of the country of residence (and in the absence of early retirement). The picture becomes very different when the contribution is not expressed per capita but for the entire birth cohort. In the current decade, 17.6 million children are born in China each year, 25.8 million in India, 4.4 million in North America and 7.4 million in Europe. China's large birth cohort combined with the low entry rate into higher education results in about the same person-years of tertiary education-based human capital as in North America where higher education is more widespread (72.5 million person-years in China and 73.8 million person-years in North America). If India had China's entry rate into higher education today (10%) and the retirement age was 65 as in most other countries, a birth cohort would contribute 106.2 million person-years of tertiary education-based human capital to the Indian economy. If in China and India, enrolments in higher education reached the levels in OECD countries today and fertility changed little, a birth cohort in China would contribute 295 million person-years of tertiary education-based human capital to its economy and a birth cohort in India would contribute 432 million person-years, or three and five times more, respectively, than a birth cohort in North America.

Demographics is expected to be a strong driver of change in higher education in the OECD area. Institutions of higher education already respond to fertility decline by increasing enrolment rates for non-traditional categories of students and by diversifying the supply of educational programmes. Declining enrolments result not only in excess personnel but also in wider swings in the age structure of the personnel.

While institutions of high education diversify to maintain current activity levels, they also continue to need to generate the human capital and produce the knowledge and skills necessary for continued technological and economic advancement. There appears to be, however, a degree of public disenchantment with the role played by the university, owing, perhaps in part, to the need for immigrant knowledge workers. One means to respond to such concern might be the development, for each field of study, of a *human capital index* to measure the impact on the economy and society at large of the knowledge and skills generated by that field of study. A human capital index could measure the relative scarcity of specific human capital in society. Institutions with different fields of study could be characterised by a composite human capital index. Government funding of institutions of higher education could use the (composite) human capital index in addition to the more traditional funding criteria. The human capital index could help ensure that institutions of higher education continue to contribute to meeting the needs of their society.

Notes

1. The actual average ratio in an OECD country was 15.4 in 2002 (OECD, 2004).
2. The data are official Japanese data provided by the OECD secretariat: the data for 1972 and 2005 have been adjusted by the Secretariat.
3. For a brief overview of multistate models and key references, see Willekens (2003).
4. $0.101 \times 25 = 2.525$.
5. $4.423 \times 6.4 + 4.423 \times 0.411 \times 25 = 73.8$.
6. $7.354 \times 6.4 + 7.354 \times 0.411 \times 25 = 123.4$.
7. $17.566 \times 1.6 + 17.566 \times 0.101 \times 25 = 72.5$.
8. $17.566 \times 6.4 + 17.566 \times 0.411 \times 25 = 294.7$.
9. $0.411 \times (15.85 + 25)$.

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ANNEX 3.A1

Methodology

This annex explains the concept of a transition rate and specifies the assumptions that have been made in the multistate simulation model of Section 3.4.

A transition rate is the rate at which individuals transfer between functional states or stages of life. For instance, entry into higher education is a transition and the propensity of a young adult to enter higher education (entry rate) is the transition rate. The rate of leaving higher education because of drop-out or graduation is a transition rate as well. The formal definition of a transition rate is the ratio between the number of transitions during a given period and the duration of exposure to the risk of a transition. The latter is equivalent to the time spent in a state (state of origin) during the period considered.

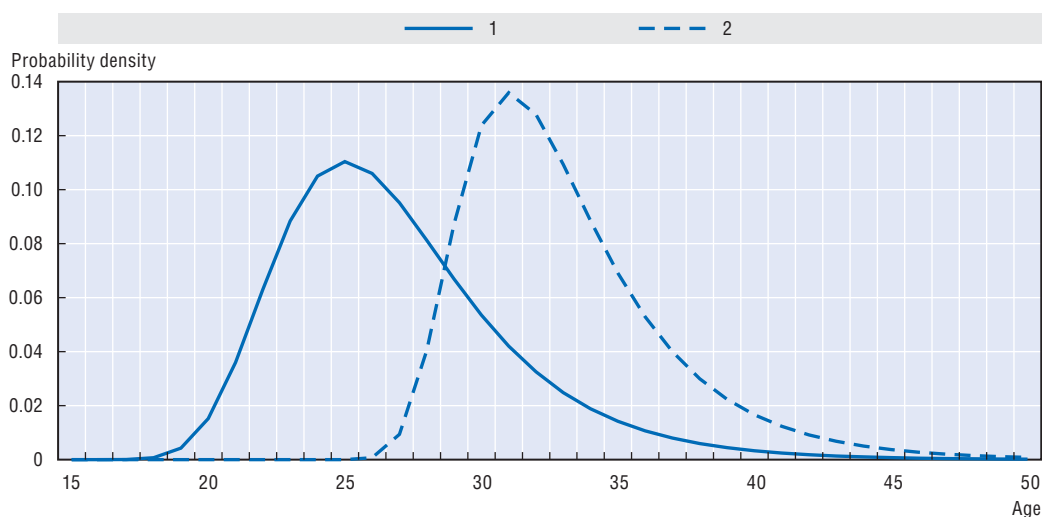
The transition rates are described by a double exponential distribution. The double exponential distribution is a skewed distribution that has been used by several authors to describe profiles of transition rates. The double exponential model is:

$$f(x) = a \exp\{-\alpha(x - \mu) - \exp[-\lambda(x - \mu)]\}$$

where α , λ and μ are parameters and a is a scaling factor to assure that $f(x)$ is a density function (area under the curve is unity). The parameter μ positions the unimodal curve on the age axis, whereas λ and α reflect the steepness of its ascending and descending sides, respectively. If $\alpha > \lambda$, the mode of the function is smaller than μ . If $\alpha < \lambda$, the mode is larger than μ . If $\alpha = \lambda$, the function is the Fisher-Tippett distribution which is an extreme value distribution with a steep ascending slope and a slower descending slope (see e.g. <http://mathworld.wolfram.com/ExtremeValueDistribution.html>). Examples of the double exponential distribution are shown in Figure 3.A1.1. Table 3.A1.1 gives the parameters. Model 1 is the Fisher-Tippett distribution. The first distribution is positioned around age 25 and the second around age 30. Both have the same downward slope (α). The upward slope is higher in the second distribution (λ). The area under the curve is different.

Table 3.A1.1. **Parameters of the double exponential distribution**

Parameter	Model 1	Model 2
a	0.3001	0.3366
μ	25	30
α	0.3	0.3
λ	0.3	0.5
CF	1.0	1.0

Figure 3.A1.1. **Double exponential distribution**

To determine the parameters of the double exponential distributions describing the transition rates among the states considered in this paper, an iterative procedure based on trial and error was used. The aim was to obtain transition rates that would result in known characteristics of the tertiary education. To derive parameter values, information presented by Vincent-Lancrin (2004) was used. In the OECD area almost every second person (47%) will enter general higher education programmes during his/her lifetime (Vincent-Lancrin, 2004, p. 247). In addition, 28% of the population aged 25 to 34 has attained tertiary education (OECD average for 2001). A further relevant piece of information is that on average in OECD countries, a 17-year-old can expect to receive 2.5 years of tertiary education.

For China, a much lower rate of entry into tertiary education was assumed; namely 10%. The drop-out rate is assumed to be lower than in the OECD, about 0.5%. Table 3.A1.2 shows the parameters of the double exponential model for the OECD area and Table 3.A1.3 shows the parameters for China.

The transition rates are shown in Figures 3.A1.2 and 3.A1.3.

Table 3.A1.2. **Parameters of the double exponential distribution, OECD**

Parameter	Entry into tertiary education	Graduation	Drop-out
a	1	1	1
μ	18.5	28.0	19.5
α	0.8	1.2	0.8
λ	0.8	0.4	0.5
Area	0.8	2.0	0.1

Table 3.A1.3. **Parameters of the double exponential distribution, China**

Parameter	Entry into tertiary education	Graduation	Drop-out
a	1	1	1
μ	18.5	28.0	19.5
α	0.8	1.2	0.8
λ	0.8	0.4	0.5
Area	0.15	2.0	0.01

Figure 3.A1.2. **Transition rates, OECD area**

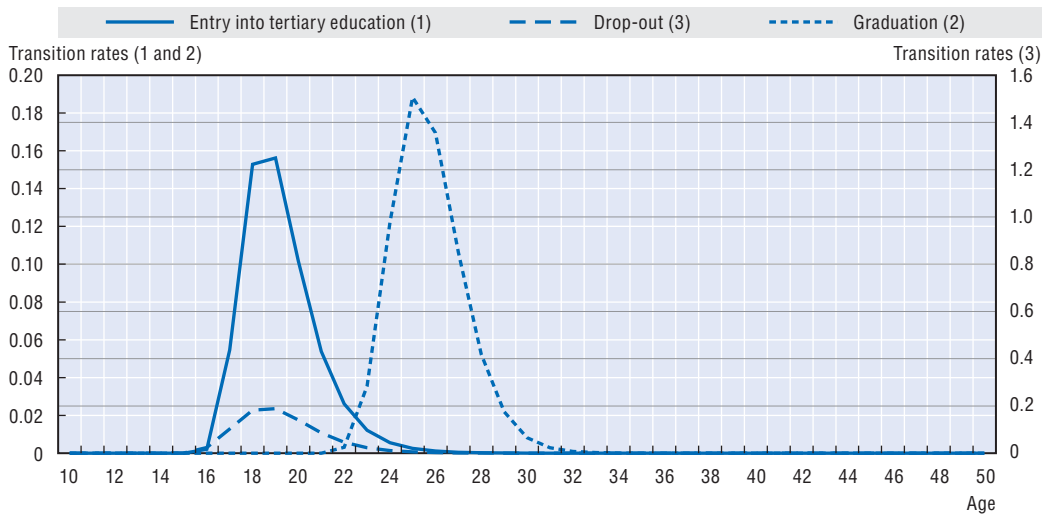


Figure 3.A1.3. **Transition rates, China**

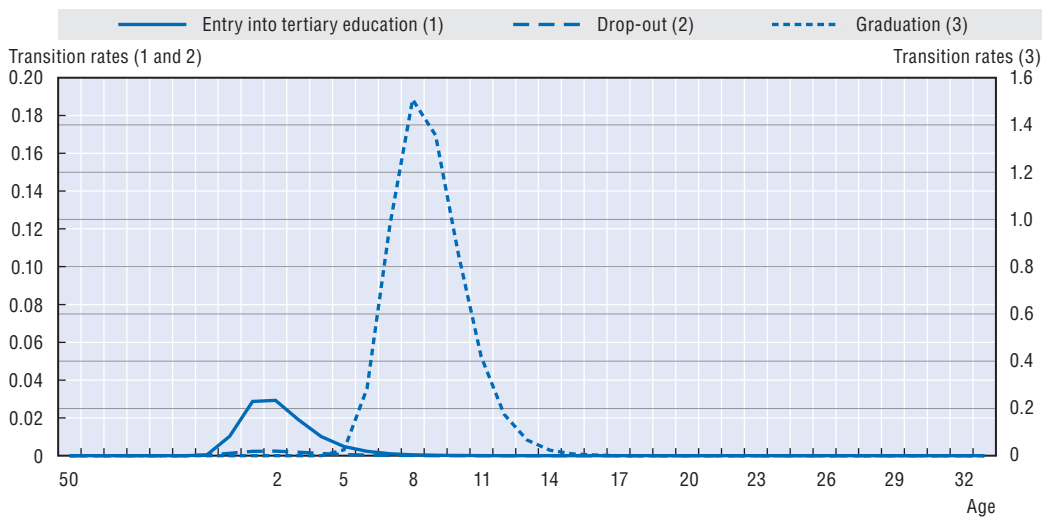


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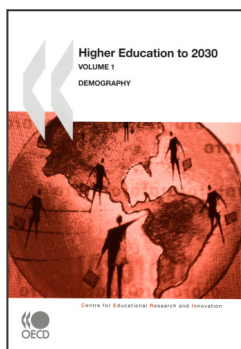
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