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The impact of population ageing on the labour market: evidence from Italy

by

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ABSTRACT

Population is ageing rapidly in Italy. According to Istat 2005-based population projections, the share of the working age population will fall from 66.4% in 2005 to 53.7% in 2050. At the same time, the share of those aged 65+ will increase sharply, reaching 33.6% in 2050, compared to 19.5% in 2005. These changes in the age structure of the Italian population will impact on the personal welfare of individuals belonging to different cohorts in various ways.

This thesis first investigates the role positive and increasing levels of (young) net migration and higher fertility could play to counteract the phenomena of population ageing and labour force ageing and decline in Italy. It is found that the working age population would remain roughly stable in the next four to five decades if 375,000 – 400,000 young net migrants migrated to Italy in each year of the projection period. Higher fertility will not have significant impacts in the short term, but might have stronger effects in the long run.

This dissertation also examines how and the extent to which an ageing population will impact on the age-earnings and age-employment opportunities of working age Italian individuals. The main findings of the empirical model tested in this thesis show that the relative scarcity of younger generations (and especially of younger generations of medium and highly educated workers) has an overall positive effect on their labour market outcomes.

This thesis finally investigates the manner and the extent to which generational crowding will impact on human capital accumulation and retirement choices of Italian younger and older individuals. It is found that younger individuals born into smaller cohorts do not have more incentives to invest in education in Italy. On the contrary, cohort size has a negative (although weak) impact on employment probabilities and a positive (although weak) impact on retirement probabilities of Italian older males.

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Chapter 1 Introduction

1.1 Background and study aims

The current demographic situation in a number of developed countries is one of an ageing population. In its simplest interpretation, population ageing is the process by which there is a redistribution of relative population shares away from the younger to the older age groups. Italy is one of the most rapidly ageing societies. Italy is also the "oldest country in the world", for having the highest proportion of people aged 60 and over and the lowest share of people aged less than 15 (Golini, 2003, p.16).

Understanding how population ageing will affect the (Italian) economy is complicated. This has stimulated a vivid international debate over the past decade (for example, see Weil (1997), Golini (2002 and 2003), Ashdown (2000), Disney (1996), House of Lords (2003), Visco (2001) and Wright (2002a, 2002b and 2004)). It is now widely recognised that population ageing will induce several economic challenges. The ageing of the Italian population will lead to an increase in the number of people of pensionable age and a decrease in the number of individuals of working age. This will be associated with an increase in the demand of services consumed by the elderly, including pensions and health, housing and residential services. However, the people of working age will decrease – both in absolute numbers and population shares – so the base expected to pay for the increase in the demand of services consumed by the elderly will become progressively smaller. The supply of labour in general and the supply of young workers in particular will also decrease in the medium to long term.

It is reasonable to think that a rapidly ageing population will lead to an unsustainable situation in the long-term. It is therefore important to investigate thoroughly the determinants of population ageing in Italy and the potential impacts on the well being of the Italian population.

The main purposes of the dissertation are to examine in detail: i) the main drivers of the phenomenon of population ageing in Italy; ii) the extent to which the Italian population will be restructured to relatively greater proportions of older age groups according to official population projections in the next decades; iii) the role higher levels of (young) net migration and fertility could play to counteract or decelerate the phenomena of population ageing and labour force decline and ageing in Italy; iv) the manner and the extent to which "generational crowding" will impact on personal welfare - expressed in terms of employment opportunities, wages and human capital accumulation - of individuals belonging to different birth cohorts in the next four to five decades.

1.2 Historical, present and future demographic trends

Population ageing is the major outcome of the so-called *demographic transition*, a process denoted by a fall from high to low fertility and mortality. The concept of demographic transition is based on Thomson's (1929) interpretation of observed changes in birth and death rates in industrialised countries in the eighteenth and nineteenth centuries and the first three decades of the twentieth century. A concise definition of demographic transition comes from Demeny (1972), who claims that "in traditional societies, fertility and mortality are high. In modern societies, fertility and mortality are low. In between there is the demographic transition".

As Jackson (2001) points out, the demographic transition process is normally divided into three stages. Prior to the onset of the transition (Stage I), births and deaths are high and roughly in equilibrium and population growth is either low or static. At the end of the transition (Stage III), at least theoretically, low to zero, potentially slightly negative population growth is again reached. During the transition (Stage II), populations grow in size. The transition is triggered first by a decline in infant mortality and then by a decline in fertility. As infant mortality falls ahead of fertility, more new-born babies survive, causing the population age structure to become younger. Before fertility begins to fall significantly, most of these survivors have children themselves, causing further population "juvenescence" and expansion. Once fertility falls significantly, the rate of population growth slows. The population continues to grow in size for at least one generation (momentum effect). However, the population age structure becomes older: the proportion of the population at the younger ages decreases and the proportion at the older ages increases, causing (structural) population ageing. The three stages are clearly simplified in the demographic transition theory but truly reflect what has happened in many countries.

The majority of developing countries are in Stage II or Stage III of the model. However, most developed countries are beyond Stage III. Theoretically, the demographic transition period ends when fertility reaches the replacement level and zero population growth is reached again. However, in the majority of developed countries, including Italy, fertility has either fallen or is continuing to fall well below replacement level. This is viewed by Lesthaeghe and van de Kaa (1986) as representing a second demographic transition (for more details, see van de Kaa, 2002). After reaching a peak of 2.7 births per woman in childbearing age in 1964, fertility has been constantly decreasing in Italy and has been below the replacement level of 2.1 births per woman since 1977. Fertility has increased slightly in recent years, but only to a very small extent. The total fertility rate was 1.41 in 2008, around half of the peak it reached in 1964.

At the same time, mortality has decreased at all ages. For example, in 1899-02 only 59.2% of an (hypothetical) initial birth cohort of males were still alive at age 10, compared to 99.4% in 2003[1]. Only 6.7% of the same hypothetical cohort were still alive at 80 years of age in 1899-02, compared to 50.3% in 2003. Equally, life expectancy at birth has increased significantly. A man born in 1951 could expect to live for 63.7 years, a man born in 2006 could expect to live for 78.4 years. Similarly, a woman born in 1951 could expect to live on average for 67.2 years, compared to 84.0 for a woman born in 2006.

Fertility and mortality have decreased in many other industrialised countries, but both phenomena have been particularly strong in Italy. Italy currently displays one of the lowest fertility levels in Europe, together with Germany, Spain and Greece. Italy

[1] A detailed explanation of hypothetical birth cohorts is provided in Section 2.2.2.

has also turned from a "typical emigration country" to a "typical immigration country", with the early 1970s being the turning point. In the first years of the new millennium, immigration has increased significantly, with the total number of immigrants peaking at around 600,000 in 2003. Historical trends in fertility, mortality and migration in Italy are investigated in detail in Chapter 2. A thorough investigation of historical demographic trends is crucial to understand the current demographic situation of a country and to make sensible assumptions on future demographic trends.

The current demographic situation in Italy can be described as a population with below replacement level fertility, gradually decreasing mortality and sharply increasing levels of net migration[2]. What will happen to the size and age structure of the population if current trends continue? In order to provide at best a partial answer to this question, it is necessary to carry out a series of population projections, based on specific fertility, mortality and migration assumptions. Istat (the Italian Office of National Statistics) is responsible for the production of official national population projections for Italy as a whole and its constituent regions and routinely carries out population projections. Chapter 2 investigates the model, assumptions and results of Istat 2005-based population projections. According to Istat 2005-based projections, the Italian population will age significantly in the next decades. The population share of the working age population (aged 15 to 64) is estimated to fall from 66.4% in 2005 to 60.8% in 2030 and finally to 53.7% in 2050. Conversely, the population share of those aged 65+ is projected to increase sharply, reaching 27% in 2030 and 33.6% in 2050, compared to 19.5% in 2005. Consequently, the old-age dependency ratio (given by the number of people aged 65+ divided by the number of people aged 0 to 14) is projected to increase from 29% in 2005 to 44% in 2030 and to 63% in 2050.

1.3 Alternative demographic futures?

[2] As will be explained in detail in Chapter 2, Italy has been receiving high numbers of immigrants in the last five to ten years, after experiencing high levels of emigration in the previous decades.

Istat population projections are somehow restrictive giving that the range of net migration and fertility assumptions used is limited. Istat assumes that the total fertility rate will increase to 1.60 by 2050 and that 150,000 net migrants will move to Italy in each year of the projection period. But what would happen if fertility and migration were (significantly) higher than what projected by Istat? Would higher levels of migration and fertility be sufficient to decelerate or counteract the phenomena of population ageing and labour force ageing and decline in Italy? This is investigated in Chapter 3.

Alternative migration and fertility scenarios are investigated in Chapter 3, based on positive and increasing levels of net migration and higher fertility rates. Population projections based on different migration and fertility assumptions are carried out using Popgroup, a demographic software developed at the Cathie Marsh Centre for Census and Survey Research, based at the University of Manchester. The projection technique used by both Istat and Popgroup is the cohort component method.

1.4 Impact of population ageing on the Italian labour market

Population ageing implies not only more older people as a fraction of the total population, but also more older workers as a fraction of the working population. In terms of its economic repercussion on the labour market, population ageing is equivalent to both a decline in the potential labour supply and a decline in the labour supply of younger relative to that of older workers. The supply of younger workers depends on their generation size and the national birth rate about twenty years earlier. Small generations hailing from low birth rate periods such as the 1980s are in short supply when they attain the working age. Large generations such as those born in the early 1960s are in excess supply at labour market entry (in relative terms).

According to Istat 2005-based population projections, the Italian labour force will decrease in size and age to a significant extent in the next decades. The age structure of the work force will be altered significantly. The potential supply of younger to older workers – given here as the ratio of the number of workers aged 15-39 to the number of workers aged 40-64 – is projected to decrease from 1.04 in 2005 to 0.83 in

2050. If older (more experienced) and younger (less experienced) workers are not perfect substitutes in production and perform different tasks, this will have implications for age-earnings and age-employment profiles.

There already exists a vast literature on the effects of cohort size on age-earnings and age-employment profiles. Most of the studies of the cohort-crowding literature were published in the late 1970s, 1980s and 1990s and investigate the labour market opportunities of the 1950s baby boomers (individuals belonging to unusually large cohorts) when entering the labour market. One can use a similar approach to investigate the impact of labour force ageing on individuals' age-earnings and employment profiles. The only difference is that, in the context of an ageing labour force, individuals entering the labour market belong to unusually small (rather than unusually large) cohorts. The existing cohort-crowding literature finds some evidence of an adverse effect of cohort size on earnings and employment opportunities of members of large cohorts, across a number of countries. Also, this negative effect seems to be stronger for highly educated workers. It is argued that the higher the level of education attained by individuals, the lower the degree of substitutability amongst workers of different ages with the same education level and the stronger the negative impact of cohort size on employment and earnings opportunities.

Most of the studies of the cohort-crowding literature focus on the impact of cohort size on age-earnings and age-employment profiles of US workers. There are also a few studies that investigate this issue in countries other than the United States, including Japan, Israel, Canada, the United Kingdom and Sweden. However, up to the present, there has been no evidence on Italy. The only exception is one comprehensive study published almost three decades ago by the OECD and focusing on ten countries, including Italy (OECD (1980)). An empirical model aimed to investigate the effect of cohort size on age-earnings and age-employment profiles of Italian male workers aged 20 to 54 is developed in Chapter 4.

The exact extent to which wages and employment opportunities of workers belonging to different cohorts change depends on the degree of substitutability between younger and older workers in the production process and the institutional framework of the labour market. If the Italian labour market were to work without significant frictions and the wage rates were free to move both upwards and downwards, the labour market would simply adjust through the wage mechanism: the relative wages of the scarcer factor of production (younger workers in the context of an ageing population) would rise. However, if the Italian labour market were imperfectly competitive and to some extent rigid, the wage structure would be prevented from adjusting completely to variations in relative factor scarcities. The consequences would arise in terms of employment and one would expect an inverse relationship between an individual's probability of being employed and the size of her cohort. To investigate this issue in Italy, eight waves (1994 – 2001) of the European Community Household Panel (ECHP) - a longitudinal survey of households and individuals living in private households within the European Union - are used.

The European Community Household Panel survey finished in 2001. However, it has been progressively replaced with data collection under the EU-SILC regulations. In Italy, the ECHP has been replaced with the survey "Reddito e Condizioni di Vita" ("Income and Living Conditions"). Up to the present, the survey has been carried out four times (annually from 2004 to 2007). In Chapter 5, individual data from the second wave of "Income and Living Conditions", the results of the empirical analysis carried out in Chapter 4 and the outcome of Italian population projections for the period 2005 – 2050 are used to perform a simple simulation in which average future wages of Italian men aged between 20 and 54 are projected for the next four and a half decades. The first set of wage figures are computed using the results of the baseline population projections, using Istat 2005-based fertility and mortality assumptions and zero net migration assumptions. The second set of wage figures are computed using the results of the alternative population projections carried out in Chapter 3, based on a number of different fertility and migration assumptions.

1.5 Impact of population ageing on human capital accumulation and retirement decisions

Individuals aged less than 20 and more than 54 are excluded in the empirical analysis of Chapter 4 given the non randomness of education and retirement decisions. But are individuals belonging to larger cohorts more or less likely to invest in education? Equally, are individuals belonging to larger cohorts more or less likely to enter retirement compared to members belonging to smaller cohorts?

The literature on these issues is rather scarce. The few existing studies that investigate whether the position in the demographic cycle has an impact on human capital accumulation argue that young individuals born into large cohorts have fewer incentives to invest in education. If the substitutability between younger and older workers decreases with education and the earnings of individuals born into large cohorts are depressed over the life-cycle, then the present value of lifetime earnings of boomers is depressed more for the highly educated workers. Similarly, if jobs carried out by individuals with more education also require more on-the-job training, individuals belonging to unusually large cohorts might try to increase the likelihood of getting a job when entering the labour market by investing less in education. However, one could also argue that individuals belonging to larger cohorts might invest more in education if relative shifts in labour supply (higher shares of younger workers) increase youth unemployment.

To my knowledge, there are no studies that specifically focus on the impact of cohort size on retirement and labour market probabilities of older individuals. Chapter 6 investigates whether and to what extent demographic variables influence educational and labour market attainment of younger males and labour market attainment of older males in Italy.

1.6 Outline of the study

To recap, the remainder of the thesis is structured as follows. Italian historical and current demographic trends are analysed in detail in Chapter 2. Future potential demographic trends are also addressed in Chapter 2, with particular attention to Istat 2005-based population projections. The role positive and increasing levels of net migration and higher fertility could play to counteract or decelerate the phenomenon of population and labour force ageing in Italy is investigated in Chapter 3. The impact of labour force decline and ageing on age-earnings and age-employment profiles of Italian workers aged 20 to 54 belonging to different birth cohorts is addressed in Chapters 4. A simple simulation in which average future wages of Italian men aged between 20 and 54 are projected for the next four and a half decades is carried out in Chapter 5. The impact of population ageing on human capital accumulation and labour market attainment of Italian younger and older males is investigated in Chapter 6. Chapter 7 is a short conclusion and discussion.

Chapter 2 Italian demographic past, present and future

2.1 Introduction

The current demographic situation in a number of industrialised countries, including Italy, is one of an ageing population. Population ageing is, in its simplest interpretation, the increase in the average or median age of a population. It is the process by which there is a redistribution of relative population shares away from the younger to the older age groups. Population ageing is caused by two main factors: a decrease in the rate at which births take place and an increase in the age at which people die. In the last half a century, the total fertility rate in Europe dropped from 2.66 to 1.51 whereas life expectancy increased from 65.6 years to 73.8 (United Nations, 2006).

The current demographic situation in Italy can be described as a population with below replacement level fertility, gradually decreasing mortality and sharply increasing levels of net migration. Italy is one of the most rapidly ageing societies. Italy is also the "oldest country in the world", for having the highest proportion of people aged 60 and over and the lowest share of people aged less than 15 (Golini, 2003, p.16). In order to understand the current demographic situation in Italy, it is necessary to study its demographic past in terms of historical trends in fertility, mortality and net migration. Section 2.1 is a thorough descriptive analysis of Italian demographic trends in the last one and a half centuries, with particular focus on the three components of population change: fertility (Section 2.2.1), mortality (Section 2.2.2) and migration (Section 2.2.3). Three different data sources are used: i) Istat (the Italian Office of National Statistics); ii) the World Bank (WB); and iii) the United Nations (UN).

What will happen to the size and age structures of the population if current trends continue? In order to provide an answer to this question, it is necessary to carry out a series of population projections, based on specific fertility, mortality and net migration assumptions. Istat is responsible for the production of official national population projections for Italy as a whole and its constituent regions and routinely carries out population projections. The primary purpose of the projections is to provide an estimate of future population which is used as a common framework for national planning in a number of different fields. Section 2.3 investigates the model and assumptions (Section 2.3.1) and the results (Section 2.3.2) of Istat 2005-based population projections. Section 2.3.3 investigates the assumptions of Istat 2007-based population projections. Section 2.4 concludes.

2.2 Demographic Past

The change in population size is given by the sum of natural increase and net migration. Natural increase is the difference between number of births (B_t) and deaths (D_t). Net migration is the difference between the number of immigrants (individuals entering a country, I_t) and emigrants (individuals leaving a country, E_t). This is expressed in Equation [2.1], where population change is given by P_{t+1} - P_t:

$$P_{t+1} = P_t + B_t - D_t + I_t - E_t \qquad [2.1]$$

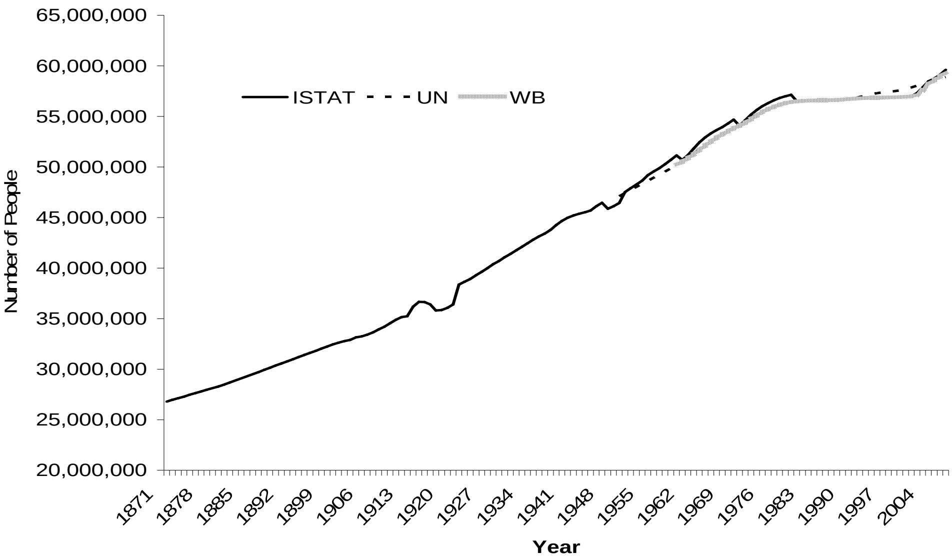
Hence, data on births, deaths and migration are crucial in order to understand and decompose population changes. Three different data sources are used to analyse Italian historical population changes: Istat, the World Bank and the United Nations. Istat provides data since the end of the 19th century / beginning of the 20th century, the World Bank since 1960 and the UN since 1950. Istat, UN and World Bank data on fertility and mortality are very similar, whereas substantial differences arise in terms of their estimates of net migration.

Figure 2.1 below displays Istat, UN and World Bank data on Italian population since 1871, estimated at the end of the calendar year (Istat) or in the middle of the calendar year (United Nations and World Bank). Istat data refer to present population from

1871 to 1948 and to resident population from 1949 onwards[3]. Also, data from 1982 onwards have been re-estimated following the inter-censual reconstruction.

The Figure shows that the Italian population steadily increased between 1871 and 1980, with the First World War period being the main exception. The Italian population remained almost constant in the 1980s and 1990s and slightly increased in the last five years of the period under consideration. Istat estimates that there were 59,619,290 people living in Italy at the end of 2007.

Figure 2.1: Estimated Italian population, 1871-2007



Sources: Istat, World Bank and United Nations

In order to understand this growth pattern, it is essential to examine the trends in fertility, mortality and net migration during the period.

3 In Italy, data on resident and present population is collected at the municipality level. Present population includes the population registered in the municipality and present in the municipality at the survey date but officially registered in another municipality or abroad. Resident population includes only the population registered in the municipality. People temporarily living in another municipality or abroad (for seasonal jobs or any other temporary reason) are included in the official residents.

2.2.1 Fertility

There are two different ways to approach the study of fertility: *period fertility analysis* (based on the total fertility rate (TFR) indicator) and *cohort fertility analysis* (based on the completed fertility rate (CFR) indicator).

The TFR summarises the number of children a woman would be expected to have during her child-bearing age, bearing children at the age-specific rate prevailing in any given year. The TFR is a synthetic rate; it is not based on the fertility of any real group of women nor on counting up the total number of children born over their lifetime. TFR is the sum of the age-specific fertility rates (ASFRs), which are given by the ratios of the number of births at each age to the number of women (in thousands) at each age. When single year-of-age data are used, the age-specific rates are simply summed. When five year age groupings are used the result is multiplied by five, to account for the width of the age band.

The main problem with the TFR is that it can be distorted by shifts in the timing of childbearing, i.e. the average age at which women give birth. This is explained quite clearly by De Beer *et al.* (1991, p. 40):

> If, at a certain point in time, increasing numbers of women decide to stop child-bearing, then the total number of births will decrease due to the loss of third or higher order births. If, at the same time, increasing numbers of women decide to postpone the arrival of a first and/or second child to a later age, then the total number of births drops even further. Summing up these age specific rates gives very low TFR values.
>
> After a number of years the tide might turn. The women who postponed childbearing will have grown older and may decide to [begin childbearing] at age 27, 30, or even later [and] the fertility rates at these ages [will] start rising again. [If] at the same time, the youngest generations prefer to have their first and or second child at young ages again, then fertility rates at these ages will also start rising. [T]heir sum, the TFR, ends up at a high level again.

The completed fertility indicator (CFR) refers to the average number of children actually born to women from a given cohort. Because the CFR requires longitudinal data, it can only be calculated for women who have reached their late forties. Hence, it is a measure of completed fertility.

Usually national statistical agencies publish data on age-specific and total fertility rates. For example, Table 2.1 below shows 2004 single-year age-specific fertility rates of women aged 15 to 49 published by Istat. The table shows that, for example, for every 1,000 women aged 29 in 2004, 89.9 had a live birth in that year.

Table 2.1: Single-year age-specific and total fertility rates, 2004

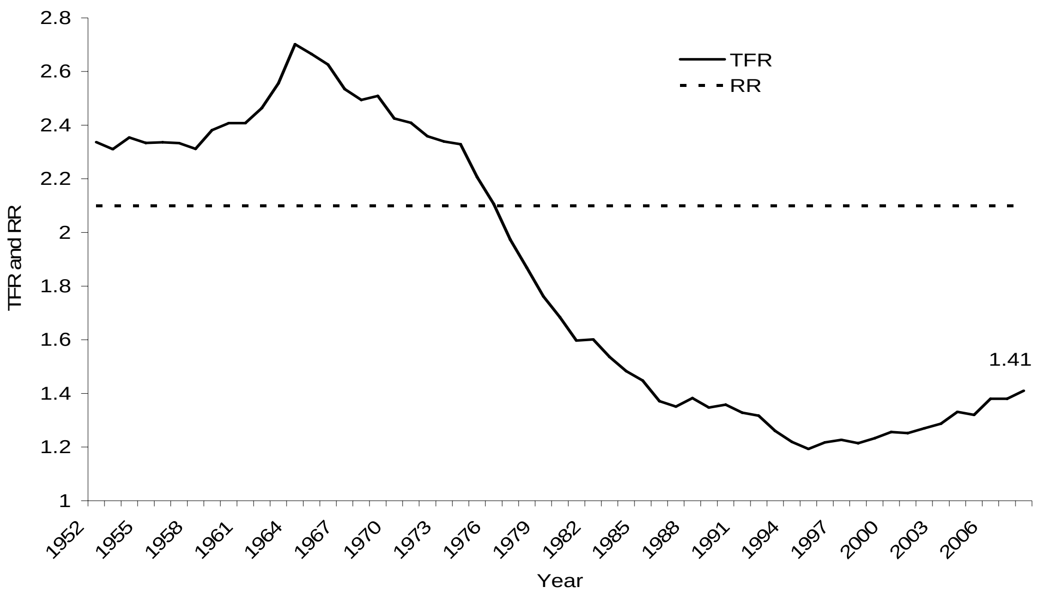
Age of the mother	Age-specific fertility rate (per 1,000 women)
15	0.1653
16	3.0959
17	6.1794
18	9.9512
19	15.8718
20	21.3560
21	26.6903
22	33.3332
23	39.8220
24	47.6592
25	56.8456
26	65.2632
27	74.5636
28	84.0740
29	*89.9140*
30	94.7473
31	97.2362
32	94.3899
33	89.1310
34	81.0164
35	71.7013
36	62.2404
37	49.4626
38	38.2746
39	29.4306
40	20.6305
41	13.3381
42	8.2587
43	4.4720
44	2.2337
45	1.0646
46	0.5183
47	0.2587
48	0.1520
49	0.0820
$TFR_{2004} = \frac{\sum_{x=15}^{49} ASFR_{x,2004}}{1,000}$	1.333

Source: Istat

Figure 2.2 shows the total fertility rate between 1952 and 2007. The Figure also displays the replacement rate (RR), which is approximately 2.1 live births per woman. It corresponds to the number of children a woman would need to have to maintain population size constant (i.e. in the context of zero net migration, to keep the number of births and deaths equal). Figure 2.2 shows that Italy experienced a sharp increase in fertility in the 1950s and 1960s, like many other industrialised countries. This happened in the so called "baby boom" period, when fertility lay above the replacement level. In Italy, the TFR peaked at 2.7 in 1964. However, since then, the trend has been downwards and the TFR has been below the replacement level from 1977 onwards. The TFR slightly increased again after 1998, reaching 1.41 in 2008. However, it is still about around half of the peak it reached in 1964 and a third below the replacement level

.

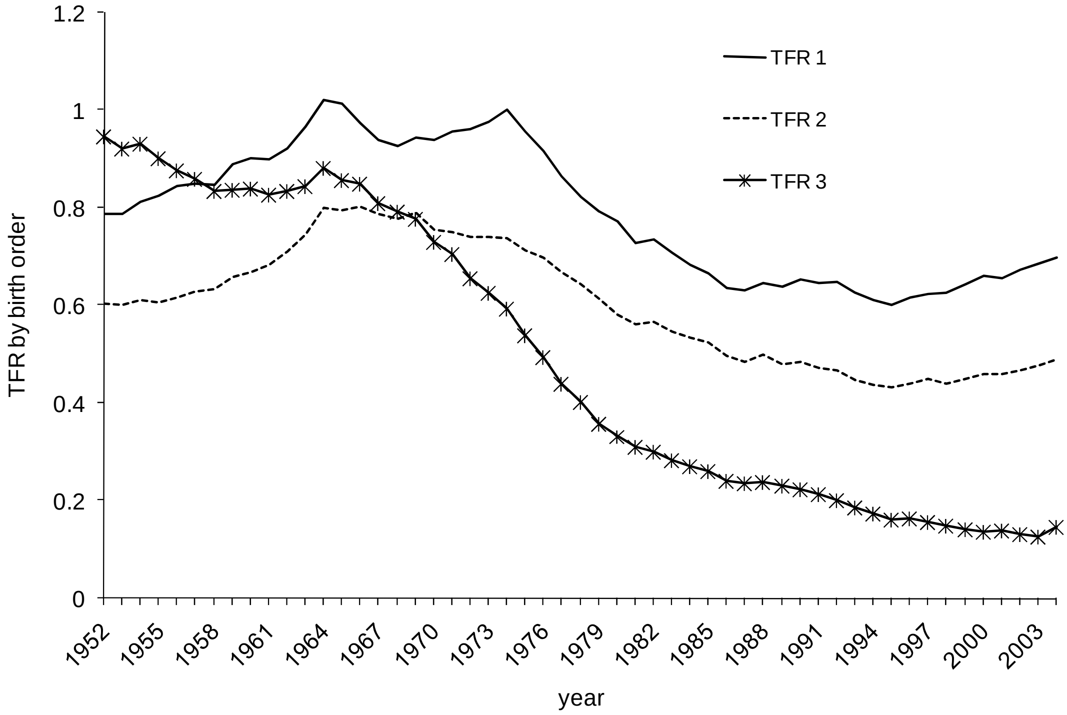
Figure 2.2: Total fertility rate and replacement rate, 1952-2008



Source: Istat

Figure 2.3 shows the decomposition of the TFR by birth order, where birth order refers to the number of children born alive to the mother, including the present child. The first-order birth refers to the eldest child born alive to a woman. Accordingly, TFR1 is the fertility rate of women giving birth to their first child, TFR2 is the fertility rate of women giving birth to their second child and TFR3 is the fertility rate of women giving birth to their third (or higher) child. Clearly, the sum of TFR1, TFR2 and TFR3 gives the TFR. The Figure shows that the decrease in TFR3 has been significantly sharper than the decrease in TFR2 and TFR1, suggesting a decrease in the number of "large families". It is also interesting to note that in the baby-boom peak TFR3 was higher than TFR2.

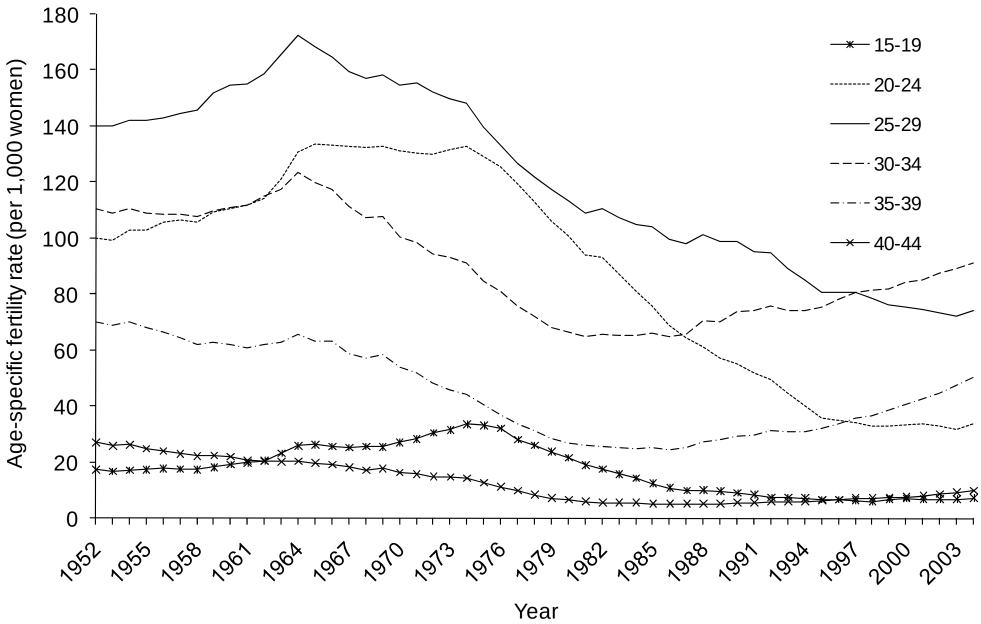
Figure 2.3: Decomposition of total fertility rate by birth order, 1952-2004



Source: Istat

Figure 2.4 displays changes in five-year fertility rates in the period 1952 - 2004. The Figure shows that age-specific fertility rates for women aged 15-19, 20-24 and 25-29 followed a pattern of change that roughly parallels the trend in TFR (shown in Figure 2.2), increasing until the mid 60s and gradually decreasing thereafter. Different conclusions can be drawn for women aged 30-34 and 35-39: their ASFRs followed a different path, increasing in the late 80s, 90s and first four years of the new millennium. Hence, there seems to be a general decreasing pattern of fertility at younger ages coupled with rises in fertility at older ages. The determinants of fertility postponement are vividly debated in the literature and mainly refer to the effects of educational attainment, the conflict between employment and parenthood, the changing character of partnership relations and the influence of contraceptive technology (primarily the pill). For a good discussion, see Sobotkal (2004).

Figure 2.4: Five-year age specific fertility rates, 1952-2004



Source: Istat

A simple manipulation of 1952 – 2004 age-specific fertility rates enables to carry out a *cohort fertility analysis*, tracing the fertility of women belonging to the same cohort through time. This is done through a diagrammatic representation of the Lexis diagram, as shown in Tables 2.2 and 2.3 below.

Seven five-year age groups and ten five-year time periods are taken into account: age groups range from 15-19 to 45-49 (childbearing age) and time periods range from 1955-59 to 2000-04. The year of birth of each of the sixteen cohorts needs to be read "diagonally". Data referring to the oldest and youngest cohorts are highlighted in Table 2.2. The oldest cohort is c1, this includes women aged 45-49 in 1955-59 and born in 1910-14; the youngest cohort is c16, this includes women aged 15-19 in the time period 2000-04 and born in 1985-1989.

Table 2.2: Diagrammatic representation of the relationship between age, period and cohort groups (Lexis Diagram)

Period / **Age**	**1955-59**	**1960-64**	**1965-69**	**1970-74**	**1975-79**	**1980-84**	**1985-89**	**1990-94**	**1995-99**	**2000-04**	**Cohort born in:**
15-19	c7	c8	c9	c10	c11	c12	c13	c14	c15	c16	
20-24	c6	c7	c8	c9	c10	c11	c12	c13	c14	c15	1985-89
25-29	c5	c6	c7	c8	c9	c10	c11	c12	c13	c14	1980-84
30-34	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	1975-79
35-39	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	1970-74
40-44	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	1965-69
45-49	*c1*	c2	c3	c4	c5	c6	c7	c8	c9	c10	1960-64
Cohort born in:		*1910-14*	1915-19	1920-24	1924-29	1930-34	1935-39	1940-44	1945-49	1950-54	1955-59

Table 2.3 summarises Istat five-year specific fertility rates (per 1,000 women) referring to the sixteen cohorts identified in Table 2.2. For example, the table shows that out of 1,000 women born in 1940-44 (belonging to cohort 7), 17.7 had a live birth between 1955 and 1959, when aged 15-19; 117.8 had a live birth between 1960 and 1964, when aged 20 to 24; 161.8 had a live birth between 1965 and 1969, when aged 25-29 etc.

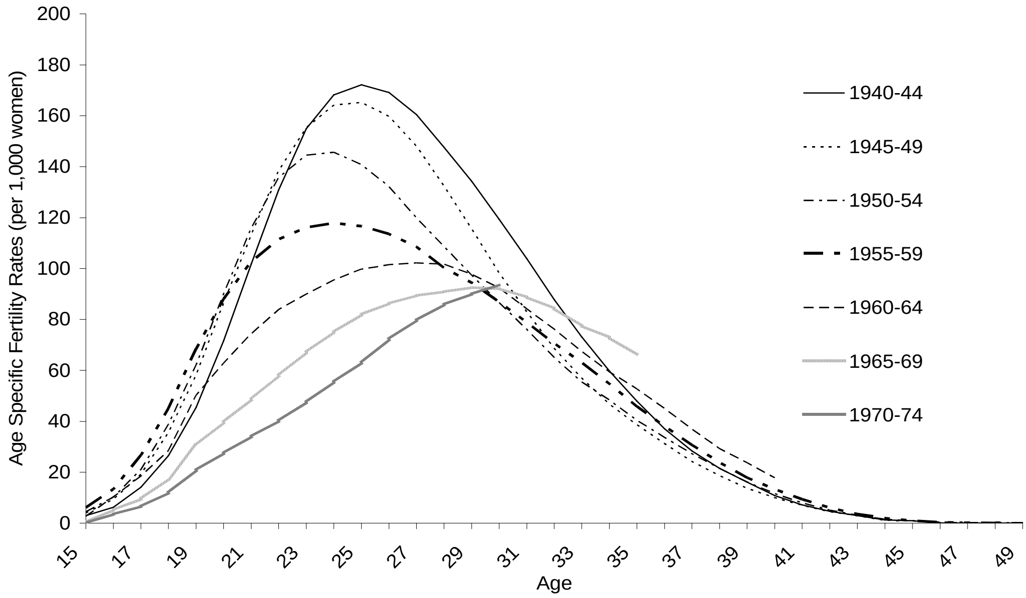
Table 2.3: Diagrammatic representation of the Lexis Diagram for five-year age specific fertility rates (per 1,000 women)

Period / **Age**	**1955-59**	**1960-64**	**1965-69**	**1970-74**	**1975-79**	**1980-84**	**1985-89**	**1990-94**	**1995-99**	**2000-04**	**Cohort born in:**
15-19	17.7	21.8	25.8	30.3	28.7	17.7	10.5	7.8	6.6	6.8	
20-24	106.1	117.8	133.0	131.3	118.8	91.4	65.6	48.9	34.9	33.3	1985-89
25-29	145.6	161.4	161.8	152.1	127.8	109.1	100.5	92.8	80.1	74.4	1980-84
30-34	108.7	115.6	112.6	95.5	76.5	65.7	67.6	74.0	78.8	87.2	1975-79
35-39	64.6	62.6	60.1	48.9	34.3	26.0	26.3	30.3	34.7	44.9	1970-74
40-44	23.3	20.7	18.4	15.1	9.9	5.7	5.1	5.7	6.6	8.5	1965-69
45-49	1.8	1.6	1.4	1.1	0.8	0.3	0.2	0.3	0.4	0.4	1960-64
Cohort born in:		1910-14	1915-19	1920-24	1924-29	1930-34	1935-39	1940-44	1945-49	1950-54	1955-59

Source: Author's calculation from Istat fertility data

Figure 2.5 shows ASFRs for seven different cohorts of women. The oldest cohort was born in 1940-44 (c7 in Table 2.2), the youngest in 1970-74 (c13 in Table 2.2). As expected, age specific fertility rates follow an inverted U shape: they are relatively low for women "at the edges" of the childbearing age (i.e. women aged 15-19 and 40-49) and higher for women aged 20-39. The Figure also shows that ASFRs of young women (aged 15-29) belonging to younger cohorts (born after 1960) are significantly lower than ASFRs of young women belonging to older cohorts (born between 1940 and 1959), displaying a persistent decrease in fertility. Also, the peak age of childbearing was around 24-25 years of age for older cohorts whereas it ranges around 30 years of age for the two youngest cohorts, highlighting once again a shift in the age at which women have children.

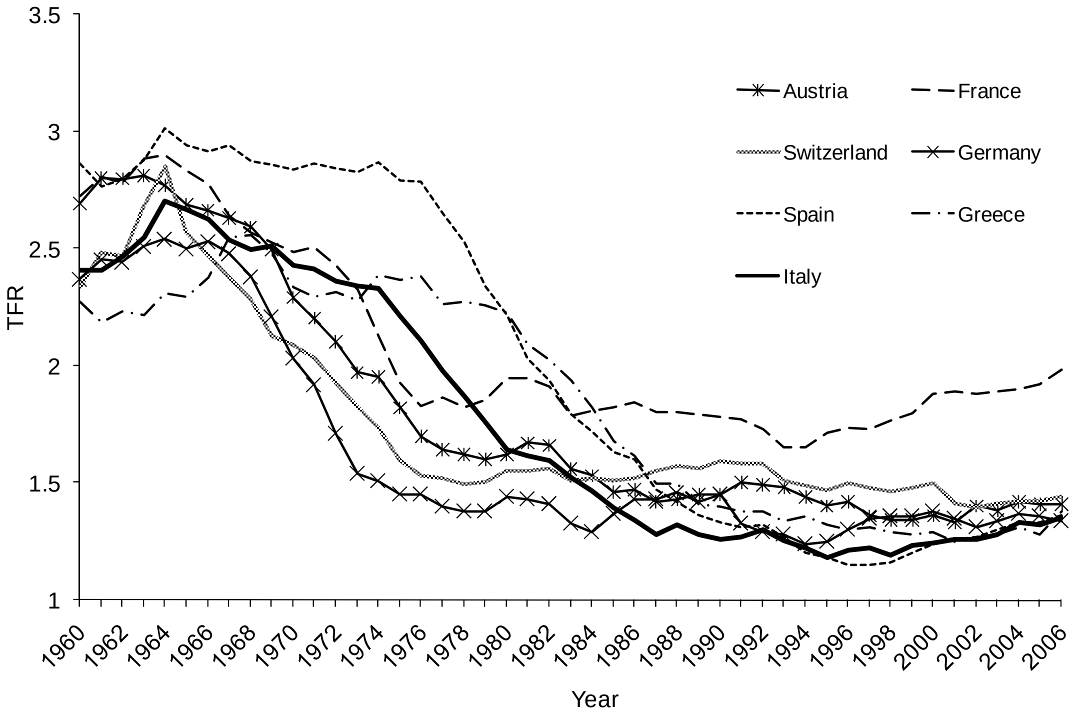
Figure 2.5: Age specific cohort fertility rates: birth cohorts 1940-44 to 1970-74



Source: Author’s calculation from Istat fertility data

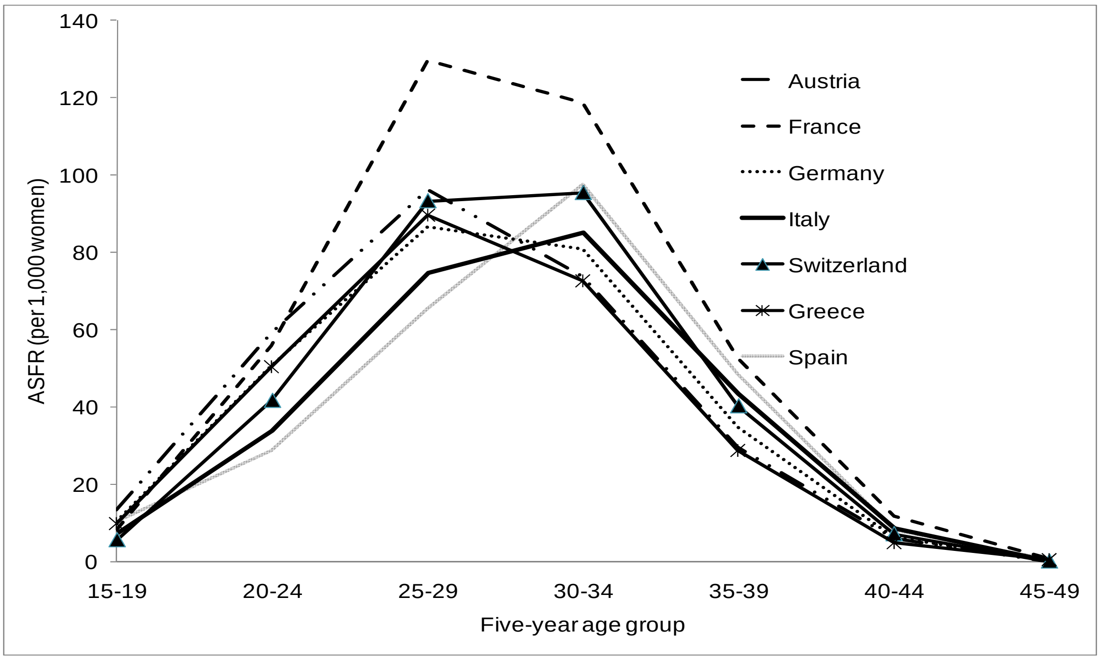
Before turning to mortality, historical Italian fertility rates are compared to those of a number of selected countries which are geographically or culturally / economically similar to Italy (i.e. France, Germany, Austria, Switzerland, Spain and Greece). Figure 2.6 shows that in all of these countries the TFR peaked in the early 1960s. Spain experienced the highest peak (3.01 in 1964); Germany the lowest (2.54 in 1964). Spain also experienced the steepest decline in fertility, and, together with Italy and Germany, displayed the lowest fertility rate in 2006. Fertility in France has decreased to a lesser extent: France was the only country in 2006 experiencing a fertility rate close to the replacement rate (1.98). A similar pattern emerges in Figure 2.7, showing five-year age-specific fertility rates (per 1,000 women) for the period 2000-2005. Fertility peaked at age 25-29 in France (129.53), at age 30-34 in Spain and Italy. If compared to Germany, Austria and Greece, Italy exhibited lower fertility rates at younger ages (15-19 to 25-29) but higher fertility rates at older ages (30-34 to 40-44).

Figure 2.6: Total fertility rate in selected European countries, 1960-2006



Source: United Nations

Figure 2.7: Age-specific fertility rates (per 1,000 women) in selected European countries, 2000-2005



Source: World Bank

2.2.2 Mortality

There are also two different ways to approach the study of mortality: period mortality analysis and cohort mortality analysis. The former is based on a specific calendar period and is measured through the age-specific death rates (m_x); the latter is based on the experience of a specific group of people born during a specific calendar period (i.e. belonging to the same birth cohort) and is measured through the probability of dying (q_x).

Age-specific death rates (m_x) – also called central rates of mortality - are defined as the ratio between the number of deaths of people aged x last birthday in a given calendar year and population aged x years over the same period. For example, if the point chosen to compute the population at risk is 30 June and one wants to compute age-specific death rates at age 30, m_{30} is given by the number of deaths of people aged 30 last birthday divided by the number of people aged 30 at 30 June. This procedure violates the principle of correspondence. For example, let us consider someone who is aged 30 years last birthday on 30 June, whose birthday is on 12

September and who dies on 12 December. She will be aged x+1 last birthday when she dies and thus her death will be included in the numerator of the age-specific rate at age x+1 last birthday. However, she will be included in the denominator of the age-specific rate at age x last birthday.

The probability of dying (q_x) – also called the initial rate of mortality or age-specific mortality rate - is the probability that a life aged exactly x will die in the next year i.e. before attaining exact age x+1. q_x is the ratio of the number of deaths of people aged x last birthday on their date of death to the number of people celebrating their x-th birthday in year t (i.e. number of people belonging to the same birth cohort). In other terms, the number of people who are born in a given cohort are followed up until either they celebrate their next birthday or they die. Data on q_x are reported in life tables.

Clearly, q_x reflects the experience of a real group of people, whereas m_x does not. Equation [2.2] explains how to compute m_x from q_x. It can be applied as long as two main assumptions hold: (i) mortality only varies with age, and not with calendar time; and (ii) deaths are evenly distributed across each single year of age[4].

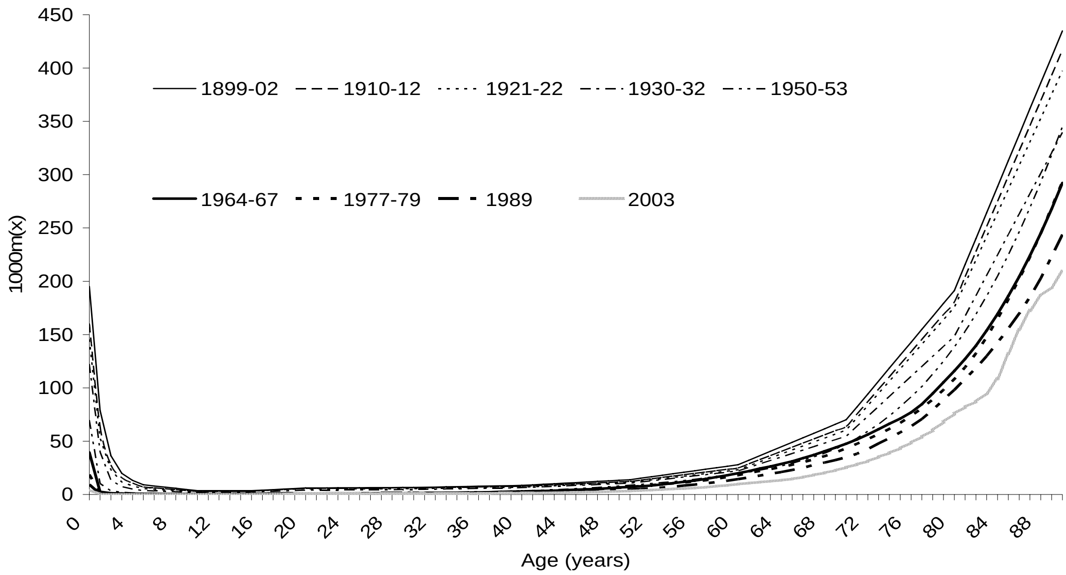
$$m_x = \frac{-2q_x}{q_x - 2} \qquad [2.2]$$

Figure 2.8 displays age-specific death rates of Italian males for a number of selected time periods: 1899-02, 1910-12, 1921-22, 1930-32, 1950-53, 1964-67, 1977-79, 1989 and 2003[5]. Age specific death rates follow, as expected, an U shape pattern: death rates tend to be higher at "the edges" – people aged 0 or more than 70 – and relatively close to 0 for those aged between 10 and 40 years. Also, age-specific death rates significantly decreased in the last century at all years of age. For example, in

[4] Assumption (ii) implies that, for example, the average age at death of those dying between their 64th and 65th birthday is 64 years and 6 months. In other words, the number of deaths between 64 years exactly and 64 years and 6 months is assumed to be equal to the number of deaths between 64 years and 6 months and 65 years exactly.
[5] Linear interpolation is used to interpolate missing data for the following periods: 1899-02, 1910-11, 1921-22 and 1930-32. The m_x values are computed applying Equation [2].

1899-02 the death rates (multiplied by 1,000 – i.e. for every 1,000 people) for new born male babies and males aged 90 were 195 and 434, respectively. These compare to 4.4 and 209, respectively, in 2003.

Figure 2.8: Age specific death rates – males, 1899-2003

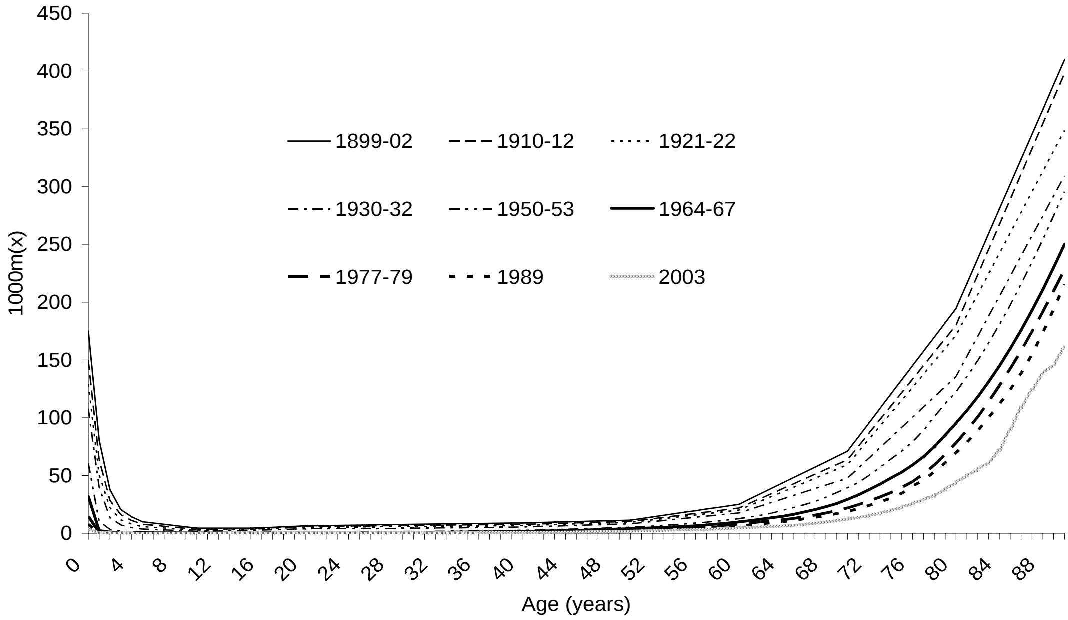


Source: Author's computations from Istat life tables

Figure 2.9 displays female age-specific death rates for the same selected time periods[6]. The pattern is similar to that of males, but female age-specific death rates are generally lower. In 1899-02 female death rates (multiplied by 1,000) for new born babies and people aged 90 were 174 and 409, respectively. These compare to 3.7 and 160.8, respectively, in 2003.

[6] Linear interpolation is used to interpolate missing data for the following periods: 1899-02, 1910-12, 1921-22 and 1930-32.

Figure 2.9: Age specific death rates – females, 1899-2003



Source: Author's computations from Istat life tables

Mortality data are normally reported in life tables. In theory, life tables describe the mortality of a group of people belonging to the same cohort. In order to collect life table figures for a certain cohort, one would need to wait until every member of the cohort dies. This obviously creates problems when calculating life tables for real populations. In practical applications, life tables are divided into single years of age and the probability of dying (q_x) is computed for each single year of age based on the mortality experience at a particular calendar time. Such tables are called *period life tables* and represent the experience of an hypothetical (or synthetic) cohort of people. For a more detailed explanation of how life tables are constructed, see Hinde (1996), Chapter 4.

Istat regularly publishes period life tables. These also include data on the survivor function (S(x)), which is defined as follows:

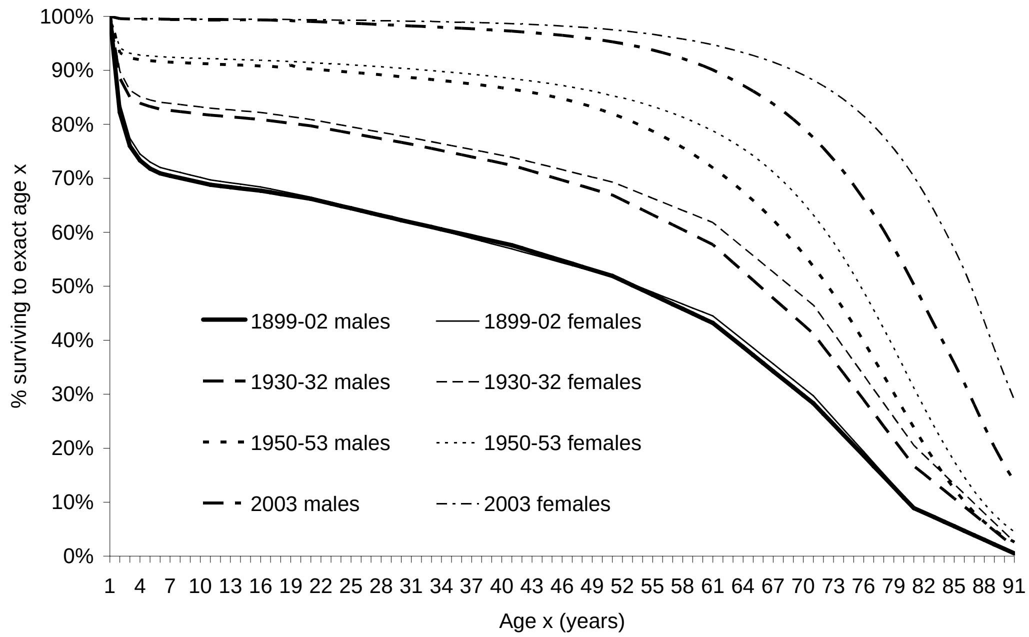
$$S(x) = \frac{l_x}{l_0} \qquad [2.3]$$

where l_0 is the initial synthetic birth cohort of people (also called radix, usually equal to 1,000 or 100,000) and l_x is the number of people out of the initial l_0 births who survive to a particular exact age x. The survivor function simply indicates the proportion of the l_0 births who survive to exact age x.

Figure 2.10 displays the survivor functions for males and females for a number of selected time periods: 1899-02, 1930-32, 1950-53 and 2003. The value of the survivorship function at age 0 is clearly 100%, as it is simply given by l_0 divided by l_0. Figure 2.10 shows that the area below the survivor function has steadily increased in the last century, indicating higher shares of survivors at all ages. Also, female survivor functions lie above male survivor functions for all the periods under consideration, suggesting that females have higher survivor rates. For example, in 1899-02 only 59.2% of the initial male radix were still alive at age 10, 6.7% reached 80 years of age and 0.8% reached 90 years. These compare to 69.7%, 9% and 0.5%, respectively, for females.

In 2003, 99.4% of the initial male radix were still alive at age 10, 50.3% reached 80 years of age and 13.8% reached 90 years. These compare to 99.5%, 70.3% and 28.9%, respectively, for females.

Figure 2.10: Survivor functions – males and females, 1899-2003



Source: Istat life tables

The number of survivors and the probability of dying are obviously related: the number of survivors to exact age x+1 is given by the product of the number of survivors to exact age x and one minus the probability of dying at age x, as shown in Equation [2.4] below:

$$l_{x+1} = l_x \cdot (1 - q_x) \qquad [2.4]$$

The average of the sum of l_x and l_{x+1} gives L_x, the average number alive in the interval between exact ages x and x+1. It is assumed that L_x is the number alive at the midpoint of the age class x. It is also defined as the number of person years lived between exact ages x and x+1.

$$L_x = \frac{1}{2} \cdot \left(l_x + l_{x+1} \right) \qquad [2.5]$$

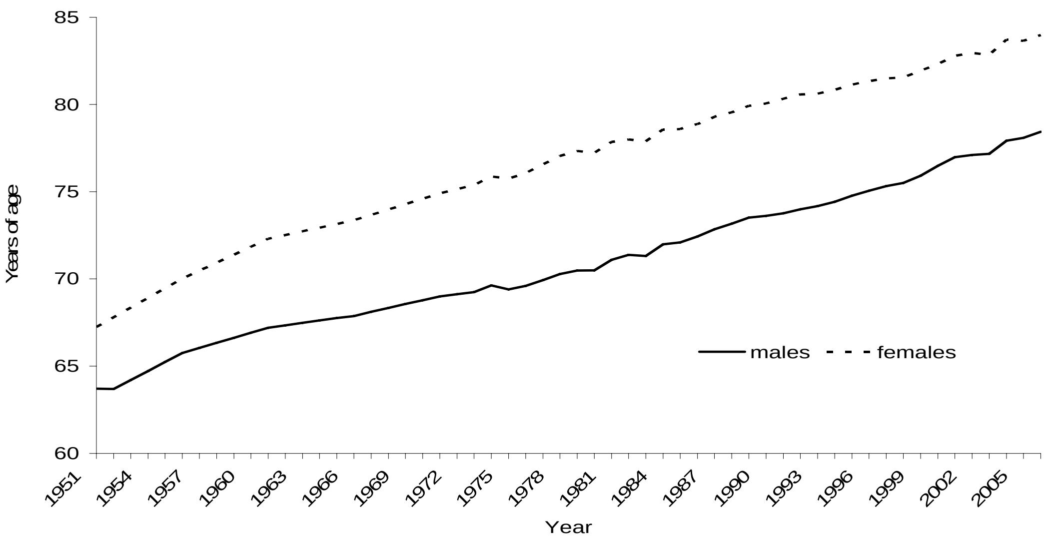
Life expectancy is another crucial mortality indicator. It is a period (hypothetical) measure of mortality which states the average number of years a group of people born in any particular year can be expected to live if mortality at each age remains at those rates prevailing in that year. More simply, it is the average remaining lifetime (in years) for a person who survives to the beginning of the indicated age interval. For example, life expectancy at 1 (e_1) is the average remaining lifetime (in years) for a person who has reached her 1st birthday. Life expectancy at year x can be computed as:

$$e_x = \frac{L_x + L_{x+1} + \ldots + L_{w-1}}{l_x} \qquad [2.6]$$

where w is the last year of age taken in to account.

Life expectancy at birth (e_0) is the life table function most frequently used as an index of the level of mortality. Figure 2.11 below displays life expectancy at birth for both males and females from 1951 onwards[7]. The Figure shows that life expectancy at birth for both males and females has been steadily increasing between 1951 and 2006 and suggests a sizeable mortality advantage for the latter. For example, in 1951 life expectancy at birth was 63.7 years for males and 67.2 for females, compared to 78.4 and 84.0, respectively, in 2006.

Figure 2.11: Life expectancy at birth – males and females, 1951-2006



Source: Istat life tables

[7] Data are linearly interpolated for a number of years between 1952 and 1973, due to missing observations.

Table 2.4 displays life expectancy at birth for both males and females for a number of selected countries which are either geographically or culturally / economically close to Italy (e.g. Germany, Austria, Switzerland, Slovenia, Spain and Greece). The figures presented in the Table suggest that life expectancy in Italy has been in line with (and often slightly higher than) that of the other comparator countries, with the only exception being Switzerland. All these countries show a steady increase in life expectancy in the last thirty five years.

Table 2.4: Life expectancy at birth in a number of selected countries, 1970-2006

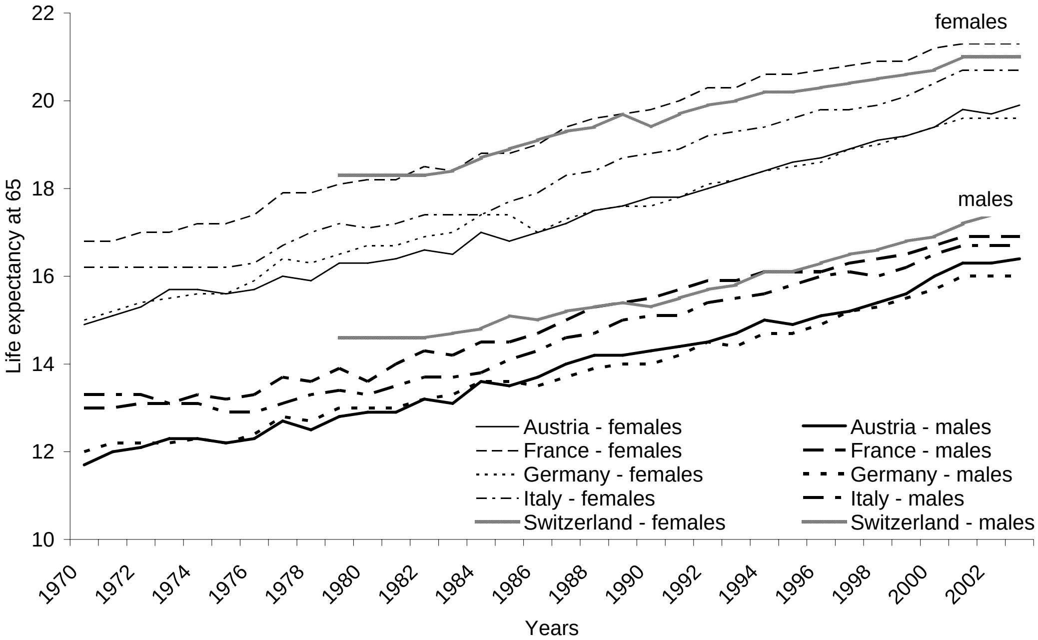
		1970	1980	1990	2000	2002	2004	2006
Germany	M	67.5	69.6	72.0	75.1	75.7	76.5	77.2
	F	73.5	76.1	78.4	81.2	81.3	81.9	82.4
Austria	M	66.5	69.0	72.2	75.2	75.8	76.4	77.2
	F	73.4	76.0	78.8	81.2	81.7	82.1	82.8
France	M	68.4	70.2	72.8	75.3	75.7	76.7	77.3
	F	75.8	78.3	80.9	83.0	83.0	83.8	84.4
Switzerland	M	70.1	72.3	74.0	77.0	77.9	78.6	79.2
	F	76.1	78.8	80.7	82.8	83.2	83.8	84.2
Spain	M	69.9	72.2	73.3	75.8	76.3	76.9	77.7
	F	75.2	78.2	80.3	82.9	83.2	83.7	84.4
Greece	M	71.4	73.1	74.6	75.5	76.2	76.6	77.2
	F	76.0	77.7	79.3	80.6	81.1	81.3	81.9
Slovenia	M	65.0	67.3	69.8	72.2	72.6	73.5	74.5
	F	72.3	75.2	77.8	79.9	80.5	80.8	82.2
Italy	M	68.8	70.5	73.6	76.5	77.1	77.7	78.4
	F	74.6	77.2	80.1	82.3	83.0	83.7	84.0

Sources: Eurostat and Istat

Figures 2.12 and 2.13 display life expectancy at ages 65 and 80. All countries display higher life expectancy for females and a general increase in life expectancy (for both men and women) in the last forty years. On average, life expectancy at 65 for females was 15.7 in 1970, compared to 20.5 in 2003. These compare to 12.5 and 16.7, respectively, for males. This means, for example, that a man reaching age 65 in 1970 could expect to live, on average, for other 12.5 years, whereas a man reaching age 65 in 2003 could expected to live, on average, for other 16.7 years. Also, on average, life expectancy at 80 for females was 6.5 in 1970, compared to 9.1 in 2003. These compare to 5.6 and 7.5, respectively, for males.

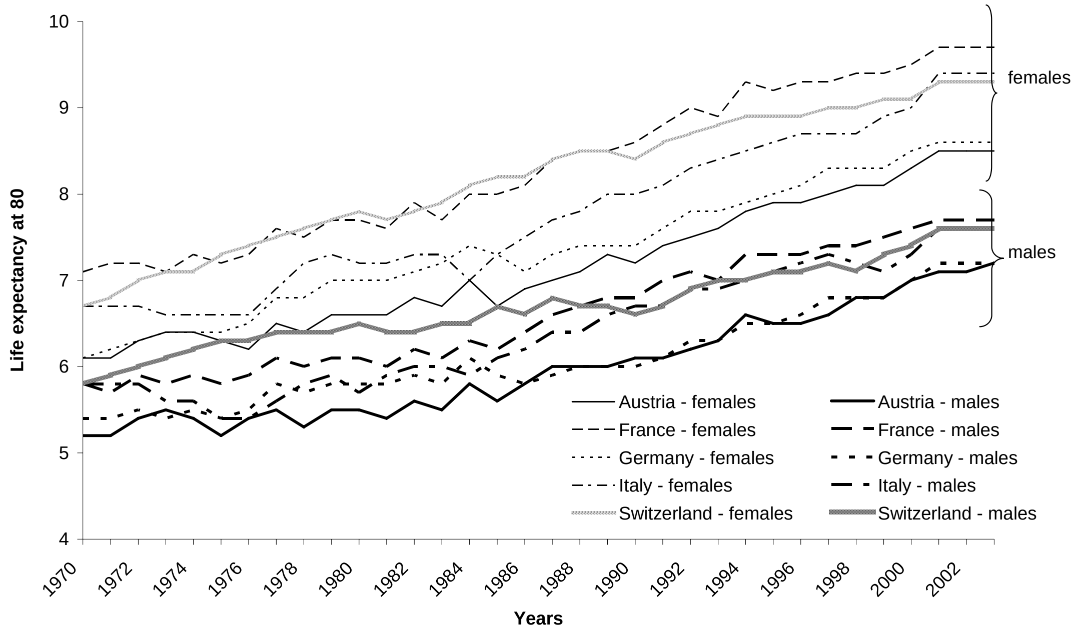
Life expectancy at ages 65 and 80 in Italy has been historically lower than in France and Switzerland and higher than in Germany and Austria.

Figure 2.12: Life expectancy at 65 in a number of selected countries, 1970-2003



Source: OECD

Figure 2.13: Life expectancy at 80 in a number of selected countries, 1970-2003



Source: OECD

Another important mortality indicator is *healthy life expectancy* (HALE), originally developed by the World Health Organisation (WHO). HALE is an estimate of how many years people can expect to live in good health. It is based on a number of health indicators, including sight, hearing, communication, mobility, manual skills, pain and emotional make-up. The difference between life expectancy and healthy life expectancy gives an estimate of the number of years people can expect to spend in *poor* health. Table 2.5 below summarises life expectancy and healthy life expectancy figures for a number of countries in 2002. According to these figures, healthy life expectancy in Italy is higher than the European average (72.2 versus 71.1). Only Switzerland exhibits a higher HALE. Also, the number of years people live in poor health (i.e. life expectancy minus healthy life expectancy) is lower in Italy than in Europe as a whole (7 versus 7.5).

Table 2.5: Life expectancy and healthy life expectancy in a number of selected countries, 2002

	Life expectancy	Healthy Life Expectancy	Difference
Switzerland	80.6	73.2	7.4
France	79.7	72	7.7
Spain	78.6	72.6	6
Germany	78.7	71.8	6.9
Greece	78.4	71	7.4
Slovenia	76.7	68.5	8.2
Italy	79.7	72.7	7
European average	78.6	71.1	7.5

Source: World Health Organization

Declining mortality in Italy and in other industrialised countries have been caused by a number of factors, including medical improvements, better access to care, improved standards of living and, more generally better education and nutrition.

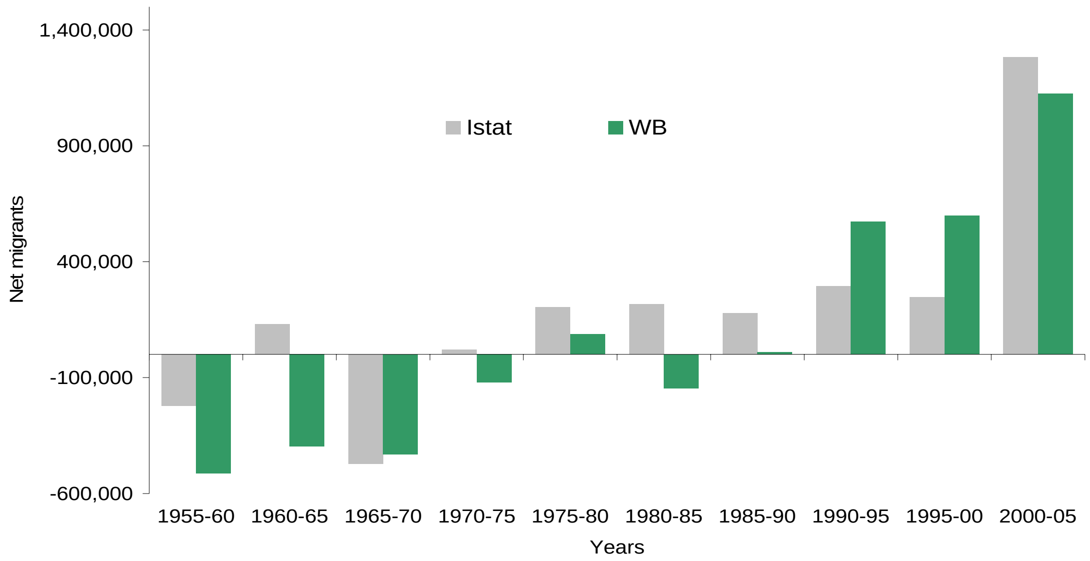
2.2.3 International Migration

The other fundamental component of national population change is migration. The Italian Government gather data on migration using local authorities' population registers, which are accounts of residents within a country. They are usually maintained via the legal requirement that both nationals and foreigners residing in the country must register with the local authorities. The Italian registers provide data on immigrants ("iscritti dall'estero") and emigrants ("cancellati per l'estero").

Whilst different sources, such as Istat, the World Bank and the UN, provide similar estimations on fertility and mortality, they provide *different estimates of migration*. It is indeed simpler to collect data on births and deaths than on migrants for obvious reasons.

Figure 2.14 below summarises Istat and World Bank net migration figures from 1955 onwards. The numbers shown in the Figure are the sum of annual net migration estimates for five-year periods, from 1955-1960 to 2000-2005. The figures and patterns provided by the two sources are different in some of the time periods under consideration. However, migration data for the last five years seem to be closer. Istat estimates a total net international migration of 1,283,198 people, the World Bank of 1,125,240. Istat also estimates a total net international migration of 222,410 people in 2006 and 492,823 people in 2007.

Figure 2.14: Number of net migrants, 1955-2005

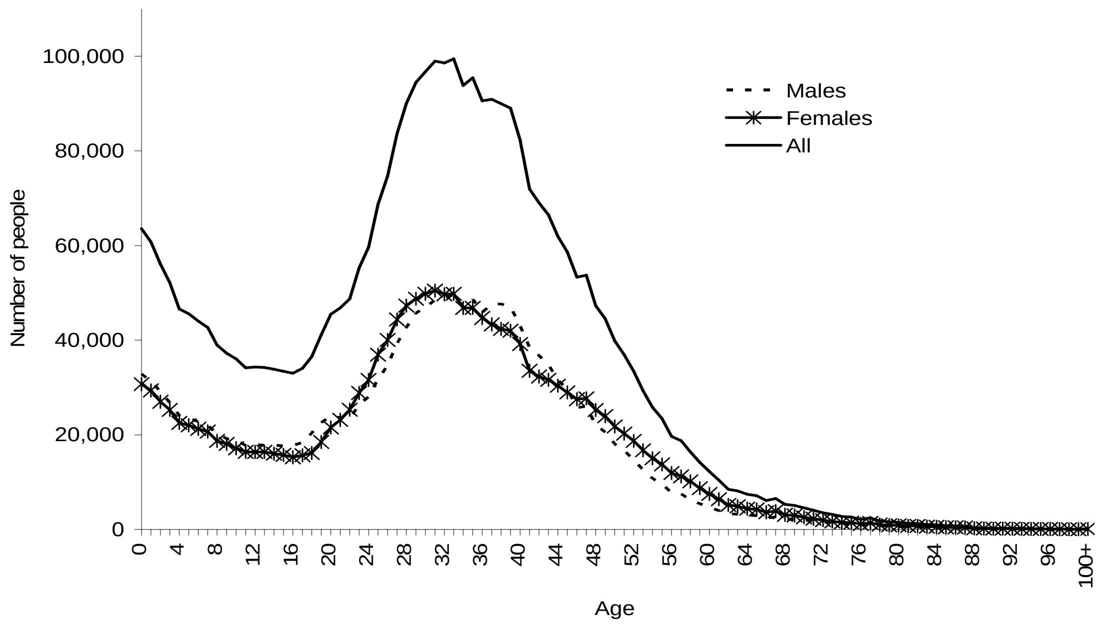


Sources: Istat and World Bank

Note: Istat data do not include "registrations for other reasons" (i.e. registrations due to administrative population registers updating, including: registration of persons previously mistakenly cancelled because missing and successively reappeared; registration of persons not registered at the Census and consequently, not included in the legal population but actually resident) and cancellations for other reasons (i.e. cancellations due to administrative population registers updating, including: cancellation of persons previously mistakenly registered because missing at the administrative verification of residence; cancellation of persons registered at the Census but they could not\did not want to register at the population register of the municipality where they have been counted by the Census).

Istat estimates that there were 1,549,373 foreign-born residents in Italy on 1 January 2003, compared to 1,990,159 in 2004; 2,402,157 in 2005; 2,670,514 in 2006; 2,938,922 in 2007; and 3,432,651in 2008. Figure 2.15 below shows that around three quarters of male and female foreign-born residents at 1 January 2008 were aged between 15 and 55.

Figure 2.15: Number of foreign-born residents by single year of age, January 2008



Source: Istat

Table 2.6 below shows the origin of foreign-born residents living in Italy in 2004. Almost one in five was from Romania, followed by Albania (11.7%), Morocco (10.7%), China (4.6%) and Ukraine (3.9%).

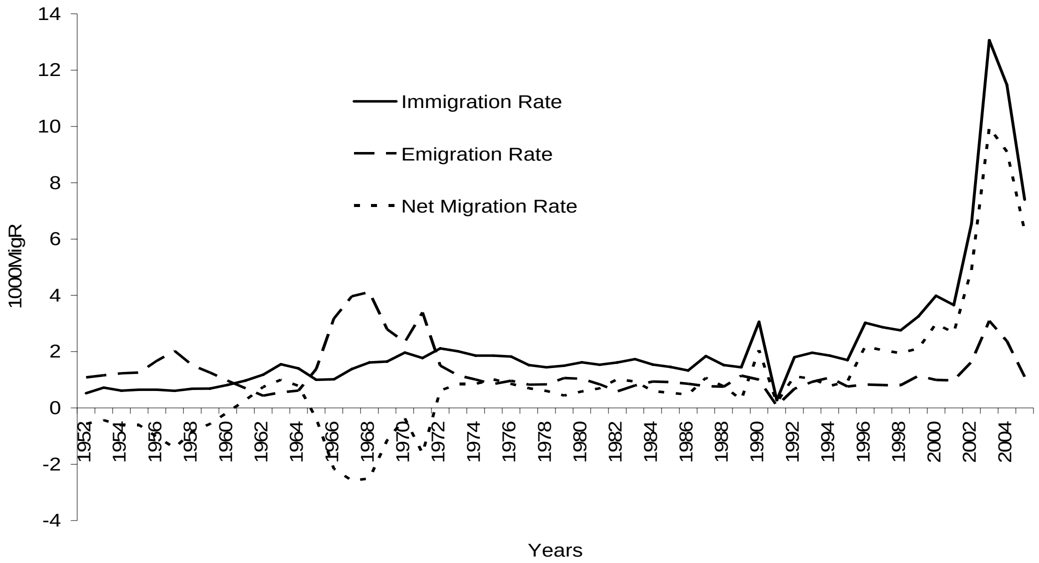
Table 2.6: Origin of foreign-born residents, January 2008

Country of Origin	Number	%
Romania	625,278	18.2%
Albania	401,949	11.7%
Morocco	365,908	10.7%
China	156,519	4.6%
Ukraine	132,718	3.9%
Philippines	105,675	3.1%
Tunisia	93,601	2.7%
Poland	90,218	2.6%
Macedonia	78,090	2.3%
India	77,432	2.3%
Ecuador	73,235	2.1%
Peru	70,755	2.1%
Egypt	69,572	2.0%
Moldova	68,591	2.0%
Serbia	68,542	2.0%
Senegal	62,620	1.8%
Sri Lanka	61,064	1.8%
Bangladesh	55,242	1.6%
Pakistan	49,344	1.4%
Nigeria	40,641	1.2%
Germany	40,163	1.2%
Brazil	38,400	1.1%
Bulgaria	37,848	1.1%
France	33,477	1.0%
Other	30,803	15.6%

Source: Istat

Figure 2.16 below summarises Istat data on immigration, emigration and net migration *rates*. The rates are computed by dividing the number of immigrants, emigrants and net migrants by the population at risk (i.e. total population) in the period. The Figure shows that Italy turned from a “typical emigration country” to a “typical immigration” country, with the early 1970s being the turning point. A good review of the determinants of the Italian transition from emigration to immigration country is provided in Bonifazi et al (2008). Amongst the main factors they include: i) high domestic economic growth in the late 60s and early 70s (between 1964 and 1973 the Italian economy grew at an average annual rate of 5%); ii) new immigration restrictions in countries traditionally receiving Italian immigrants iii) an inadequate legislative framework that favoured the growth of both legal and illegal immigration ; iv) a large informal economy and v) the general tolerant attitude towards migration (which has, however, changed dramatically in the following decades).

Figure 2.16: Migration rates, 1952-2005

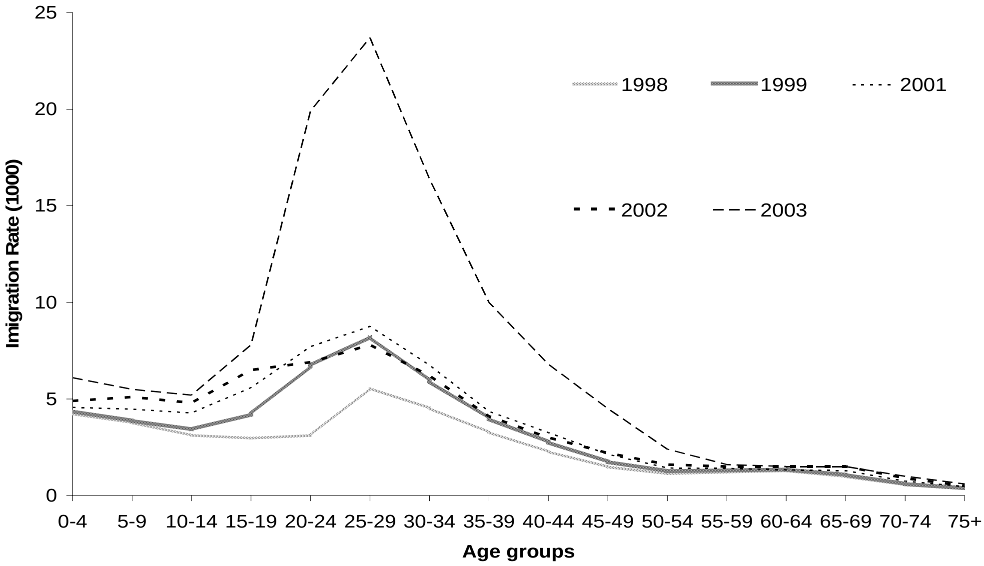


Source: Istat

Figures 2.17 – 2.20 below display immigration and emigration rates by five-year age groups for males and females, respectively, between 1998 and 2003. The Figures show that emigration rates have been quite low, with people aged 25-34 being slightly more likely to emigrate. Also, emigration rates have been significantly lower than immigration rates. However, emigration numbers are very likely to be underestimated due to emigrants often not informing local authorities when leaving the country.

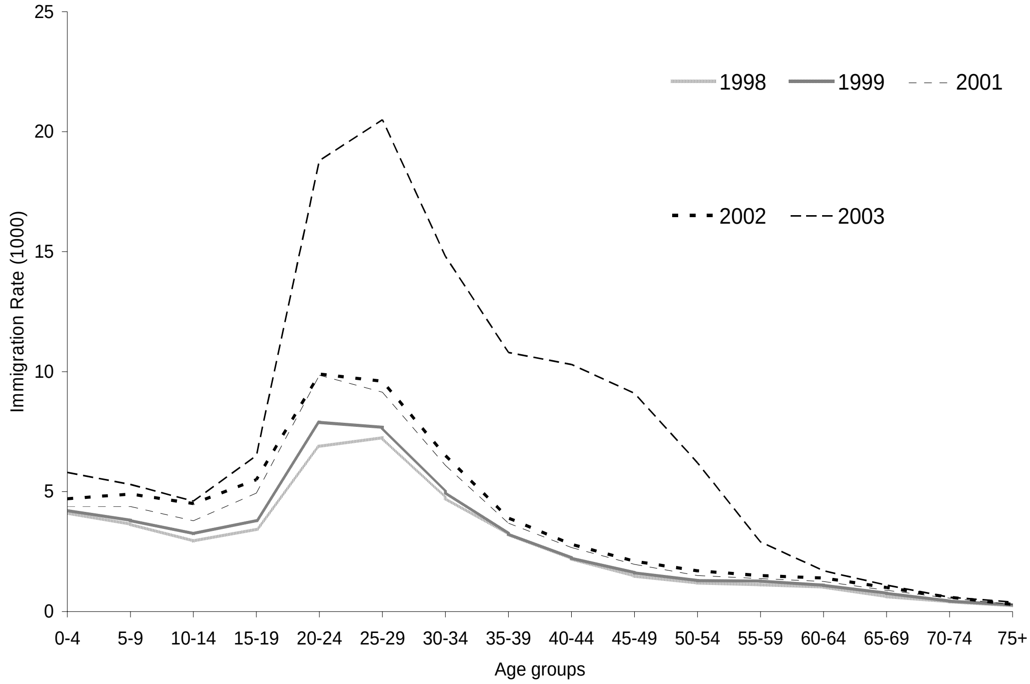
The Figures also show that immigration rates increased significantly in the last years and peaked in 2003, for both males and females. Specifically, male immigration rates reached 23.7 (for every 1,000 people) for the 25-29 age group in 2003. The pattern of female immigration rates is slightly different, being relatively high also for the 35-49 age group. This is probably due to the large inflow of middle aged women (coming mostly from Eastern Europe countries) working as social carers in private households ("badanti").

Figure 2.17: Immigration rates - males, 1998-2003



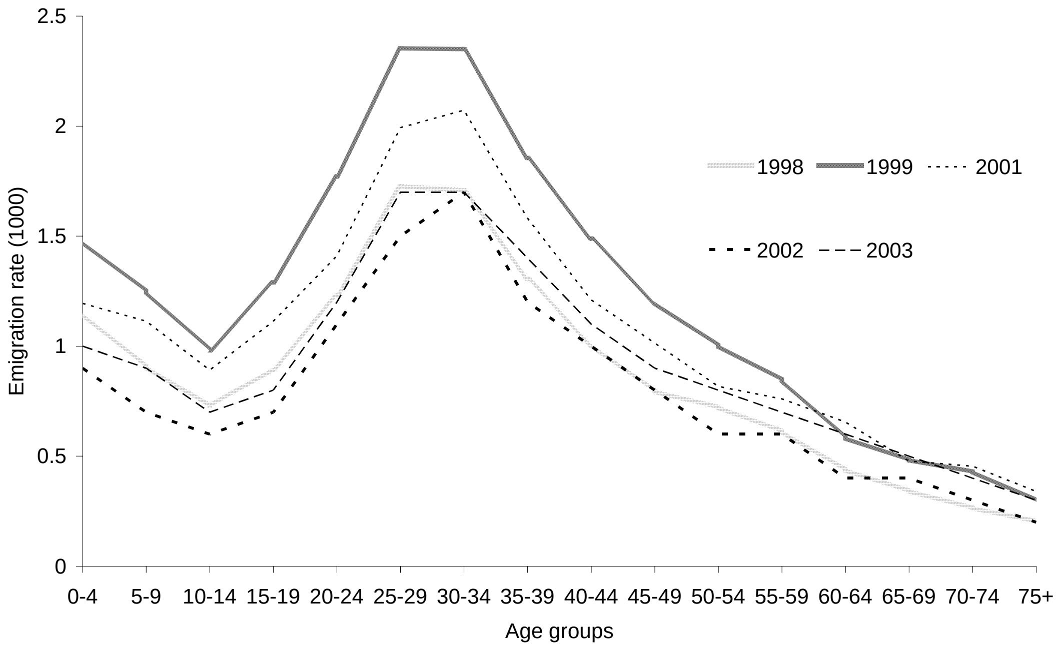
Source: Istat

Figure 2.18: Immigration rates - females, 1998-2003



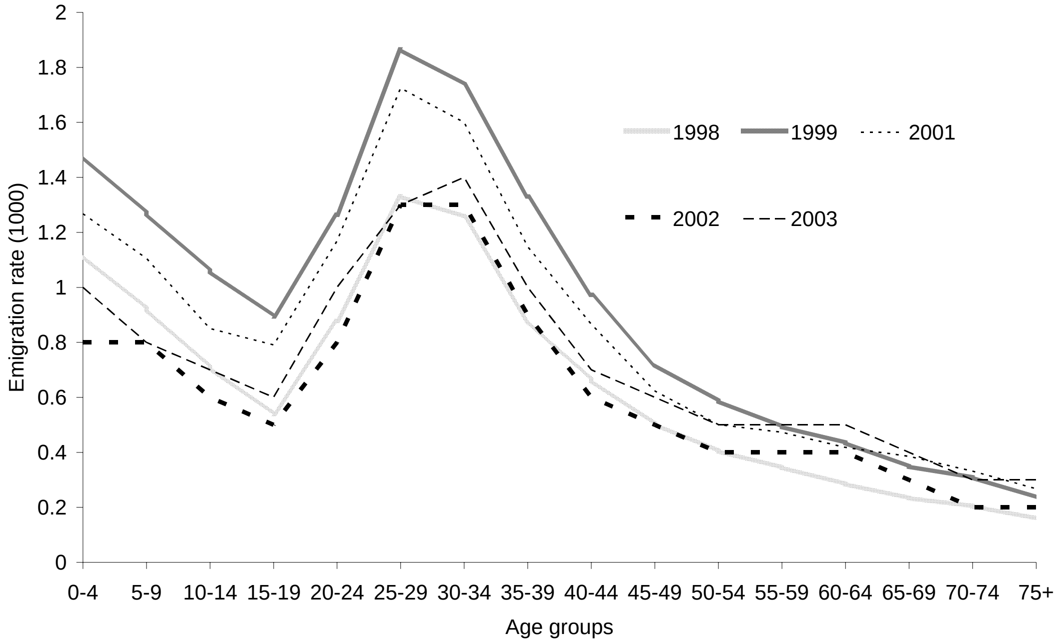
Source: Istat

Figure 2.19: Emigration rates - males, 1998-2003



Source: Istat

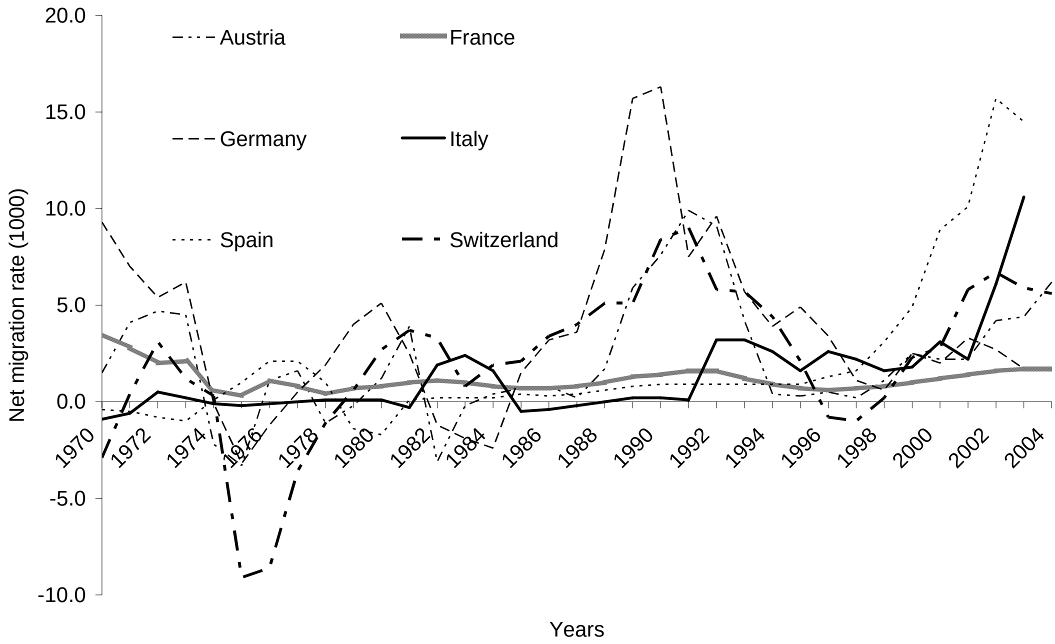
Figure 2.20: Emigration rates - females, 1998-2003



Source: Istat

Figure 2.21 below displays net migration rates (per 1,000 people) for a number of countries which are either geographically or culturally / economically similar to Italy. The data have been collected by the OECD and are based on countries' official statistics. Germany experienced very high net migration rates in the 80s and 90s (peaking at 16.3 in 1990) whereas countries such as Italy and Spain started to experience high immigration flows only in the last 5 years. In 2003, for example, net migration rate was 10.6 in Italy and 14.5 in Spain.

Figure 2.21: Net migration rate in a number of selected countries, 1970- 2004



Source: OECD

2.2.4 Italian migration system

Before proceeding further in the analysis, the main features of the Italian immigration system are quickly summarised, with reference to the main underlying legislation.

The first real attempt at setting and implementing a defined immigration policy in Italy was made in 1998, with the Law number 40. The law focused on three main migration pillars, namely integration, quotas and restriction of undocumented immigration. It also illustrated the importance of substantial immigration to counteract the phenomenon of population ageing in Italy (Levison (2005) and Chaloff (2003)). It concluded that it would be reasonable to admit between 50,000 and 80,000 immigrants every year.

Following the introduction of the Law Number 40, 1998 (article 3), the Italian President of the Council of Ministers and the Parliament set an annual quota of immigrants who are authorised to work in Italy. Different quotas are set for immigrants looking for employment, self-employment or seasonal employment and by country of origin. The *final* immigration quotas set between 1998 and 2007 amounted to 58,000 in 1998 and 1999; 83,000 in 2000; 89,400 in 2001; 42,600 in 2002; 79,500 in 2003, 2004 and 2005; 490,000 in 2006; 82,000 in 2007; and 230,000 in 2008. Some of these figures were initially lower and revised upward during the year. For example, the 2006 immigration quota was set to 170,000 in February 2006 and then revised to 490,000 – an increase of 350,000 immigrants – in October 2006. The target was increased in response to experience: the quota was too low if compared with the actual number of foreign-borns applying for immigration.

According to Ismu[8], the process has proved to be unsatisfactory. This is mainly due to *too low quotas*, which have often been revised upward during the year, and *strong delays*. Also, self-employers and non seasonal employees have often been penalised in terms of numbers admitted when compared to seasonal workers (ISMU, 2007). Also IDOS[9] (2004) agree on the fact that "the quota system still appears as inadequate with respect to labour needs, and the grant of a permanent residence permits is affected in some cases by slow and heavy procedures" (p.7).

2.3 Italian demographic future?

The current demographic situation in Italy can be described as a population with below replacement level fertility, gradually decreasing mortality and sharply increasing levels of net migration. What will happen to the size and age structures of the population if current trends continue? And what will happen to the size and age structures of the population if migration will stabilize at a lower level after reaching high peaks in the last few years?

[8] Ismu is an autonomous and independent organization promoting studies, research and projects on multi-ethnic and multi-cultural society, and focusing in particular on the phenomenon of international migrations.

[9] IDOS is the Italian contact point within the European Migration Network, originally designed by the Italian Ministry of Interior.

2.3.1 Istat population projections: the model and assumptions

Istat routinely carries out and publishes 'official' population projections (see Istat, 2005 and 2008a), based on precise fertility, mortality and migration assumptions. Three scenarios are usually investigated: central (or principal), high and low, with the former being the most verisimilar. The "high scenario" is based on low mortality – high fertility – high net migration assumptions, the "low scenario" on high mortality – low fertility and low net migration assumptions. The *cohort component method* is used: given the structure of the population by single year of age and sex in the base year, the model calculates the number of births, deaths and migrants in the first year of the projection and then iterates the procedure for as many years as are needed to obtain the population projection required. Population is given by the number of people at 1 January; births, deaths and migrants are given by the number of those who are born, die or migrate during the year (i.e. between 1 January of year t to 1 January of year t+1).

Istat penultimate population projections (Istat 2005) are investigated. 2005 is the base year and population projections are carried out until 2050, for a total of 4 ½ decades. However, one should bear in mind that population projections become increasingly uncertain the further they are carried forward. Istat latest population projections were carried out in 2008, are 2007-based and refer to the period 2007 – 2051. In the thesis, 2005-based projections are investigated because Istat demographic team provided me with detailed fertility, mortality and migration assumptions for the 2005-based projections in April 2007. Conversely to what happens in other countries such as the United Kingdom and Ireland, in Italy assumptions on future levels of age-specific mortality, fertility and migration rates are not published on-line and are available only on request. As will be discussed in Chapter 3, detailed fertility, mortality and migration assumptions are necessary to carry out population projections. 2005-based and 2007-based assumptions are similar, but only to a certain extent. This will be discussed in more detail in Section 2.3.3.

The first step of the cohort component model adopted by Istat consists in calculating the *number of births in year t* - ${}_{t}B$ – which is computed as follows:

$$ {}_{t}B = \sum_{x} 0.5 \cdot ({}_{t}F_{x} + {}_{t+1}F_{x+1}) \cdot {}_{t}ASFR_{x} \qquad [2.7] $$

where ${}_{t}F_{x}$ is the number of females of childbearing age (14 to 49) aged x at 1 January t, ${}_{t+1}F_{x+1}$ is the number of females of childbearing age aged x+1 at 1 January t+1 and ${}_{t}ASFR_{x}$ is the age-specific fertility rate of women of childbearing age aged x in year t.

${}_{t+1}F_{x+1}$ is given by:

$$ {}_{t+1}F_{x+1} = {}_{t}F_{x} - {}_{t}D_{x}^{F} - {}_{t}E_{x}^{F} + {}_{t}I_{x}^{F} \qquad [2.8] $$

where
${}_{t}D_{x}^{F}$ = number of females of childbearing age aged x at 1 January t dying in year t
${}_{t}E_{x}^{F}$ = number of females of childbearing age aged x at 1 January t emigrating abroad in year t
${}_{t}I_{x}^{F}$ = number of females of childbearing age aged x at 1 January t immigrating to Italy from abroad in year t

Also:

${}_{t}D_{x}^{F} = {}_{t}F_{x} \cdot (1 - {}_{t}\lambda_{x}^{F})$, where ${}_{t}\lambda_{x}^{F}$ is the probability to survive until 1 January t+1 for women of childbearing age aged x at 1 January of year t (${}_{t}F_{x}$). ${}_{t}\lambda_{x}^{F}$ is equal to L_{x+1}^{F} / L_{x}^{F} where L_{x} is the number of person years lived between exact ages x and x+1 and L_{x+1} is number of person years lived between exact ages x+1 and x+2. L_{x}^{F} also gives the average number alive in the interval between exact ages x and x+1.
${}_{t}E_{x}^{F} = {}_{t}F_{x} \cdot {}_{t}\lambda_{x}^{F} \cdot {}_{t}em_{x}^{F}$, where ${}_{t}em_{x}^{F}$ is the probability for a woman of childbearing age aged x at 1 January of year t to emigrate abroad. The probability of emigrating is applied only to ${}_{t}F_{x} \cdot {}_{t}\lambda_{x}^{F}$ - the number of female survivors at the end of year t.

The number of new born males and females is then obtained by applying a sex ratio of births of 106 males for every 100 females.

Once the number of births is computed, the population at 1 January of year t+1 is computed as in Equation [2.1]:

$${}_{t+1}P_{x+1} = {}_tP_x - {}_tD_x - {}_tE_x + {}_tI_x \qquad [2.1]$$

where:

${}_tD_x = {}_tP_x \cdot (1 - {}_t\lambda_x)$ and
${}_tE_x = {}_tP_x \cdot {}_t\lambda_x \cdot {}_tem_x$

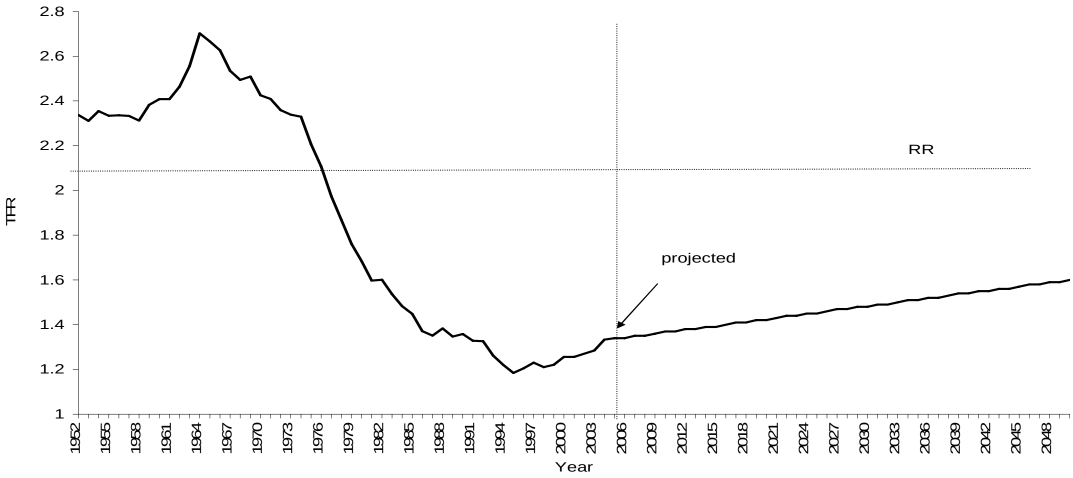
For new born babies, P is given by the number of births (${}_tB$). Also, the probability of migration of new born babies is applied for only half a year.

Istat uses historical fertility data to project fertility between 2005 and 2050. Data on the number of females in childbearing age by year of birth and age and on the number of births by age, year of birth of the mother and birth order for the period 1958 to 2003 are used. Data for the period 1999 – 2003 are estimated as in *Indagine campionaria sulle nascite 2000-01 e 2003*. The TFR and ASFRs for incomplete and future generations are projected by birth order. Five different age groups (i.e 13-20, 21-26, 27-28, 29-37 and 38-42) are identified to project TFR and ASFRs for first birth order. Recent changes in women's delayed propensity to have their first child are taken into account. The probability of parity[10] progression (the probability that a woman with i children will experience a birth of order i+1) is used to project TFR and ASFRs for birth orders higher than one.

Istat estimates a gradual linear increase in the TFR, shifting from 1.34 in 2005 to 1.6 in 2050, in line with Eurostat average. This is shown in Figure 2.22.

[10] In demography, the parity of a woman indicates the number of children a woman has already had.

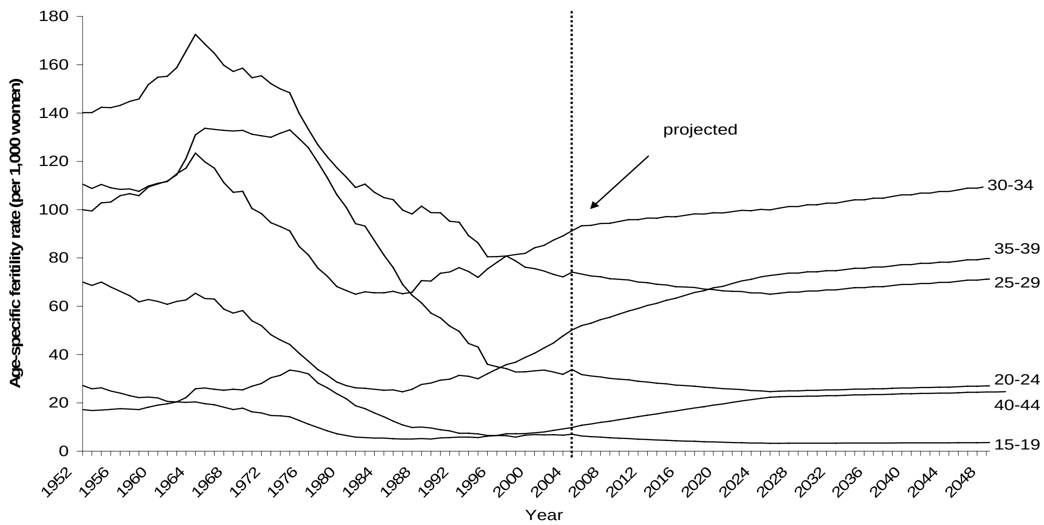
Figure 2.22: Estimated and projected total fertility and replacement rates, 1952-2050



Source: Istat

Age-specific fertility rates of women aged 30-34, 35-39 and 40-44 are projected to follow a pattern of change that roughly parallels the trend in TFR. The ASFR of women aged 35-39 is projected to experience the highest increase, shifting from 52.04 (per 1,000 women) in 2005 to 80.24 in 2050. Conversely, ASFRs of younger women, i.e. women aged 15-19, 20-24 and 25-29, are projected to decrease until around 2025 and to stabilise afterwards.

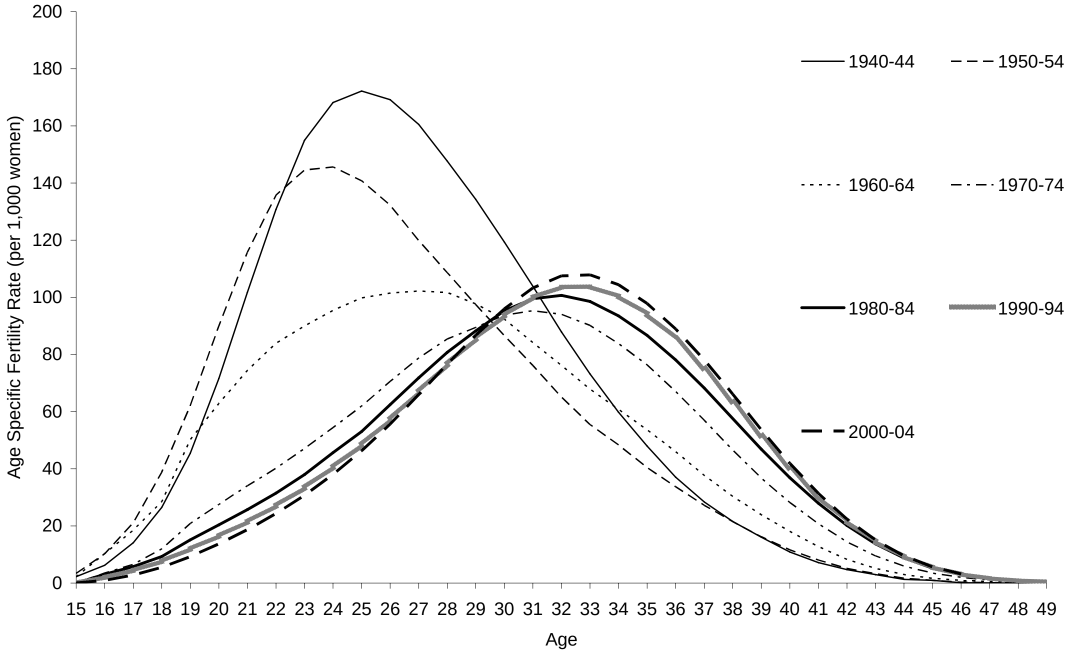
Figure 2.23: Five-year estimated & projected age specific fertility rates, 1952-2050



Source: Istat

Figure 2.24 shows ASFRs of seven different cohorts of women (born in 1940-44 to 2000-04). ASFRs of the youngest cohorts – born in 1990-94 and 2000-04 – are projected ASFRs. Figure 2.24 shows that the ASFR curves for older cohorts, born in 1940-44 and 1950-54, reach higher peaks in the early phases of the childbearing age. Conversely, the ASFR curves for younger cohorts are projected to peak at older ages. For example, ASFRs of the cohort born in 1940-44 peak at 25 years of age, those of cohorts born in 1990-94 and 2000-04 are projected to peak at 33 years.

Figure 2.24: Age specific cohort fertility rates: birth cohorts 1940-44 to 2000-04



Source: Author's calculation from Istat fertility data

Annual life tables by single year of age and sex for the period 1974 – 2004 are used to make mortality assumptions. The *age-period-cohort model* is used to project mortality nationally. Fifteen groups of causes of death are identified, these are as follows:

- Infectious diseases and AIDS;
- Digestive system cancers;
- Breast cancers;
- Other cancers;
- Diabetes;

- Diseases of the nervous system;
- Diseases of the respiratory system;
- Diseases of the digestive system;
- Heart ischemic diseases;
- Circulatory diseases of the encephalon;
- Other diseases of the cardio-circulatory system;
- Road traffic accidents;
- Other violent causes / injuries; and
- Other causes

The *parametric model of Lee-Carter*[11] is used to project mortality both at the regional and the national level[12]. The model combines a demographic model for mortality and a time-series model. It is estimated from historical age-specific mortality data and a temporal index of the general level of mortality[13]. Istat estimates a decrease in mortality for both men and women, in particular for men.

Figures 2.25 and 2.26 display age specific death rates for males and females, respectively, for a number of projected selected time periods: 2005, 2010, 2020, 2030, 2040 and 2050. Figures 2.25 and 2.26 show that age-specific death rates are projected to continue to fall: for example, death rates for males aged 90 are projected to decrease from 182.8. in 2005 to 113.1 in 2050 and those of females are projected to decrease from 143.5 in 2005 to 84.1 in 2050. Figures 2.25 and 2.26 also show that age specific death rates are expected to continue to be lower for females.

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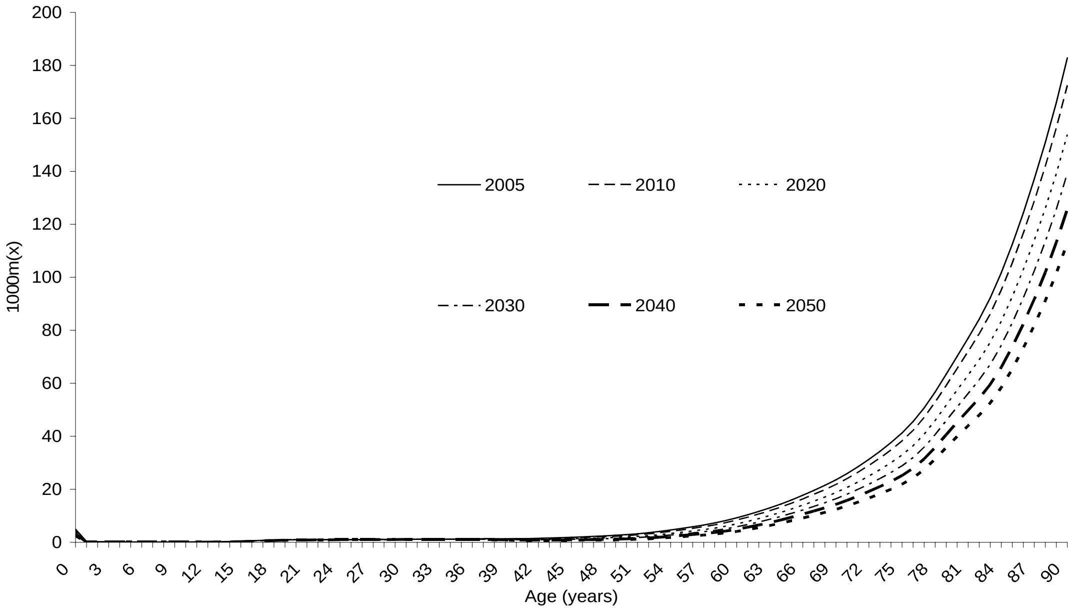
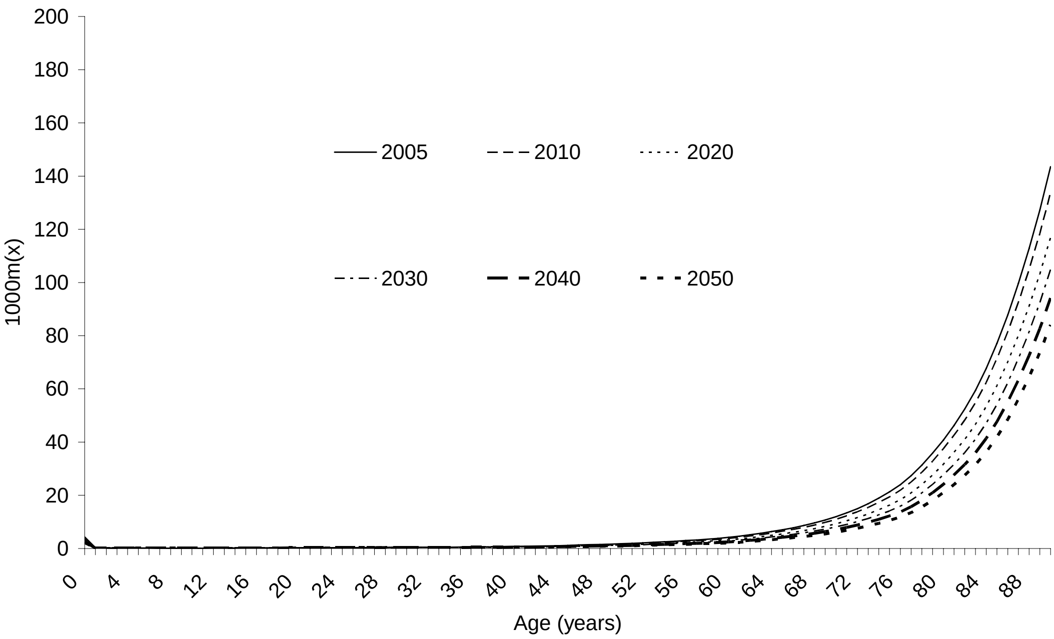
[11] Lee, R.D. and Carter L.R. (1992), Modelling and forecasting U.S. mortality. *Journal of the American Statistical Association*, *87*(419).
[12] The national figure is computed as the weighted average of the twenty regional figures.
[13] The detailed theoretical background of the Lee-Carter model can be found in Istat (2003) *Previsioni della popolazione residente per sesso, età e regione dal 1.1.2001 and 1.1.2051*, pp. 36-42, available in the Internet at http://www.istat.it/dati/catalogo/20030326_01/volume.pdf [10 May 2007]

Figure 2.25: Projected age specific death rates – males, 2005-2050



Source: Author's calculation from Istat mortality projections

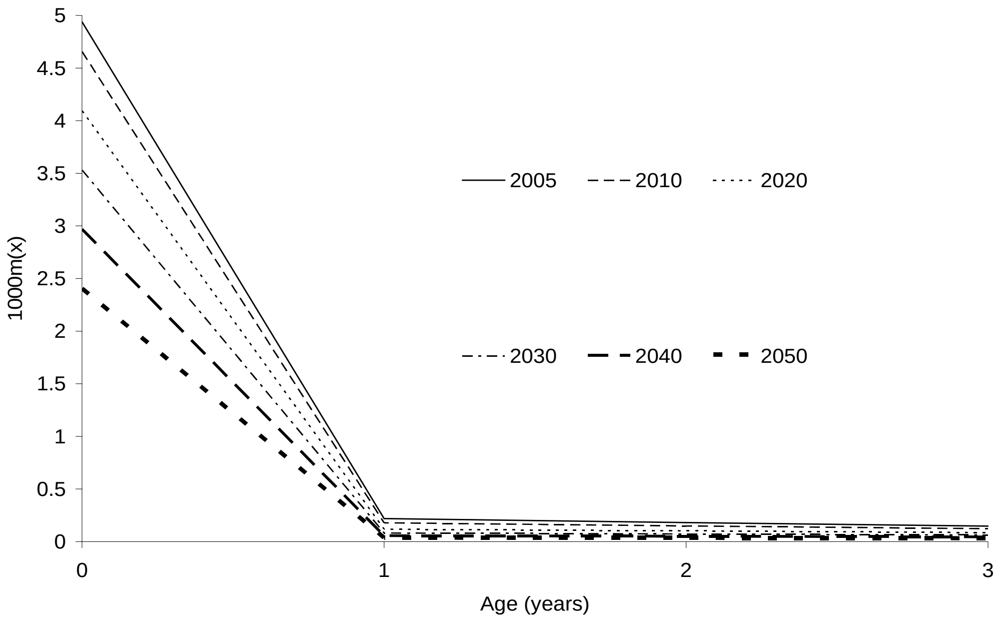
Figure 2.26: Projected age specific death rates – females, 2005-2050



Source: Author's calculation from Istat mortality projections

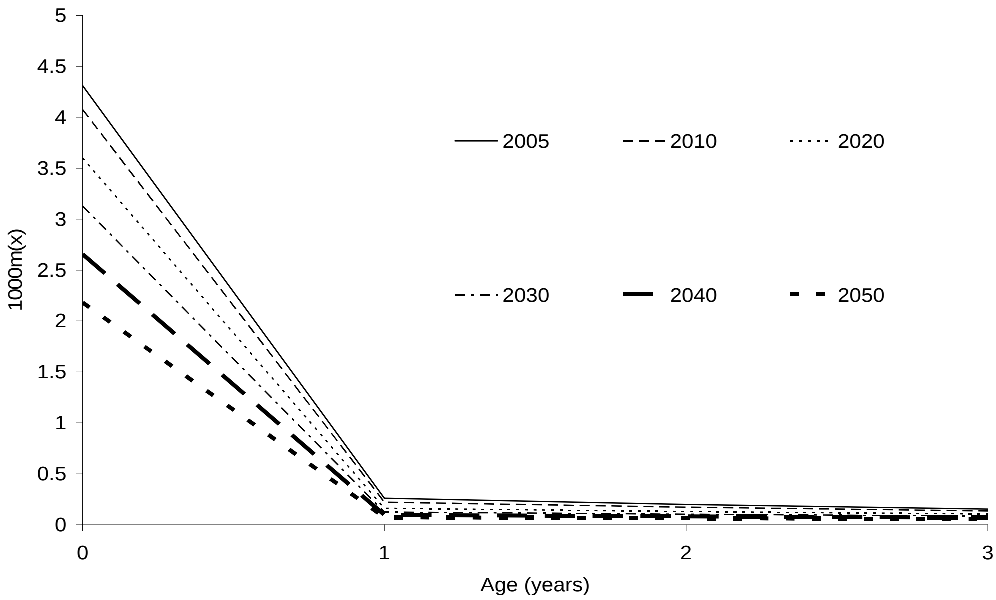
Figures 2.27 and 2.28 display projected age specific death rates for males and females, respectively, aged from 0 to 3. The two Figures show that death rates for new born babies are projected to decrease substantially, from 4.9 in 2005 to 2.4 in 2050 for males and from 4.3 in 2005 to 2.2 in 2050 for females.

Figure 2.27: Projected age specific death rates – males aged 0-3, 2005-2050



Source: Author's calculation from Istat mortality projections

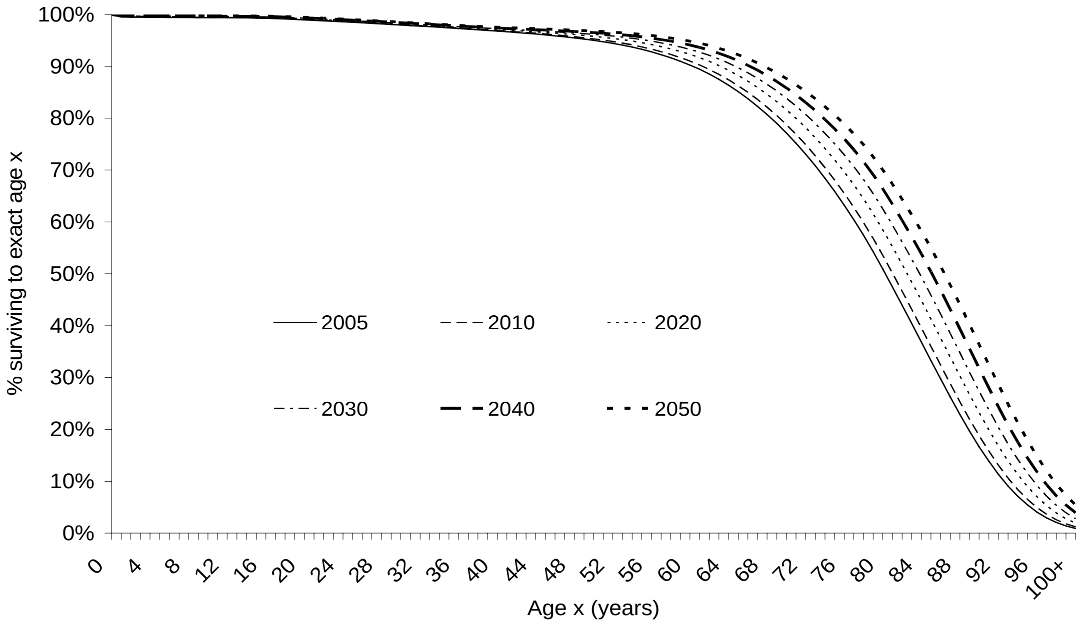
Figure 2.28: Projected age specific death rates – females aged 0-3, 2005-2050



Source: Author's calculation from Istat mortality projections

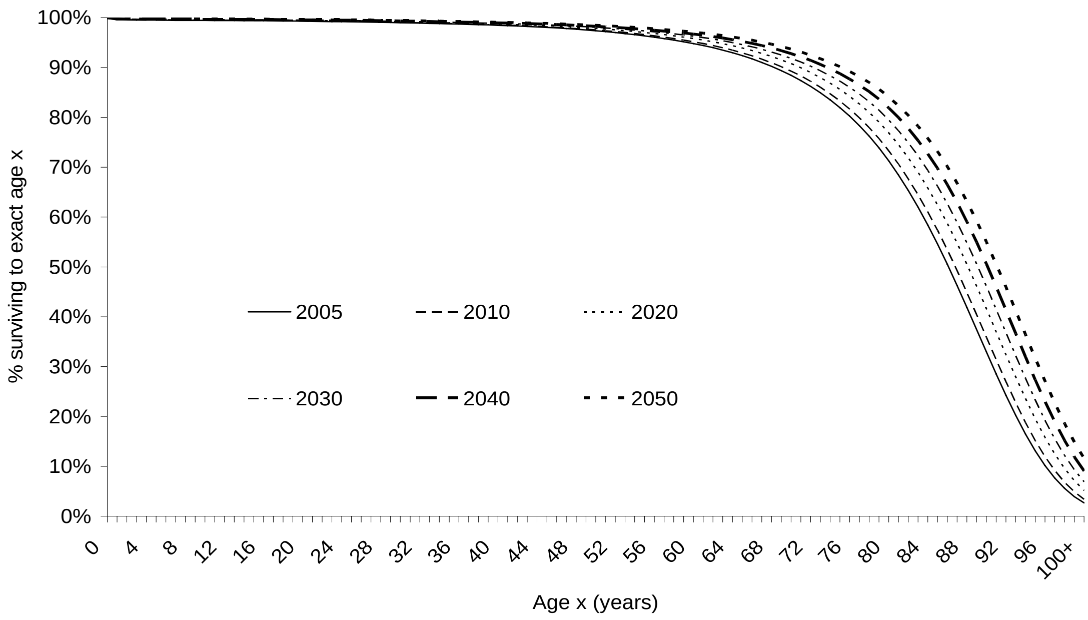
Figures 2.29 and 2.30 display projected survivor functions for males and females for a number of selected time periods: 2005, 2010, 2020, 2030 , 2040 and 2050. The two Figures under consideration show that the areas below the survivor functions are expected to continue to increase in the future, indicating higher shares of survivors at all ages. Once again, female survivor functions tend to lie above male survivor functions for all the periods under consideration, suggesting that females are projected to have higher survivor rates.

Figure 2.29: Projected survivor function – males, 2005-2050



Source: Author's calculation from Istat mortality projections

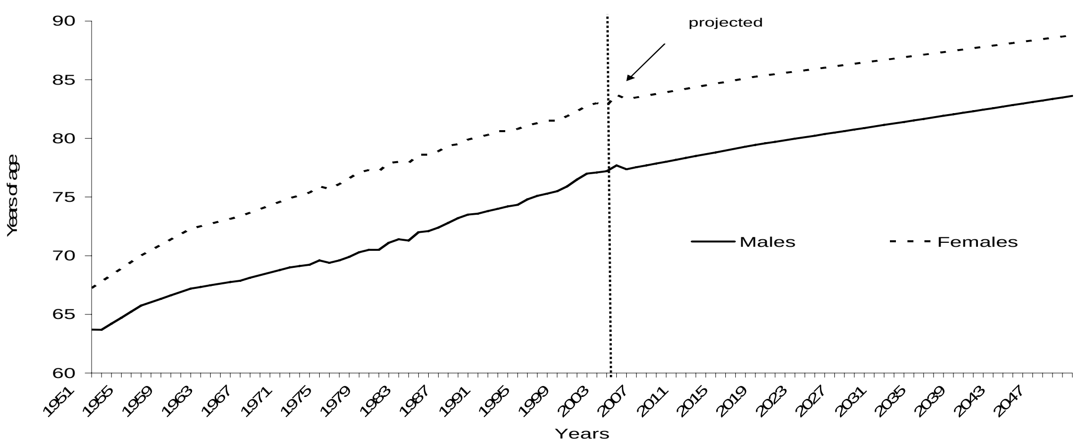
Figure 2.30: Projected survivor function – females, 2005-2050



Source: Author's calculation from Istat mortality projections

Figure 2.31 below displays estimated life expectancy at birth for both males and females from 1951 to 2004 and projected life expectancy from 2005 to 2050. The Figure shows that life expectancy at birth is projected to continue to increase for both males and females, although at a slower rate than in the past. It is projected to increase from 77.4 in 2005 to 81.0 in 2030 and finally to 83.6 in 2050 for males, compared to 83.3, 86.6 and 88.8, respectively, for females.

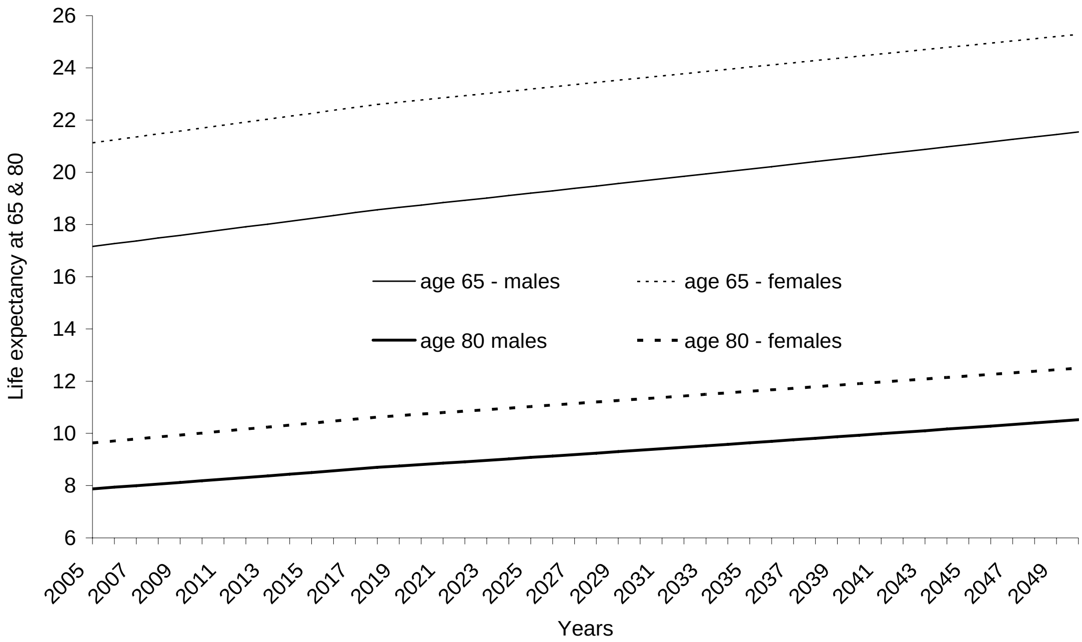
Figure 2.31: Estimated and projected life expectancy at birth, 2005-2050



Source: Istat

Figures 2.32 display projected life expectancies at ages 65 and 80 for males and females, respectively. The Figure shows that male life expectancy at 65 is projected to increase from 17.1 in 2005 to 19.7 in 2030 and finally to 21.5 in 2050, compared to 21.1, 23.6 and 25.3, respectively for females. Similarly, male life expectancy at 80 is projected to increase from 7.9 in 2005 to 9.4 in 2030 and finally to 10.5 in 2050, compared to 9.6, 11.3 and 12.5, respectively for females.

Figure 2.32: Projected life expectancy at ages 65 and 80, 2005-2050



Source: Istat

Historical immigration and emigration data from 1980 to 2004 are used to construct origin-destination matrices. Italy includes twenty regions (eight in the North, four in the Centre, six in the South and Sicily and Sardinia). In Istat migration computations "the rest of the world" is taken as the Italian 21st region. The number of emigrants is then computed as follows:

$$ {}^{w}_{t}E_{x}^{\,i} = {}_{t}P_{x}^{\,i} \cdot {}_{t}\lambda_{x}^{\,i} \cdot {}_{t}em_{x}^{\,iw} \quad \left\{ \begin{array}{|l|} {}^{w}_{t}E_{x}^{\,i,p1} \\ {}^{w}_{t}E_{x}^{\,i,p2} \\ \cdots\cdots\cdots \\ {}^{w}_{t}E_{x}^{\,i,pn} \end{array} \right. \qquad [2.9] $$

where:

${}^{w}{}_{t}E_x{}^{i}$ = number of emigrants aged x at 1 January of year t emigrating from region i to the rest of the world (w)

${}_{t}P_x{}^{i} \cdot {}_{t}\lambda_x{}^{i}$ = people aged x exposed to the risk of emigrating from region i

${}_{t}em_x{}^{iw}$ = probability of emigrating from region i to the rest of the world (w), given as the sum of the probabilities to emigrate from region i to country 1 (p1), country 2 (p2), …, country n (pn).

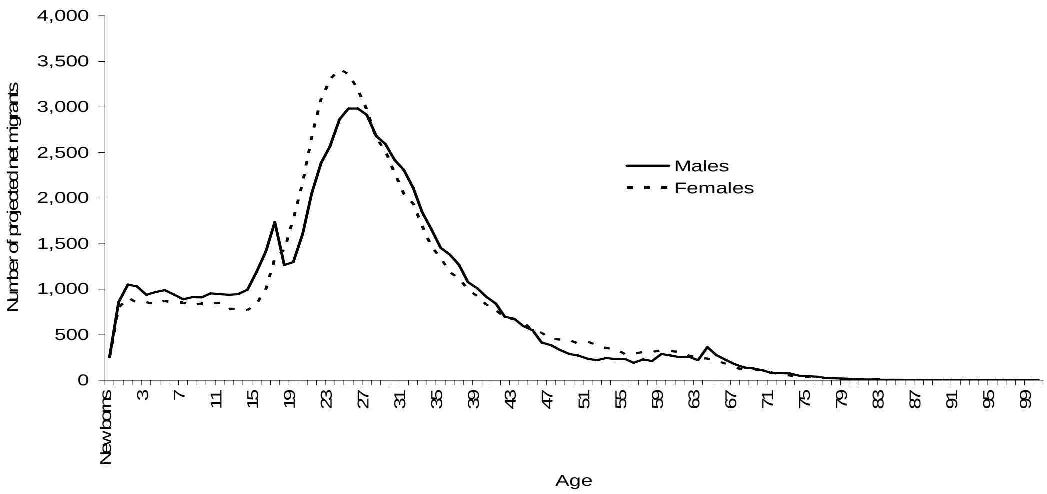
The number of international immigrants is estimated using the *TRAMO-SEATS technique* (time series regression with arima noise, missing observation and outliers – signal extraction in arima time series). The total number of immigrants is estimated as:

$$ {}^{w}{}_{t}I_x{}^{i} = \text{stock} \begin{cases} \boxed{\begin{array}{l} {}^{w}{}_{t}I_x{}^{i,p1} \\ {}^{w}{}_{t}I_x{}^{i,p2} \\ \cdots\cdots \\ {}^{w}{}_{t}I_x{}^{i,pn} \end{array}} \end{cases} \qquad [2.10] $$

where ${}^{w}{}_{t}I_x{}^{i}$ is the number of immigrants aged x at 1 January of year t immigrating to region i from the rest of the world (w), given as the sum of the probabilities to immigrate to region i from country 1 (p1), country 2 (p2), …, country n (pn).

Istat estimates a constant net migration of 150,000 net migrants (74,500 females and 75,500 males) per year for all the years of the projection period. This is shown in Figure 2.33, which displays the annual number of net migrants by sex and single year of age. Clearly, most net migrants are expected to be relatively young. The value of 150,000 is based on the average net migration figure registered in Italy in the decade 1993-2003. Also, Istat also assumes that the 150,000 annual net migrants will not relocate to another country and will not return to their home countries after migrating to Italy

Figure 2.33: Annual projected number of net migrants by single year of age groups, 2005-2050

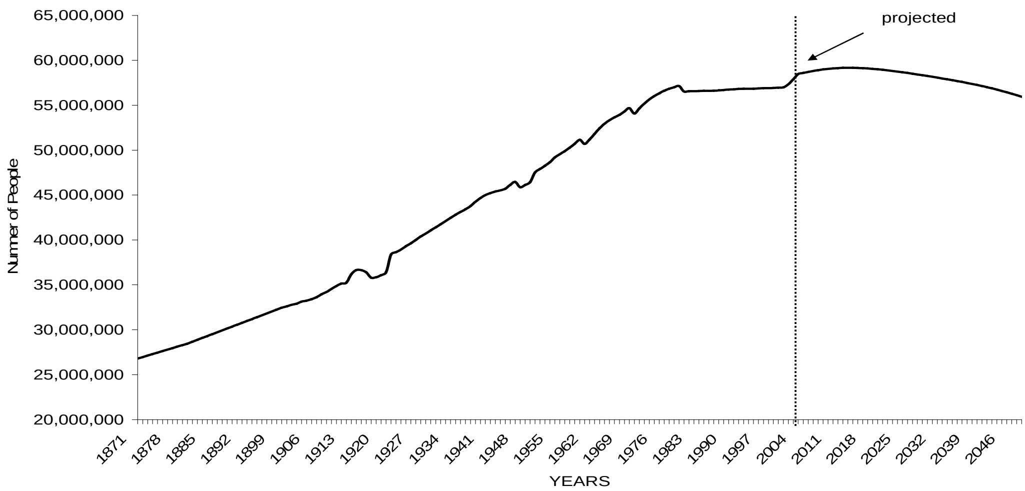


Source: Istat

2.3.2 Istat principal population projections: the results

Figure 2.34 below displays estimated and projected Italian population from 1871 to 2050. Data refer to population at the end of the calendar year (31 December). Italian population is projected to slightly increase until 2015 (increasing from 58,594,273 in 2005 to in 59,161,682 in 2015) and to decrease thereafter, reaching 55,757,363 in 2050.

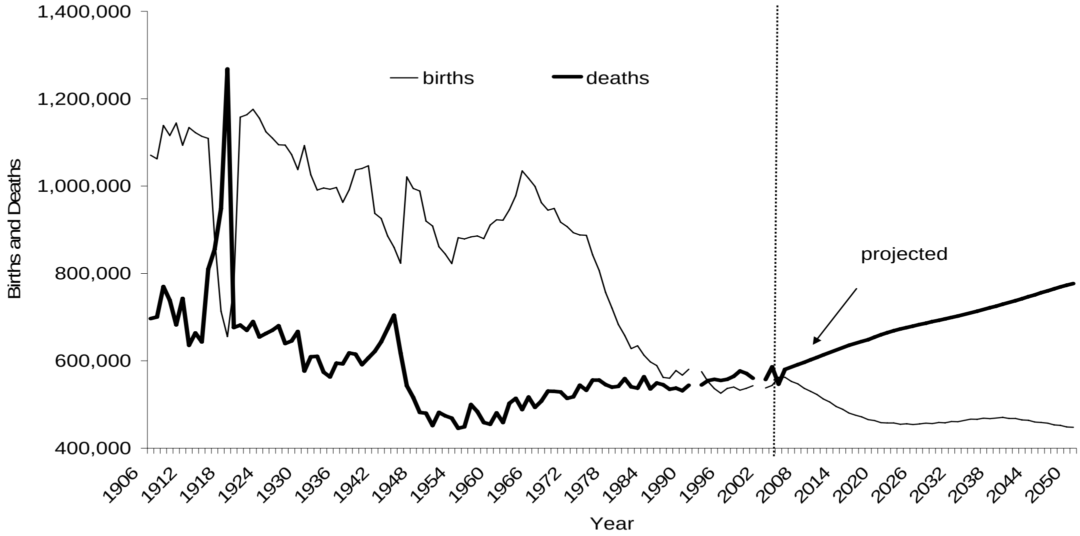
Figure 2.34: Estimated and projected Italian population, 1871-2050



Source: Istat

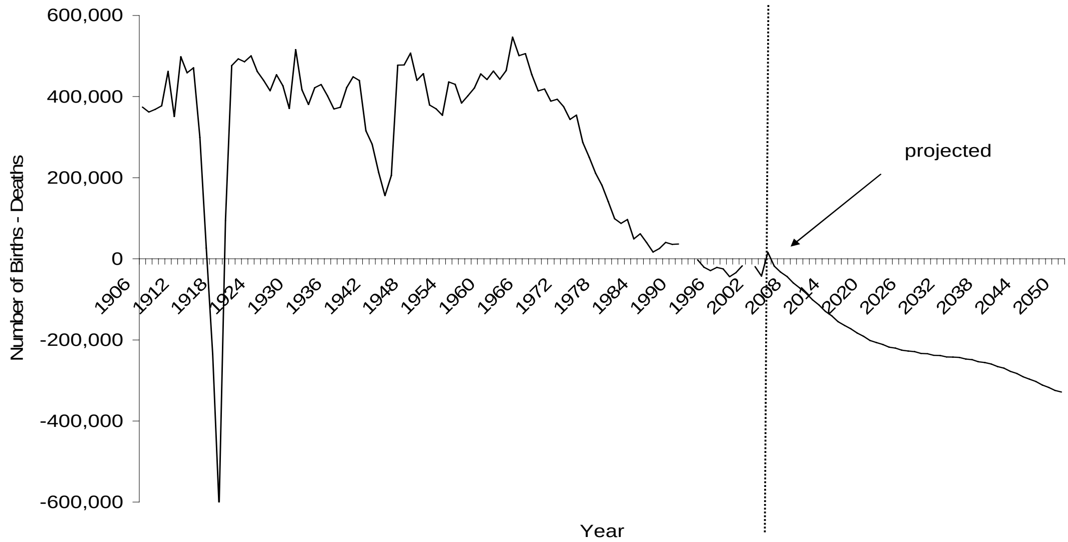
Figures 2.35 and 2.36 below show that the natural increase is projected to be negative for all the years of the projection period (due, once again, to low fertility and decreasing mortality). More importantly, it is projected to widen significantly: according to Istat projections, there will be 84,854 more deaths than births in Italy in 2010, compared to 237,835 in 2030 and 328,776 in 2050.

Figure 2.35: Estimated and projected births and deaths, 1906-2050



Source: Istat

Figure 2.36: Estimated and projected natural increase, 1906-2050



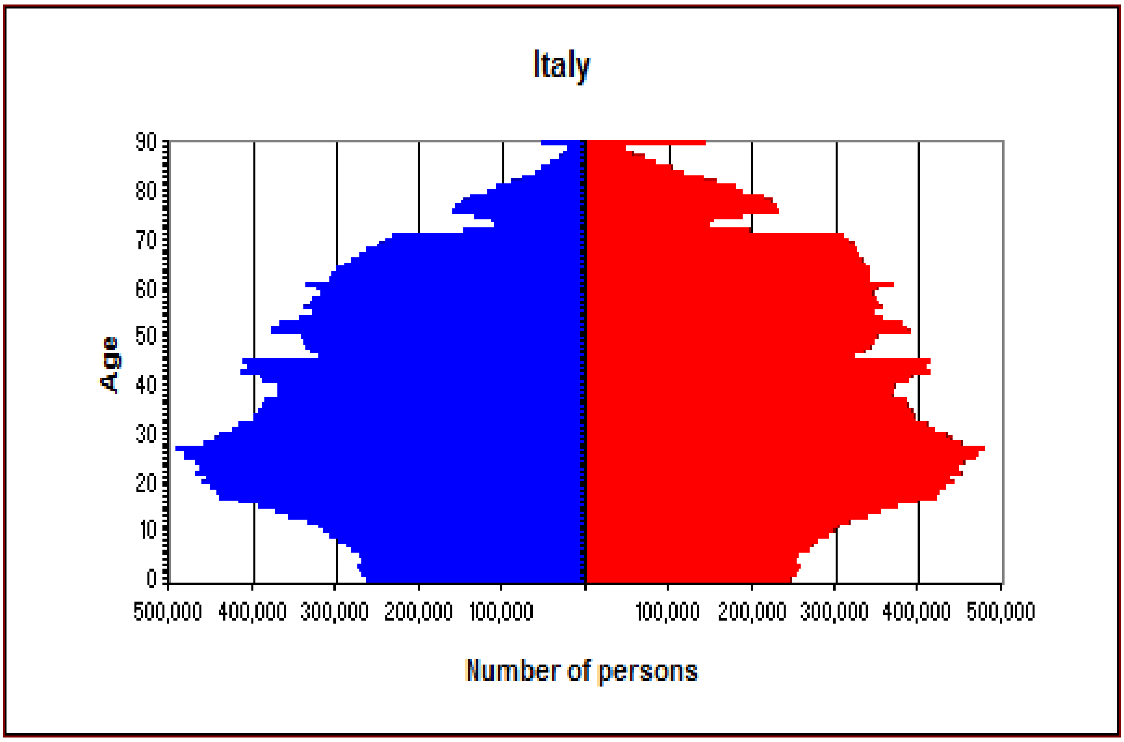
Source: Istat

Figures 2.37 to 2.40 below show Italian estimated and projected population pyramids for 1992, 2005, 2030 and 2050. Population pyramids are a graphical representation of the age and sex structure of the population. Each bar represents a particular single year of age and the length of the bar shows the absolute size of the population of that age (men on the left, women on the right). Pyramids give insight into trends in population over time.

The 1992 population pyramid (Figure 2.37) shows the “bulge” of the “baby boomers” of the 1960s in their late twenties or early thirties. The baby boomers move to slightly older age bands (late thirties or early forties) in the 2005 pyramid (Figure 2.38). The base of both pyramids is relatively narrow reflecting low fertility levels.

The 2030 and 2050 projected pyramids (Figures 2.38 and 2.39) show large bands at older ages (at the top of the pyramid) and narrow bases. The band depicting people aged 90+ becomes increasingly larger and exceeds any other band in the 2050 pyramid.

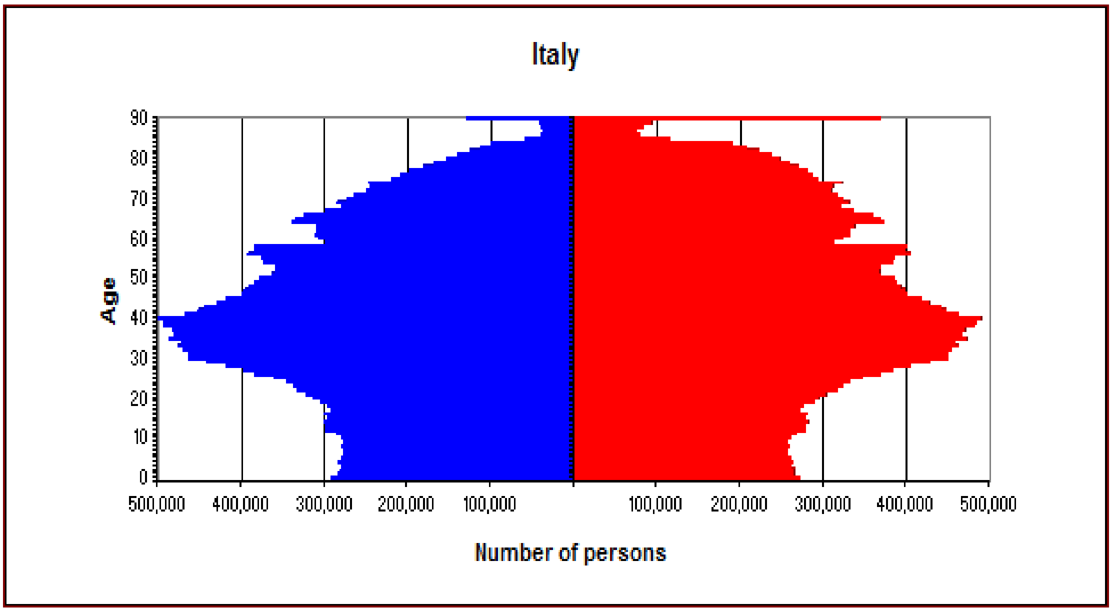
Figure 2.37: Italian population pyramid, 1992



Source: Author’s calculation from Istat data

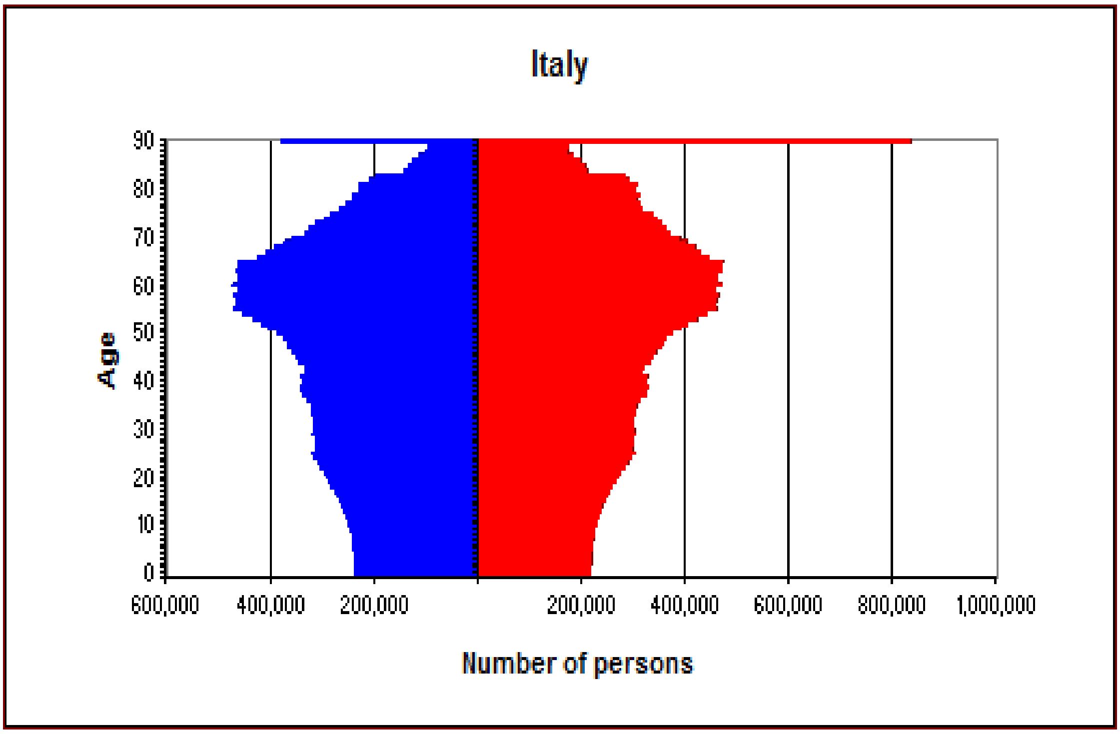
Note: men are represented in blue (left), women in red (right)

Figure 2.38: Italian population pyramid, 2005



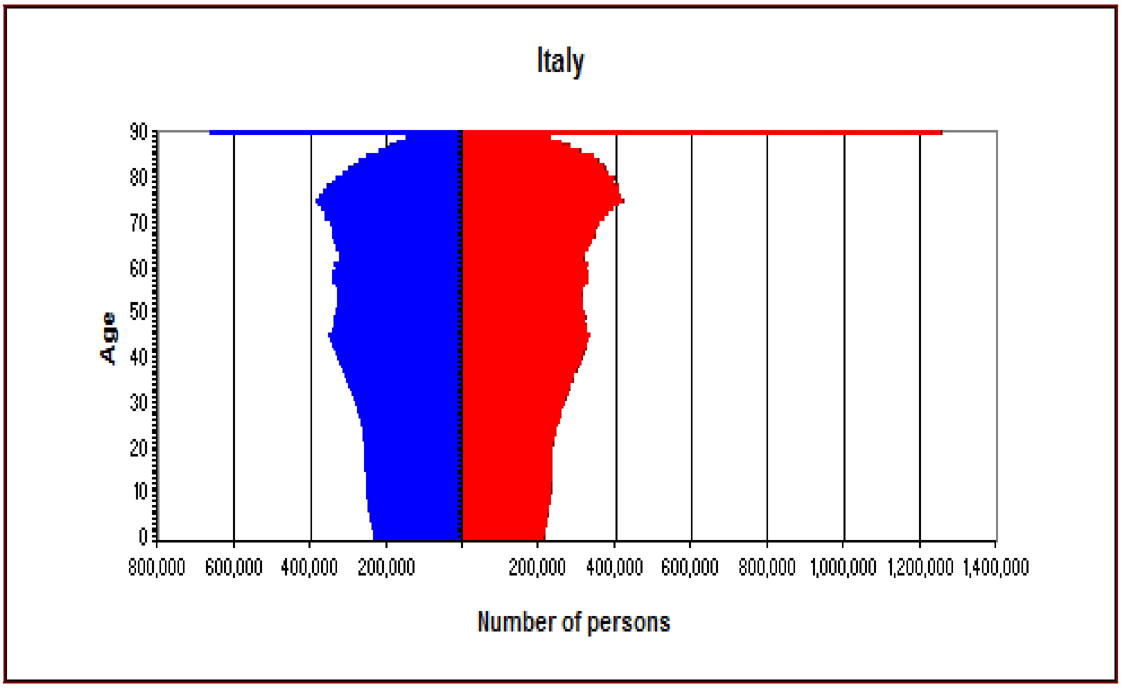
Source: Author's calculation from Istat data
Note: men are represented in blue (left), women in red (right)

Figure 2.39: Italian population pyramid, 2030



Source: Author's calculation from Istat data
Note: men are represented in blue (left), women in red (right)

Figure 2.40: Italian population pyramid, 2050

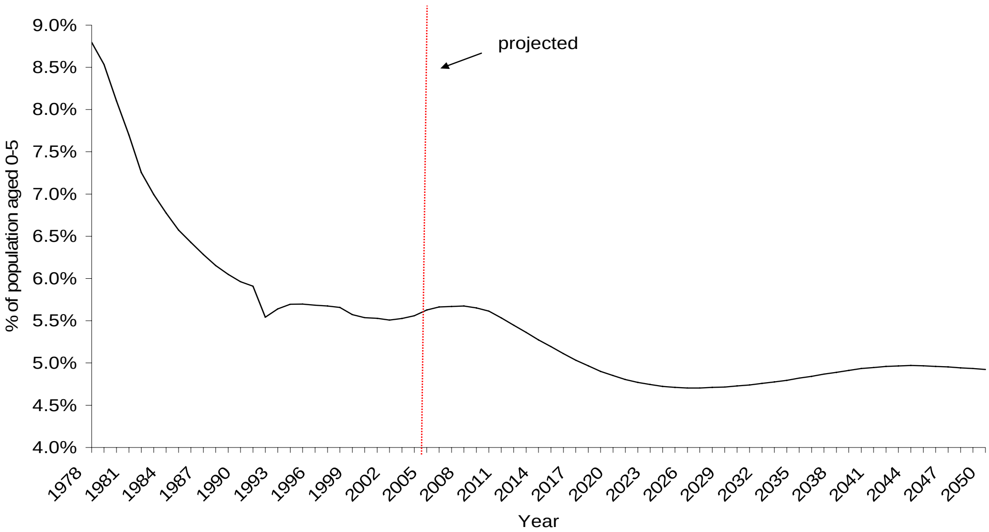


Source: Author's calculation from Istat data
Note: men are represented in blue, women in red

Figures 2.41 to 2.45 display historical and projected population shares of different age groups (i.e. pre-school group (aged 0-5); school age group (aged 6-15); working age group (aged 20-64), 65+ and 85+) from 1978 to 2050 (at 1 January).

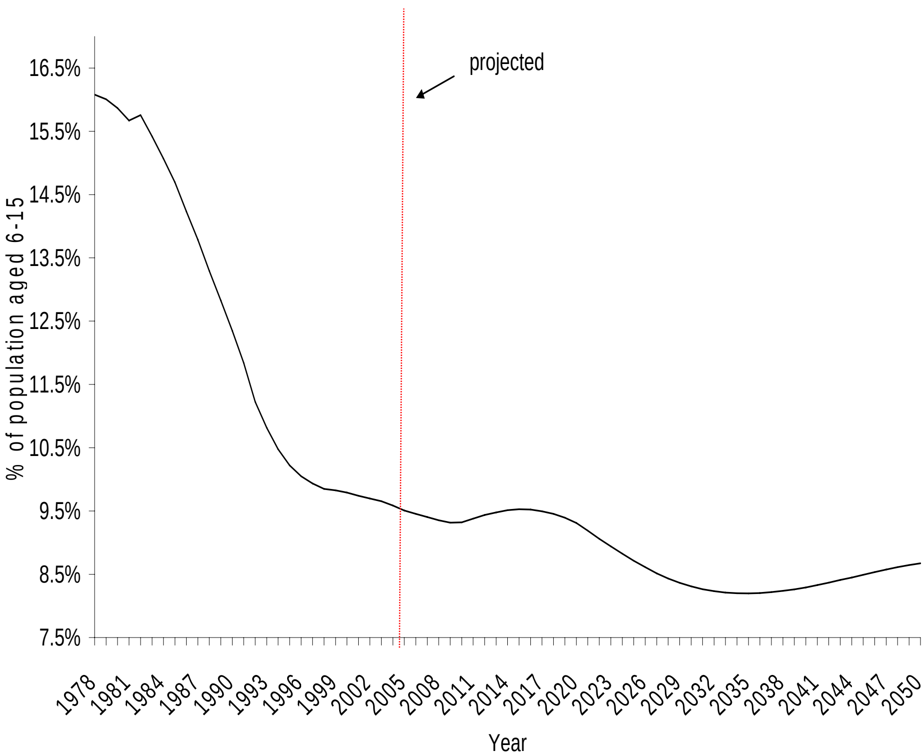
The Figures show that the population shares of the young age groups are projected to decrease: the population share of the pre-school group is estimated to decline from 8.8% in 1978 to 4.9% in 2050 and that of the school group is estimated to decrease from 16.1% in 1978 to 8.7% in 2050. A sharp decrease is also projected to affect the working age population, whose share is estimated to fall from 61.4% in 2004 to 49.3% in 2050. Conversely, the population shares of those aged 65+ and 85+ are projected to increase sharply, reaching 33.6% and 7.8%, respectively, in 2050.

Figure 2.41: Population share aged 0-5, 1978-2050



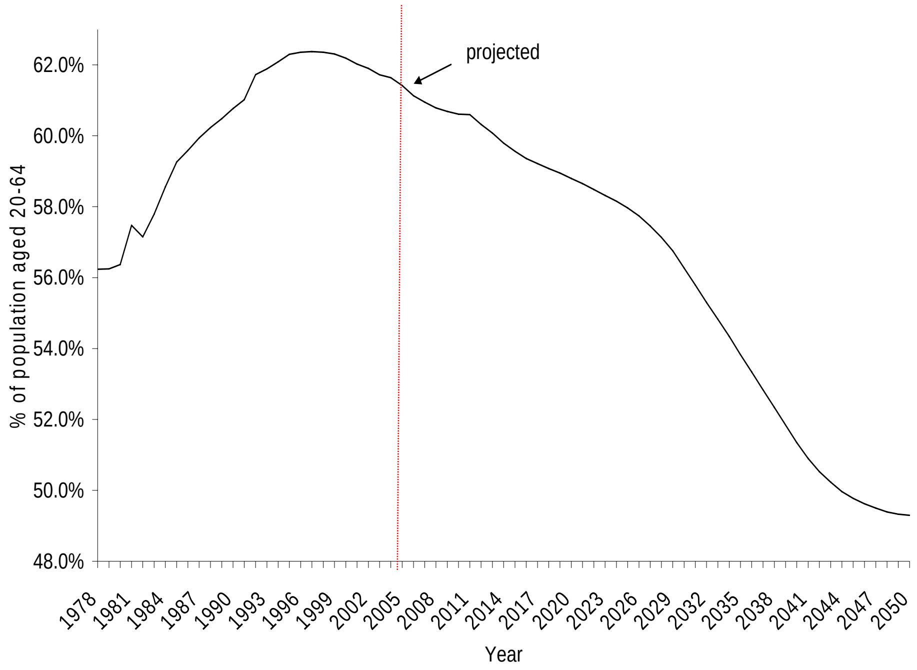
Source: Istat

Figure 2.42: Population share aged 6-15, 1978-2050



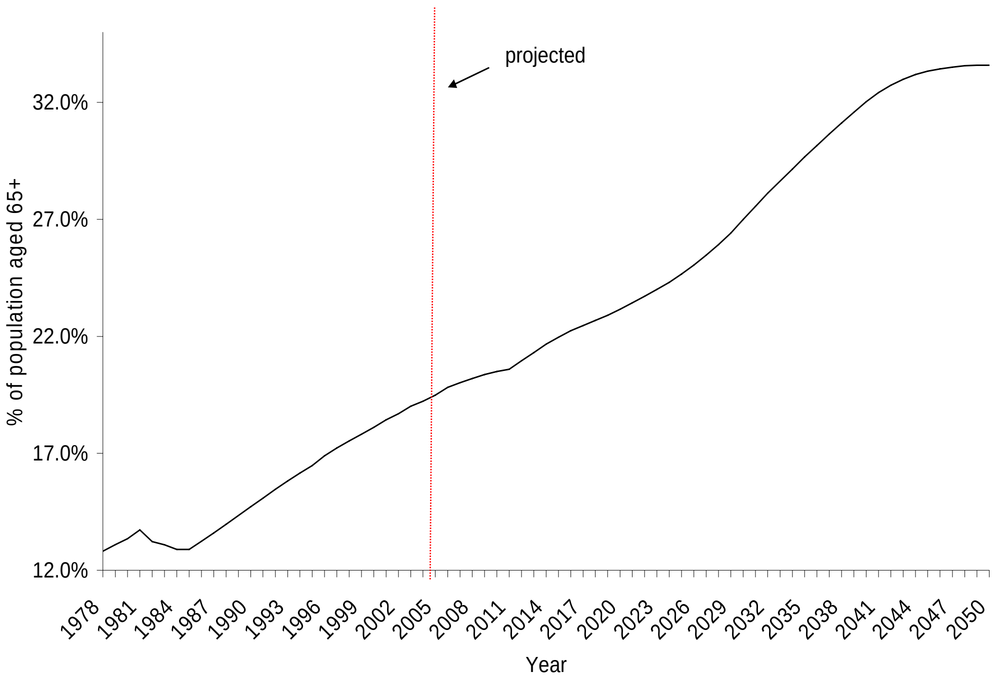
Source: Istat

Figure 2.43: Population share aged 20-64, 1978-2050



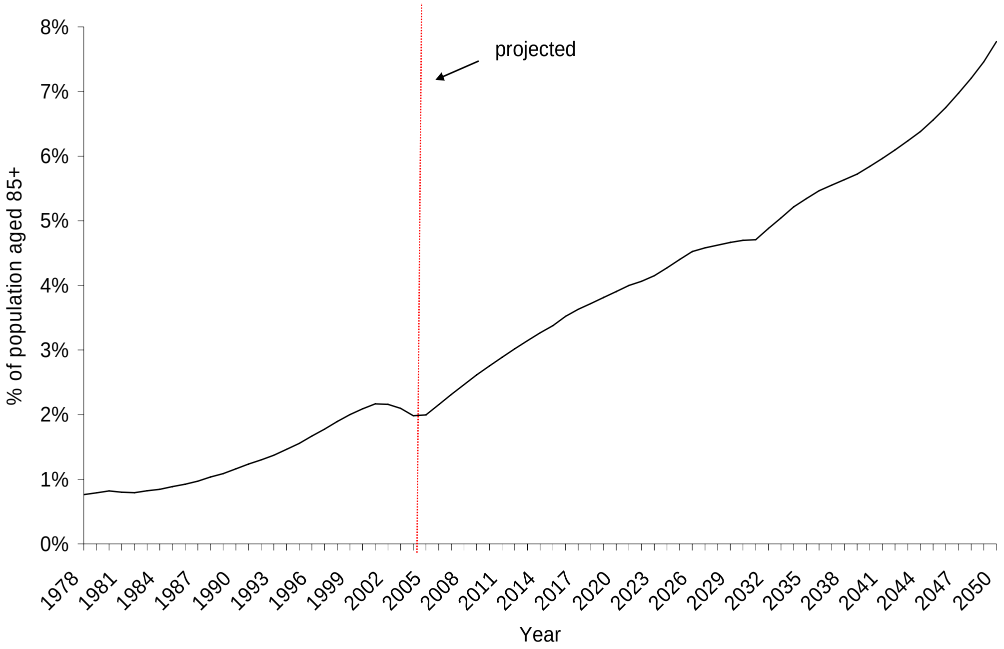
Source: Istat

Figure 2.44: Population share aged 65+, 1978-2050



Source: Istat

Figure 2.45: Population share aged 85+, 1978-2050



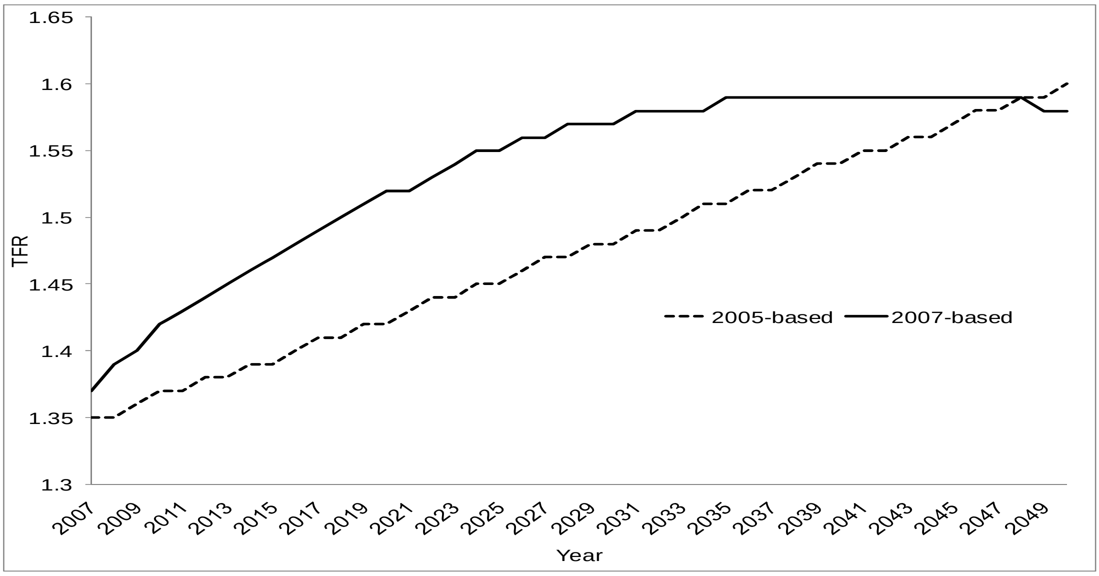
Source: Istat

2.3.3 Istat 2007-based population projections

As specified in Section 3.1, Istat latest population projections were carried out in 2008, are 2007-based and refer to the period 2007–2051. In the 2007-based projections, Istat estimates that:

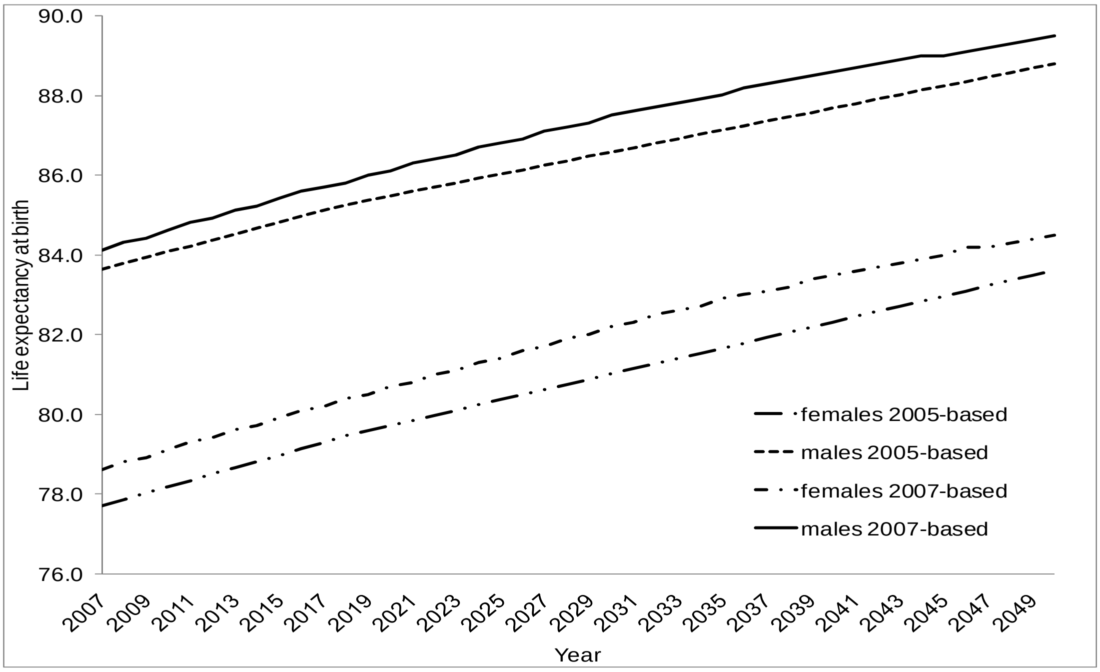
- The TFR will increase to 1.58 by 2050 (as opposed to 1.60 in the 2005-based projections). However, fertility will increase at a faster rate in the first years of the projection period and stabilise afterwards, as shown in Figure 2.46;
- Life expectancy at birth will reach 84.5 for males and 89.5 for females, as opposed to 83.6 and 88.8 in the 2005-based projections, as shown in Figure 2.47; and
- Migration will stabilise at 196,000 net migrants per year, as opposed to 150,000 in the 2005-based projections, as shown in Figure 2.48.

Figure 2.46: Istat fertility assumptions in 2005- and 2007-based projections



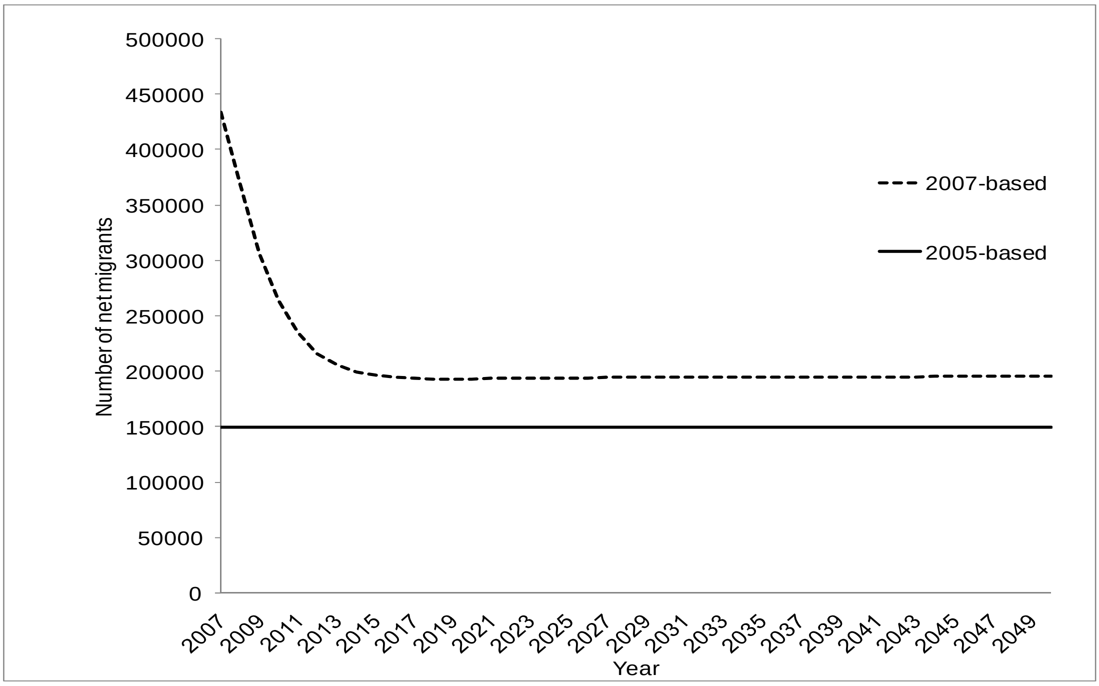
Source: Istat

Figure 2.47: Istat life expectancy at birth assumptions in 2005- and 2007-based projections



Source: Istat

Figure 2.48: Istat net migration assumptions in 2005- and 2007-based projections



Source: Istat

According to the 2007-based projections, the share of people aged 0 to 14 will decrease to 12.9% in 2050, the share of people aged 15 to 64 will decrease to 54.1% and the share of people aged 65+ will increase to 33%. These compare to 12.7%, 53.7% and 33.6%, respectively, in the 2005-based projections. Hence, also according to the 2007-based projections - which are based on higher migration and fertility assumptions - Italian population will age significantly in the next decades.

2.4 Conclusions

With the single exception of the First World War period, the natural increase in population has been historically positive in Italy. However, since the early 1990s the number of deaths has exceeded the number of births. After reaching a peak of 2.7 children per woman in childbearing age in 1964, fertility has been generally decreasing. A similar phenomenon has occurred in many other industrialised countries, but it has been particularly strong in Italy. Fertility slightly increased in recent years, but only to a small extent. The total fertility rate was 1.41 in 2008, around half of the peak it reached in 1964. Also, there has been a shift in the age at which women have children: age specific fertility rates peaked at 24-25 years of age for women born in the 1940s and at 30 years of age for women born in the 1970s. Similarly, there are less and less women having two or more children. The postponement of age at which women have their first child and the decrease in the number of women having two or more children are the main two causes of decreasing fertility trends in Italy.

Also mortality has decreased, resulting in longer life expectancy at birth. Life expectancy has increased in many other industrialised countries, but once again this phenomenon has been particularly strong in Italy. Other mortality measures, such as age-specific death rates, survivor functions and life expectancy at older ages (65 and 85) confirm a substantial decrease in mortality at all ages. Italy has also turned from a "typical emigration country" to a "typical immigration country", with the early 1970s being the turning point. In the first years of the new millennium, immigration has increased significantly, with the total number of immigrants peaking at around 600,000 in 2003.

The current demographic situation in Italy can be described as a population with below replacement level fertility, gradually decreasing mortality and sharply increasing levels of net migration. What will happen to the size and age structures of the population if current trends continue? According to Istat penultimate principal population projections, fertility will linearly increase (the TFR is projected to reach 1.6 by 2050); mortality will gradually decrease (life expectancy at birth is projected to reach 83.6 for males and 88.8 for females by 2050); and net migration will stabilise at 150,000 net migrants per year. If these assumptions prove to be correct, Italian population will age significantly: the population share of the younger age groups will decrease substantially whereas the population share of the older age groups will increase. Also the working age population is projected to decrease significantly, meaning there will be less people of working age available to work in the labour market.

Should the Italian Government be concerned about growing numbers of older people and a declining labour force? There is well established and growing literature concerned with the negative economic consequences of population decline and population ageing (see for example, Borsch-Supan (2003); Weil (1997); Wright (2002a); Wright and Lisenkova (2007) and Lisenkova *et al* (2008)). For example, as the 65+ age group grows the demand for state-supplied health and personal care, residential services, housing, pensions and other services consumed by the elderly increases. Unfortunately at the same time, the base expected to pay for this increase – essentially people of working age – will become progressively smaller both in absolute numbers and in relative population share. It is not difficult to conclude that such a situation of increasing imbalance is not sustainable indefinitely into the future.

It is however important to remember that not all effects of population ageing and population decline are negative. A smaller population puts less pressure on the environment. Also the number of people in the younger age groups declines. This suggests a fall in the number of children of school age and associated reductions in expenditure on primary and secondary schooling (at least in relative terms). Older workers are an important source of volunteer labour and rate of volunteering is on the rise. As the population ages, and if past trends in participation continue, the amount of volunteer labour contributed to the economy will increase sharply. Finally population ageing and a declining labour force provides incentives for governments and employers to more seriously invest in the education and training of the work force which should increase labour productivity.

But could the phenomenon of population ageing be counteracted if future levels of fertility and migration were higher than what assumed by Istat? This is investigated in the next chapter.

Chapter 3 Alternative demographic futures

3.1 Introduction

Chapter 2 concluded that, according to Istat 2005- and 2007-based population projections, Italian population and labour force will age significantly in the next four and a half decades.

Chapter 3 has two main sections. The first shows how Istat 2005-based population projections were replicated accurately using Popgroup, a demographic software developed at the Cathie Marsh Centre for Census and Survey Research, based at the University of Manchester. Both Istat and Popgroup use the cohort component method, but there are some underlying methodological differences. Section 3.2 explains how these differences were overcome. Section 3.3 explains in details how Istat projections were replicated closely using Popgroup. The software will be used again in the dissertation in order to explore alternative population projections scenarios (Sections 3.4 and 3.5) and carry out simulations of the future average wage of Italian males (Chapter 5). Hence, it is crucial to demonstrate that the software is able to carry out population projections accurately and, as importantly, that I am able to use it correctly.

Chapter 3 then explores alternative population projection scenarios, based on different fertility and migration assumptions. Alternative population projections are carried out using Popgroup. Istat population projections are restrictive giving the range of net migration and fertility assumptions that they employ. As explained in Chapter 2, Istat assumes that the TFR will increase to 1.60 by 2050 and 150,000 net migrants will move to Italy in each year of the projection period. But what would happen if fertility and migration were (significantly) higher than what projected by Istat? Would higher levels of migration and fertility be sufficient to decelerate or counteract the phenomena of population ageing and labour force ageing and decline in Italy[14]?

Alternative migration scenarios are investigated in Section 3.4. Two different scenarios are investigated. Scenario 1 assumes a positive and increasing inflow of "young migrants with children", while Scenario 2 assumes positive and increasing inflow of "young migrants without children". These are compared with a zero net migration scenario (natural change only). The zero net migration scenario is a useful 'baseline' since it provides information on how the size and age structure of the population will be changed by fertility and mortality alone. However, this does not mean that I expect zero net migration in the future. The assumptions relating to fertility and mortality are identical to those employed in Istat 2005-based principal population projections.

Alternative fertility scenarios are investigated in Section 3.5. It is assumed that fertility increases at a higher rate than in the principal scenario (Scenario 3). The assumptions relating to mortality and migration are identical to those employed in Istat 2005-based principal population projections. Section 3.5.1 investigates the impact of fertility levels in the context of zero net migration (Scenario 4). This is an important exercise to understand by how much *fertility alone* would need to increase to counteract the phenomenon of population ageing in Italy.

Paragraph 3.6 concludes.

3.2 Replication of Istat population projections

This section explains how Istat principal population projections from 1 January 2005 to 1 January 2050 were replicated using Popgroup, Section 3.2.1 summarises the detailed demographic data used to replicate Istat population projections. Section 3.2.2 explains, through some worked numerical examples, how Popgroup works.

[14] Different mortality assumptions are not investigated: people can decide if / when to migrate or have children, but not if / when to die. Also, policy makers can put into place policies aimed at increasing fertility or migration, but – for obvious moral reasons - they can not address mortality in the same way.

Section 3.3.3 investigates the methodological differences between the cohort component methods employed by Popgroup and Istat and explains how these differences were overcome.

3.2.1. The demographic data

Detailed demographic data are needed to carry out population projections. In April 2007, I was kindly provided the following data by Istat demographic team:

- Population by single year of age and sex for the base year (2005) for ages 0 to 90+;
- Sex ratio at birth - the number of male births per one female birth (106 males for every 100 females);
- ASFRs for women aged 15 to 49 for the base year and all the years of the projection period;
- Probability of dying by single year of age and sex (ASMRs) from birth to age 90+ for the base year and all the years of the projection period;
- Total number of births for all years of the projection period (endogenous and depending on the assumed ASFRs);
- Number of deaths by sex and single year of age for all years of the projection period (endogenous and depending on the assumed ASMRs);
- Number of net migrants by sex and single year of age for all years of the projection period.

The data were entered in Popgroup and used to replicate Istat population projections.

3.2.2. Entering the demographic data in Popgroup

Popgroup uses the *cohort component model*. Users need to enter past information (which can simply date back to the base year) and future assumptions on the three main components of population change: fertility; mortality; and migration. Users need to enter some *mandatory data*, which are as follows:

- population by single year of age (from 0 to 90+) and sex for the base year;
- single-year age specific fertility rates (ASFRs) for women aged 15 to 49 for the base year;
- sex ratio at birth; and
- age specific mortality rates (ASMRs) by single year of age (from new born babies to 90+) and sex for the base year.

A worked numerical example using Istat data is provided below. Figures 3.1 and 3.2 show the ASFRs of women aged 15 to 49 and the ASMRs of men aged up to 50 by single year of age for the base year (2005). ASMRs were also entered for men aged more than 50 and for women but these are not reported due to space constraints. These data are mandatory.

Figure 3.1: Example of Popgroup mandatory fertility data for the base year

Population Estimates and Forecasts **Italy Istat**

Fertility *Age schedule of fertility rates, boys per thousand girls, and mixed parentage table*

Options VALIDATE

Population Group ……………………………..

	Italia
ASFR	
Boys/1000 girls	
Mixed parentage births	

Double click any population group/rate for which you will insert below values different from the standard

Data **Age specific fertility rates (per 1,000 women)**

Population Group ……………………………..

	Age	*Standard*	Italia
TFR		*1.34*	
female	15	0.1	
female	16	2.5	
female	17	5.4	
female	18	9.1	
female	19	14.3	
female	20	19.1	
female	21	24.6	
female	22	30.9	
female	23	37.9	
female	24	46.1	
female	25	54.2	
female	26	64.6	
female	27	74.5	
female	28	83.4	
female	29	90.0	
female	30	97.1	
female	31	98.6	
female	32	96.7	
female	33	91.1	
female	34	83.1	
female	35	74.3	
female	36	63.4	
female	37	52.0	
female	38	40.4	
female	39	30.2	
female	40	21.9	
female	41	14.7	
female	42	9.0	
female	43	5.2	
female	44	2.8	
female	45	1.4	
female	46	0.7	
female	47	0.3	
female	48	0.2	
female	49	0.3	

Source: Author's computations in Popgroup

Figure 3.2: Example of Popgroup mandatory mortality data for the base year

Population Estimates and Forecasts **Italy Istat**

Mortality *Age-sex schedule of mortality rates, per thousand population*

VALIDATE

Options **Population Group ....**

Italia

ASMR

Double click the cell under any population group for which you will insert below values diffe

Data

Age specific mortality rates (per 1,000 population)

Population Group ....

Sex	Age	*Standard*	*Italia*
male	Newborn	4.6	
male	0	0.4	
male	1	0.2	
male	2	0.2	
male	3	0.1	
male	4	0.1	
male	5	0.1	
male	6	0.1	
male	7	0.1	
male	8	0.1	
male	9	0.1	
male	10	0.1	
male	11	0.1	
male	12	0.2	
male	13	0.2	
male	14	0.3	
male	15	0.5	
male	16	0.6	
male	17	0.8	
male	18	0.9	
male	19	0.9	
male	20	1.0	
male	21	1.0	
male	22	1.0	
male	23	1.0	
male	24	1.0	
male	25	1.0	
male	26	1.0	
male	27	1.0	
male	28	1.1	
male	29	1.1	
male	30	1.1	
male	31	1.1	
male	32	1.2	
male	33	1.2	
male	34	1.2	
male	35	1.2	
male	36	1.3	
male	37	1.3	
male	38	1.3	
male	39	1.3	
male	40	1.4	
male	41	1.4	
male	42	1.5	
male	43	1.6	
male	44	1.8	
male	45	1.9	
male	46	2.1	
male	47	2.3	
male	48	2.5	
male	49	2.7	
male	50	3.0	

Source: Author's computations in Popgroup

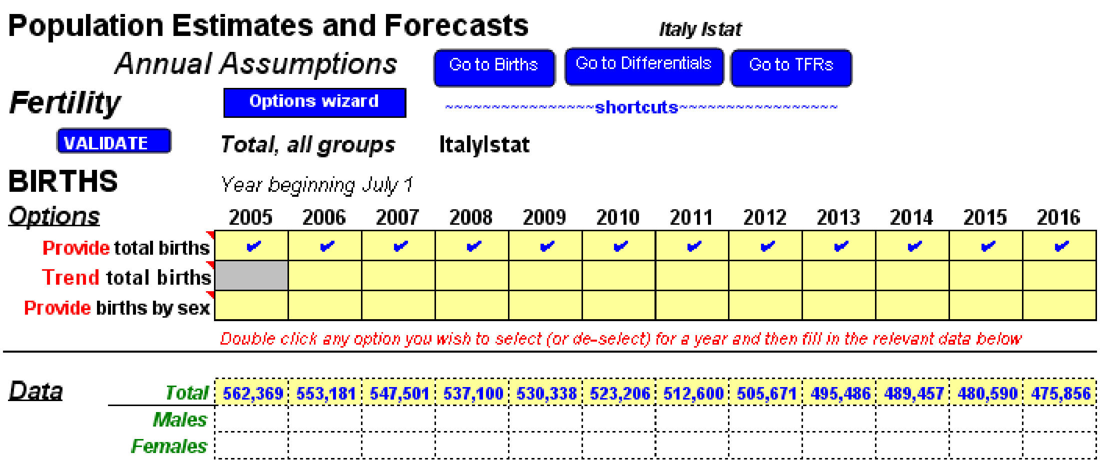
Users can also enter age specific immigration and emigration rates for the base year, by single year of age (from new born babies to 90+) and sex. According to Istat assumptions, net migration is positive at each year of age (see Figure 2.33). Hence, net migration can be treated as immigration and emigration can be set to zero. Age specific inmigration rates for the base year were computed as the ratio of the number of net migrants aged x to the population aged x (i.e. ($NetMigrants_x$) / P_x). P_x is given by the number of births for new born babies.

Users can then enter data for all the years of the projection period. Fertility, mortality and migration assumptions can be entered through either counts (i) and / or differentials (ii).

If users choose (i), they can enter: births *counts*, either total or by sex; and deaths, immigration and emigration *counts*, either total or by sex and five years of age (from 0-4 to 85+). This is clarified in the example below. In Figures 3.3, the total number of births for the period 2005 to 2016 is entered. In Figure 3.4, the number of deaths by sex and five year of age for the period 2005 to 2016 is entered.

If counts are entered, the mandatory rates of Figures 3.1 and 3.2 are used only to divide the counts to single years of age. For example, Figure 3.4 shows that according to the population projection of this worked example, 4,642 males aged between 45 and 49 are projected to die in 2010. The mandatory ASMRs of Figure 3.2 (for ages 45, 46, 47, 48 and 49) are simply used divide the 4,642 deaths to single years of age.

Figure 3.3: Example of Popgroup birth counts



Population Estimates and Forecasts — *Italy Istat*

Annual Assumptions — Go to Births | Go to Differentials | Go to TFRs

Fertility — Options wizard — ~~~~~~~~~~~~~~~~shortcuts~~~~~~~~~~~~~~~~

VALIDATE — *Total, all groups* — ItalyIstat

BIRTHS — *Year beginning July 1*

Options	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Provide total births	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Trend total births												
Provide births by sex												

Double click any option you wish to select (or de-select) for a year and then fill in the relevant data below

Data	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	562,369	553,181	547,501	537,100	530,338	523,206	512,600	505,671	495,486	489,457	480,590	475,856
Males												
Females												

Source: Author's computations in Popgroup

Figure 3.4: Example of Popgroup death counts

Population Estimates and Forecasts **Italy Istat**

Annual Assumptions Go to Deaths Go to Differentials Go to SMRs

Mortality Options wizard ~~~~~~~~~~~~~~~shortcuts~~~~~~~~~~~~~~~

VALIDATE ***Total, all groups*** **ItalyIstat**

DEATHS *Year beginning July 1*

Options		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Provide total deaths													
Trend total deaths													
Provide age-sex dths		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Double click any option you wish to select (or de-select) for a year and then fill in the relevant data below

Data

	Total	580,471	585,794	591,260	596,563	602,556	608,060	613,615	619,152	624,900	630,218	635,603	640,165
Sex	**Age**												
male	0	1,459	1,419	1,386	1,344	1,310	1,277	1,236	1,203	1,164	1,134	1,099	1,073
male	1-4	173	168	164	158	152	145	137	130	123	117	111	105
male	5-9	144	140	135	131	128	125	121	118	114	110	105	100
male	10-14	290	281	272	261	254	248	244	240	236	233	230	226
male	15-19	1,102	1,091	1,090	1,092	1,080	1,067	1,046	1,026	1,005	992	986	985
male	20-24	1,631	1,596	1,559	1,522	1,504	1,491	1,488	1,493	1,501	1,489	1,475	1,454
male	25-29	2,079	1,990	1,917	1,860	1,805	1,764	1,730	1,693	1,656	1,639	1,627	1,626
male	30-34	2,729	2,699	2,637	2,561	2,476	2,366	2,263	2,178	2,112	2,048	2,000	1,959
male	35-39	3,154	3,106	3,064	3,028	2,991	2,946	2,896	2,812	2,715	2,608	2,479	2,359
male	40-44	3,541	3,573	3,589	3,576	3,540	3,457	3,369	3,286	3,218	3,144	3,063	2,981
male	45-49	4,566	4,547	4,553	4,558	4,598	4,642	4,661	4,654	4,623	4,551	4,421	4,288
male	50-54	7,118	6,941	6,879	6,840	6,814	6,777	6,751	6,752	6,773	6,827	6,892	6,927
male	55-59	12,649	12,971	12,506	12,035	11,545	11,256	11,019	10,943	10,931	10,911	10,888	10,886
male	60-64	19,451	18,363	18,572	18,866	19,294	19,672	20,234	19,564	18,925	18,208	17,825	17,525
male	65-69	30,701	30,741	30,589	30,032	29,019	27,763	26,317	26,726	27,293	27,978	28,581	29,412
male	70-74	41,178	40,438	39,862	39,757	39,963	40,207	40,362	40,176	39,542	38,252	36,687	34,874
male	75-79	50,422	51,171	51,477	51,265	51,277	51,269	50,546	49,968	50,070	50,467	50,957	51,339
male	80-84	52,370	52,879	53,448	54,164	54,659	55,124	56,308	56,875	56,945	57,176	57,443	57,015
male	85+	55,501	58,881	62,310	65,683	69,314	72,806	76,294	79,739	83,359	86,770	90,033	93,936
	All Males	######	######	######	######	######	######	######	######	######	######	######	######
Sex	**Age**												
female	0	1,211	1,178	1,152	1,117	1,090	1,062	1,029	1,002	970	945	917	896
female	1-4	176	174	171	166	161	154	147	141	135	129	124	118
female	5-9	127	125	123	121	119	118	116	113	110	107	103	99
female	10-14	171	166	161	156	152	149	148	146	144	143	142	140
female	15-19	306	302	300	298	293	288	280	273	266	261	259	257
female	20-24	412	400	387	373	366	359	354	352	351	345	339	331
female	25-29	713	679	650	627	605	588	574	558	542	533	525	521
female	30-34	1,072	1,054	1,024	989	950	902	858	820	791	762	739	720
female	35-39	1,450	1,420	1,392	1,368	1,346	1,319	1,291	1,250	1,202	1,150	1,089	1,030
female	40-44	2,054	2,078	2,087	2,083	2,065	2,021	1,974	1,930	1,894	1,859	1,820	1,778
female	45-49	2,905	2,915	2,934	2,958	3,000	3,048	3,078	3,090	3,081	3,049	2,985	2,912
female	50-54	4,157	4,088	4,069	4,065	4,074	4,067	4,075	4,100	4,131	4,185	4,253	4,288
female	55-59	6,387	6,560	6,337	6,125	5,890	5,767	5,662	5,630	5,620	5,620	5,612	5,613
female	60-64	9,371	8,832	8,891	8,998	9,173	9,343	9,605	9,285	8,978	8,624	8,449	8,283
female	65-69	15,751	15,722	15,584	15,285	14,750	14,068	13,258	13,361	13,534	13,793	14,068	14,452
female	70-74	25,518	24,784	24,210	23,911	23,846	23,793	23,735	23,538	23,098	22,275	21,275	20,037
female	75-79	40,862	40,787	40,363	39,723	39,214	38,785	37,685	36,873	36,479	36,392	36,397	36,317
female	80-84	60,709	60,405	59,948	59,468	58,942	58,411	58,566	58,234	57,565	57,012	56,682	55,331
female	85+	116,755	121,028	125,367	129,896	134,694	139,320	144,062	148,788	153,609	158,284	162,830	167,883
	All females	######	######	######	######	######	######	######	######	######	######	######	######

Source: Author's computations in Popgroup

If users choose (ii), they can enter: fertility differentials, either total or by five years of age (of the mother); and mortality, immigration or emigration *differentials*, either total or by sex and five years of age (from 0-4 to 85+). Fertility, mortality and migration differentials were computed using the age specific fertility, mortality and migration rates Istat provided me with for all the years of the projection period[15]. If differentials are entered, these are used to multiply the mandatory rates: differentials increase or decrease the age schedule of the mandatory rates depending on whether they are greater or less than one.

This is clarified in the example below. In Figure 3.5, fertility differentials by five year of age of the mother are entered for the period 2005 to 2016. In Figure 3.6, mortality differentials by sex and five year of age were entered for the period 2005 to 2016. Figure 3.5 shows that the 2010 fertility differential for the 15 to 19 age group is 0.83. This means that the 2010 ASFRs of women aged 15 to 19 are computed by multiplying the 2005 ASFRs of women aged 15 to 19 (Figure 3.1) by 0.83. This implies that the ASFRs of women aged 15 to 19 are projected to decline between 2005 and 2010.

Figure 3.5: Example of Popgroup fertility differentials

FERTILITY DIFFERENTIALS (by which to multiply the single age schedule)

Year beginning July 1

Options	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Provide total												
Trend total												
Provide age values	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Trend age values												

Double click any option you wish to select (or de-select) for a year and then fill in the relevant data below

Data	Total												
	Age												
female	15-19	1.00	0.96	0.92	0.88	0.85	0.83	0.79	0.76	0.73	0.71	0.68	0.66
female	20-24	1.00	0.98	0.97	0.95	0.94	0.93	0.91	0.90	0.89	0.88	0.86	0.86
female	25-29	1.00	0.99	0.98	0.97	0.97	0.97	0.95	0.95	0.94	0.94	0.93	0.93
female	30-34	1.00	1.00	1.01	1.01	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.05
female	35-39	1.00	1.02	1.05	1.06	1.09	1.12	1.14	1.16	1.18	1.20	1.22	1.24
female	40-44	1.00	1.05	1.11	1.16	1.21	1.27	1.33	1.39	1.44	1.50	1.55	1.61
female	45-49	1.00	1.08	1.18	1.27	1.38	1.49	1.62	1.75	1.86	2.02	2.15	2.30

Source: Author's computations in Popgroup

[15] For instance, fertility differentials were computed as the ratio of the abridged five year ASFRs of the year under consideration (given as the average of the five single ASFRs for each five year group) and the five year abridged ASFRs of the base year (2005).

Figure 3.6: Example of Popgroup mortality differentials

MORTALITY DIFFERENTIALS **(by which to multiply the single year age-sex sch**

Year beginning July 1

Options	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Provide Total												
Trend Total												
Provide Age-sex	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Trend Age-sex												

Double click any option you wish to select (or de-select) for a year and then fill in the relevant data below

Data	Total												
Sex	Age												
male	Newborn/ 0	1.00	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.90	0.89	0.88	0.87
male	1-4	1.00	0.96	0.93	0.89	0.86	0.83	0.77	0.74	0.71	0.66	0.63	0.66
male	5-9	1.00	0.96	0.93	0.90	0.87	0.84	0.78	0.76	0.73	0.68	0.65	0.68
male	10-14	1.00	0.98	0.96	0.94	0.92	0.90	0.86	0.84	0.82	0.79	0.77	0.79
male	15-19	1.00	0.99	0.99	0.98	0.97	0.96	0.95	0.94	0.94	0.92	0.92	0.92
male	20-24	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98
male	25-29	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
male	30-34	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.97
male	35-39	1.00	0.99	0.98	0.97	0.97	0.96	0.94	0.93	0.93	0.91	0.90	0.91
male	40-44	1.00	0.98	0.96	0.94	0.93	0.91	0.87	0.86	0.84	0.81	0.79	0.81
male	45-49	1.00	0.98	0.95	0.93	0.91	0.89	0.84	0.83	0.80	0.77	0.75	0.77
male	50-54	1.00	0.98	0.95	0.93	0.91	0.89	0.85	0.83	0.81	0.77	0.75	0.77
male	55-59	1.00	0.98	0.96	0.94	0.92	0.90	0.86	0.85	0.83	0.80	0.78	0.80
male	60-64	1.00	0.98	0.97	0.95	0.93	0.92	0.88	0.87	0.85	0.82	0.81	0.82
male	65-69	1.00	0.98	0.97	0.95	0.94	0.93	0.90	0.88	0.87	0.84	0.83	0.84
male	70-74	1.00	0.98	0.97	0.96	0.94	0.93	0.90	0.89	0.87	0.85	0.83	0.85
male	75-79	1.00	0.99	0.97	0.96	0.95	0.93	0.91	0.89	0.88	0.86	0.84	0.86
male	80-84	1.00	0.99	0.97	0.96	0.95	0.94	0.91	0.90	0.89	0.87	0.86	0.87
male	85+	1.00	0.99	0.98	0.98	0.97	0.96	0.94	0.92	0.91	0.89	0.88	0.89

Sex	Age												
female	Newborn/ 0	1.00	0.99	0.98	0.97	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.87
female	1-4	1.00	0.97	0.95	0.92	0.90	0.87	0.82	0.80	0.78	0.78	0.76	0.73
female	5-9	1.00	0.98	0.95	0.93	0.91	0.89	0.84	0.82	0.80	0.80	0.79	0.76
female	10-14	1.00	0.98	0.97	0.95	0.93	0.91	0.88	0.87	0.85	0.85	0.84	0.82
female	15-19	1.00	0.99	0.98	0.96	0.95	0.94	0.92	0.91	0.90	0.90	0.88	0.87
female	20-24	1.00	0.99	0.98	0.97	0.96	0.95	0.93	0.92	0.91	0.91	0.90	0.89
female	25-29	1.00	0.99	0.99	0.98	0.98	0.97	0.96	0.95	0.95	0.95	0.94	0.94
female	30-34	1.00	0.99	0.98	0.97	0.97	0.96	0.94	0.93	0.93	0.93	0.92	0.91
female	35-39	1.00	0.99	0.97	0.96	0.95	0.94	0.91	0.90	0.89	0.89	0.88	0.86
female	40-44	1.00	0.99	0.97	0.96	0.94	0.93	0.90	0.89	0.87	0.87	0.86	0.85
female	45-49	1.00	0.99	0.97	0.95	0.94	0.93	0.90	0.88	0.87	0.87	0.86	0.84
female	50-54	1.00	0.98	0.97	0.95	0.94	0.92	0.89	0.88	0.86	0.86	0.85	0.84
female	55-59	1.00	0.98	0.97	0.95	0.93	0.92	0.89	0.87	0.86	0.86	0.84	0.83
female	60-64	1.00	0.98	0.97	0.95	0.93	0.92	0.89	0.87	0.86	0.86	0.84	0.83
female	65-69	1.00	0.98	0.97	0.95	0.94	0.92	0.89	0.87	0.86	0.86	0.84	0.83
female	70-74	1.00	0.98	0.97	0.95	0.93	0.92	0.88	0.87	0.85	0.85	0.84	0.82
female	75-79	1.00	0.98	0.97	0.95	0.93	0.92	0.88	0.87	0.85	0.85	0.84	0.82
female	80-84	1.00	0.98	0.97	0.95	0.94	0.92	0.89	0.88	0.86	0.86	0.85	0.84
female	85+	1.00	0.99	0.98	0.98	0.97	0.96	0.92	0.91	0.89	0.89	0.88	0.87

Source: Author's computations in Popgroup

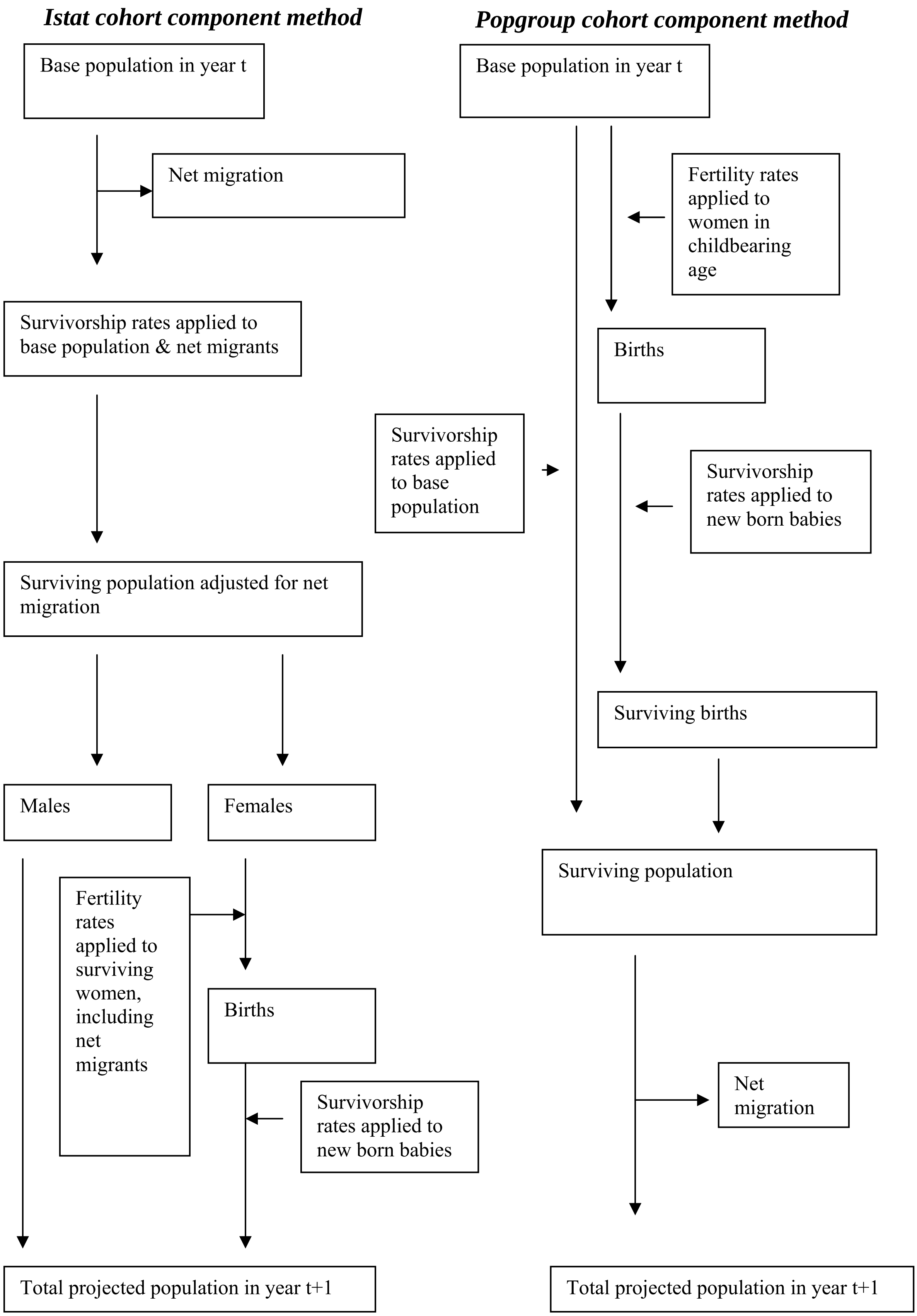
If both counts (i) and differentials (ii) are entered, counts over-ride differentials, which are then used only to estimate the age-sex distribution within the given count. For instance, let us suppose that Popgroup needs to compute the number of deaths by single year of age of males aged 45 to 49 in 2010 when both counts and differentials are entered. Popgroup first applies the mortality differential of 0.89 (Figure 3.6) to the ASMRs of Figure 3.2 and then computes the number of deaths by single year of age (45, 46, 47, 38 and 49). Popgroup finally scales the computed numbers of deaths if their sum is not consistent with the 4,642 figure entered in Figure 3.4.

3.2.3 Methodological differences between Istat and Popgroup cohort component methods

Although both Istat and Popgroup use the cohort component method, there are some differences in the specific methodologies. These are summarised in Figure 3.7 below. Popgroup first computes the surviving population, given as the sum of surviving new born babies and surviving base population, and then adds net migration. It does not take into account that net migrants can die and female net migrants can have children in the year of migration. Istat first computes the surviving population adjusted for net migration and then computes the surviving new born babies, applying the ASFRs to surviving women, including surviving female net migrants. In other terms, migrants are subject to mortality and fertility rates in the year of migration in the cohort component metohd employed by Istat; they are not in Popgroup model. Clearly, this can lead to different outcomes in the final number of deaths and births in the year of migration and in all the other years of the projection period, given that the cohort component method is based on an iterative process.

However, this issue does not raise severe problems for two main reasons: i) the annual number of net migrants computed by Istat and plugged into Popgroup (i.e. 150,000 net migrants per year) is the annual number of *surviving* net migrants; and ii) the annual number of births computed by Istat was entered as birth count in Popgroup (see Figure 3.3 above), thus overcoming Popgroup's "limitation" in ignoring that also female net migrants can have children in the year of migration.

Figure 3.7: Differences between Istat & Popgroup cohort componenet methods



3.3 Comparison between Istat and Popgroup projections

Istat 2005-based population projections were replicated using Popgroup. Istat fertility, mortality and migration (mandatory) rates were entered for the base year. Istat *counts* on total number of births and number of deaths and net migrants by sex and five year of age were entered for all the years of the projection period. Table 3.1 and Figures 3.8 to 3.25 show that Istat population projections were replicated accurately in Popgroup. The figures are broken down for five year age groups in order to show that Popgroup closely replicated Istat population projections not only for the population as a whole, but also for smaller age groups. Clearly, the likelihood of noticing errors or discrepancies is lower the more aggregated are the comparisons (e.g. population total as compared to its components).

Table 3.1 shows that the maximum error when comparing Istat and Popgroup projections (in absolute value) in the last year of the projection period (2050) is 0.15%, for males aged 85+. This is expected given that the last interval of five year migration and mortality counts in Popgroup is an open interval (85+). This can be seen in Figure 3.4.

Table 3.1: Average error (in absolute value) when comparing Istat & Pogroup projections - 2050

Age groups	Males	Females
0-4	0.09%	0.07%
5-9	0.07%	0.07%
10-14	0.05%	0.07%
15-19	0.05%	0.05%
20-24	0.02%	0.06%
25-29	0.03%	0.09%
30-34	0.03%	0.01%
35-39	0.00%	0.01%
40-44	0.01%	0.01%
45-49	0.02%	0.02%
50-54	0.02%	0.02%
55-59	0.02%	0.01%
60-64	0.02%	0.01%
65-69	0.00%	0.00%
70-74	0.03%	0.02%
75-79	0.04%	0.02%
80-84	0.00%	0.04%
85+	0.15%	0.06%
All	0.01%	0.02%

Figures 3.8 to 3.25 show the number of males and females – total and grouped by five years of age - for each year of the projection period, as projected by Istat and Popgroup cohort component methods. The Figures were originally plotted with two curves - one for Istat and one for Popgroup projections. However, the two projections were basically overlapping so only one curve is visible.

Figure 3.8: Projected number of males & females, Istat & Popgroup, 2005-2050

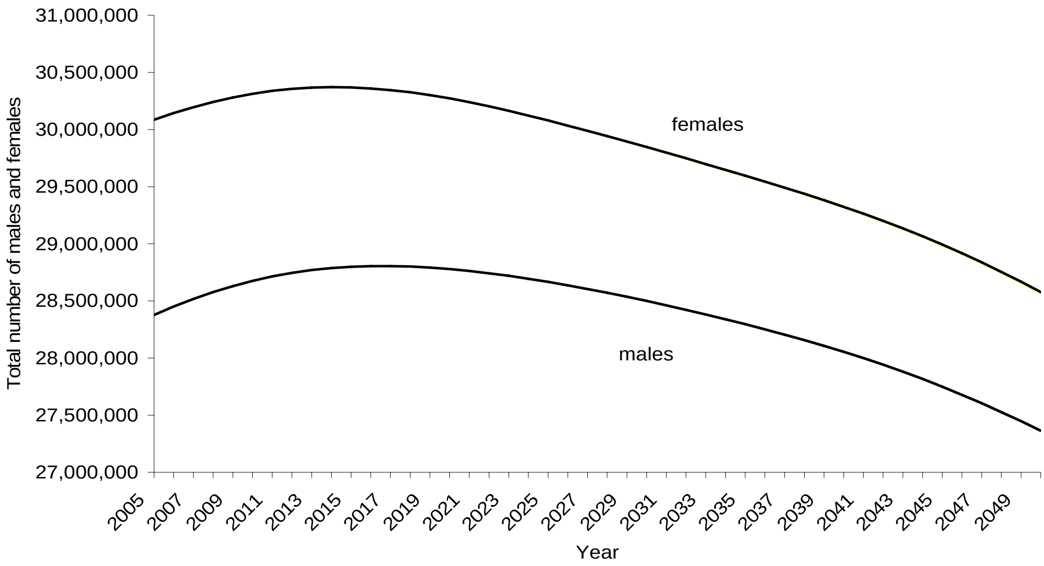


Figure 3.9: Projected number of males & females aged 0-4, Istat & Popgroup, 2005-2050

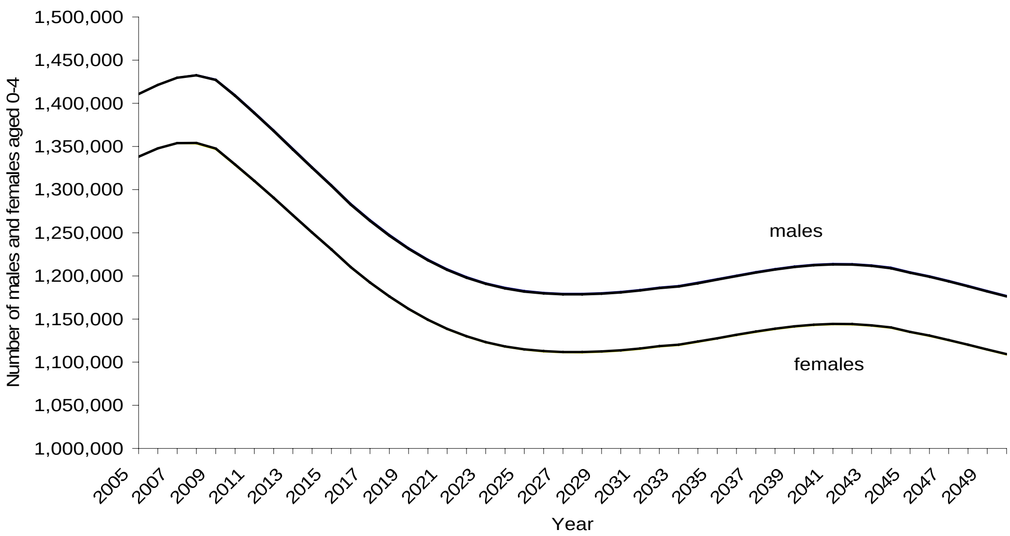


Figure 3.10: Projected number of males & females aged 5-9, Istat & Popgroup, 2005-2050

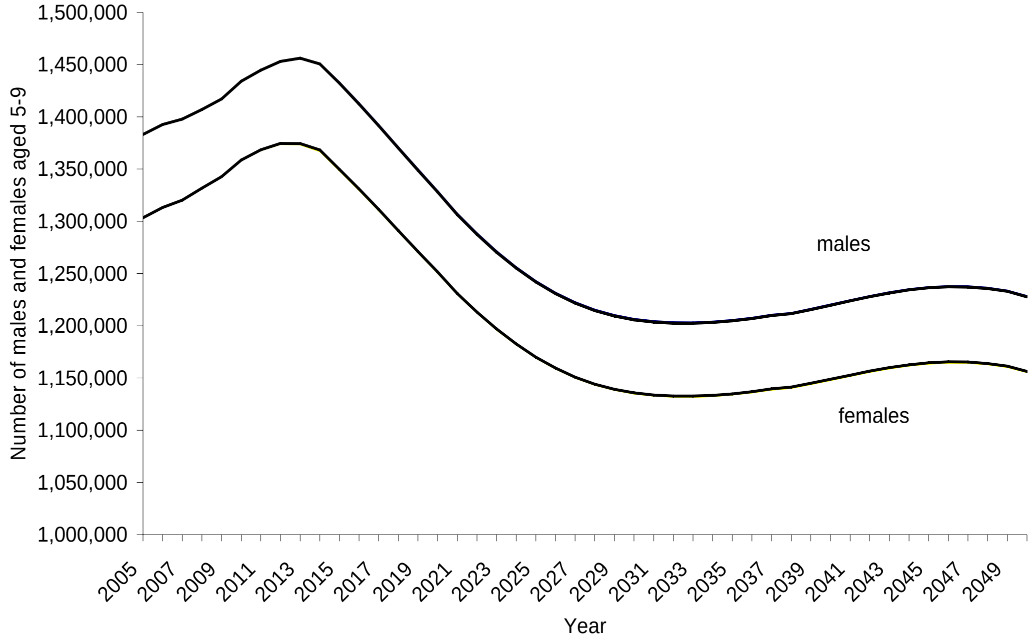


Figure 3.11: Projected number of males & females aged 10-14, Istat & Popgroup, 2005-2050

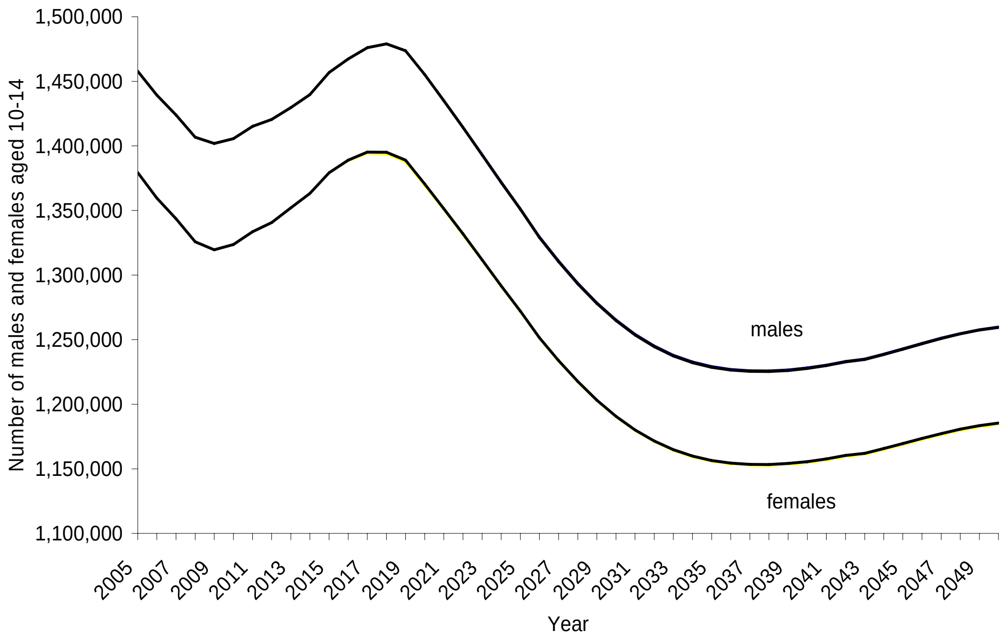


Figure 3.12: Projected number of males & females aged 15-19, Istat & Popgroup, 2005–2050

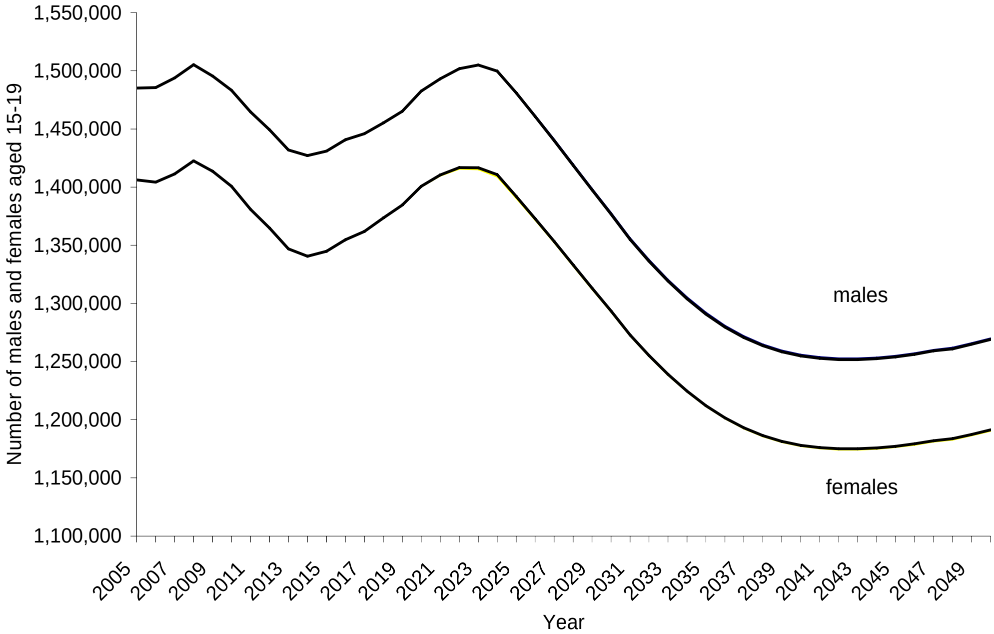


Figure 3.13: Projected number of males & females aged 20-24, Istat & Popgroup, 2005–2050

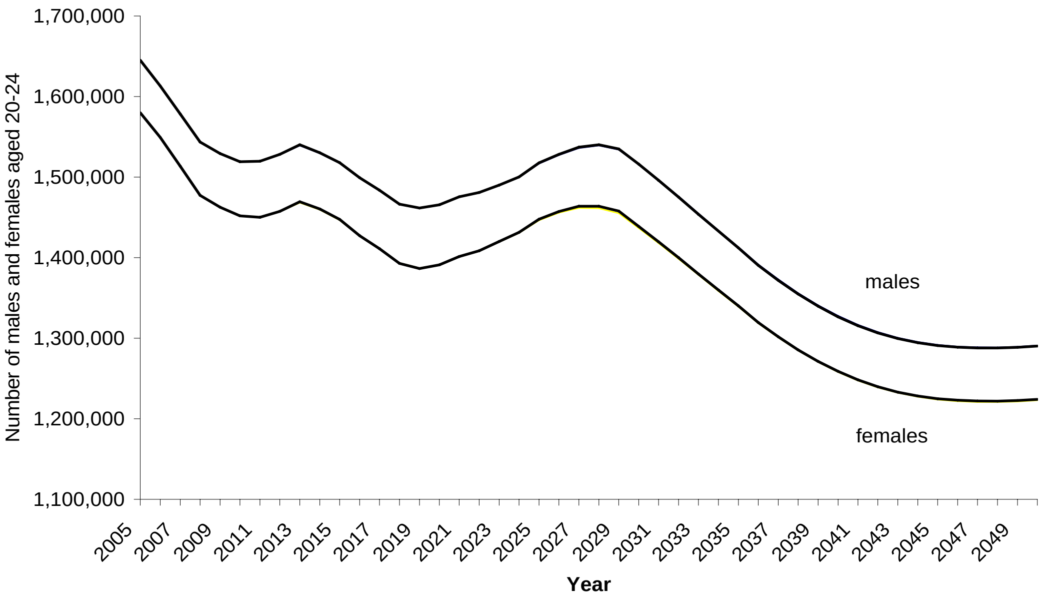


Figure 3.14: Projected number of males & females aged 25-29, Istat & Popgroup, 2005-2050

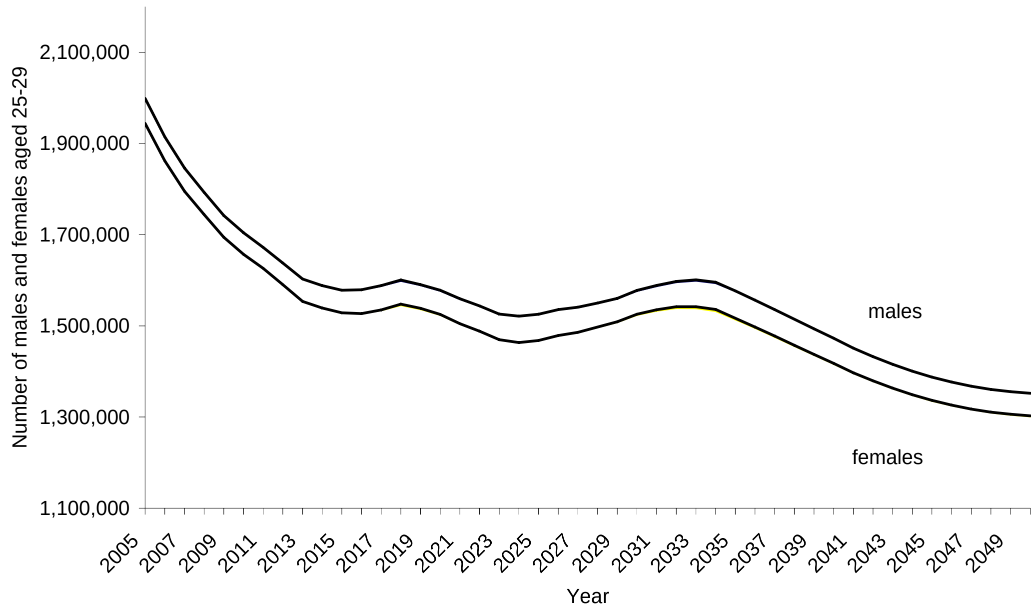


Figure 3.15: Projected number of males & females aged 30-34, Istat &Popgroup, 2005-2050

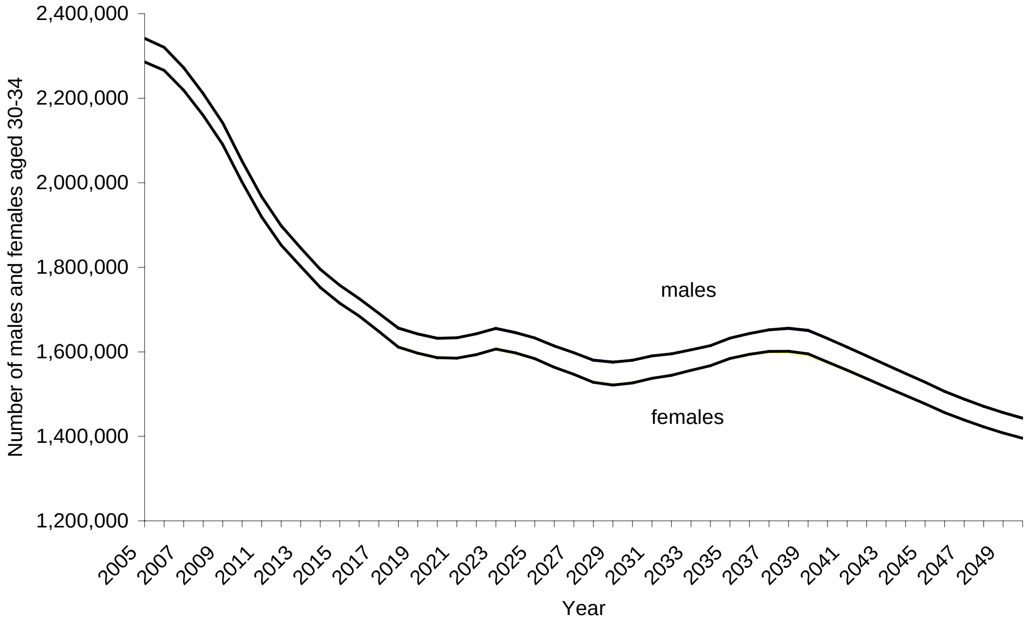


Figure 3.16: Projected number of males & females aged 35-39, Istat & Popgroup, 2005-2050

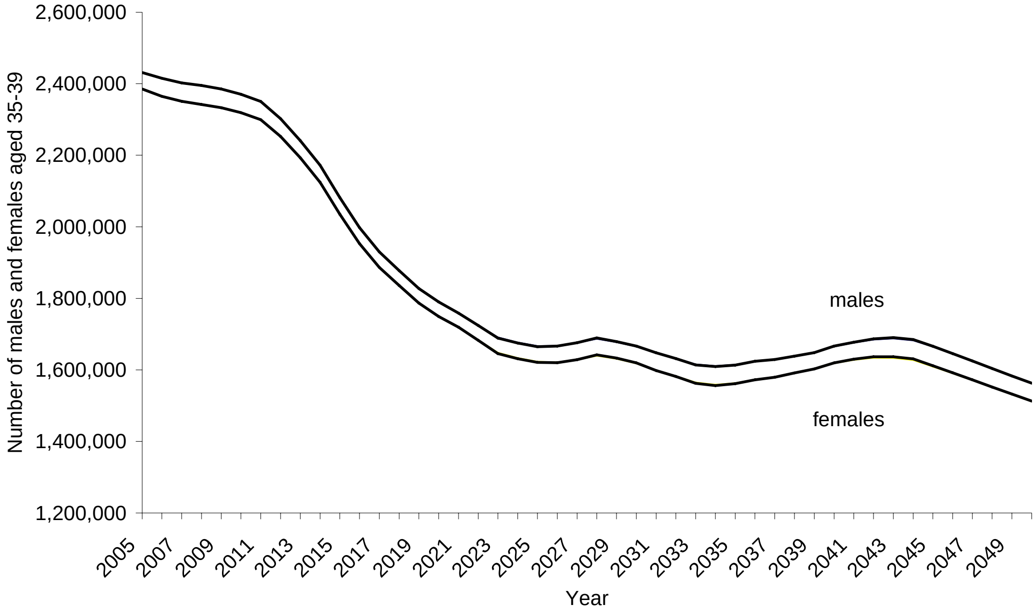


Figure 3.17: Projected number of males & females aged 40-44, Istat & Popgroup, 2005-2050

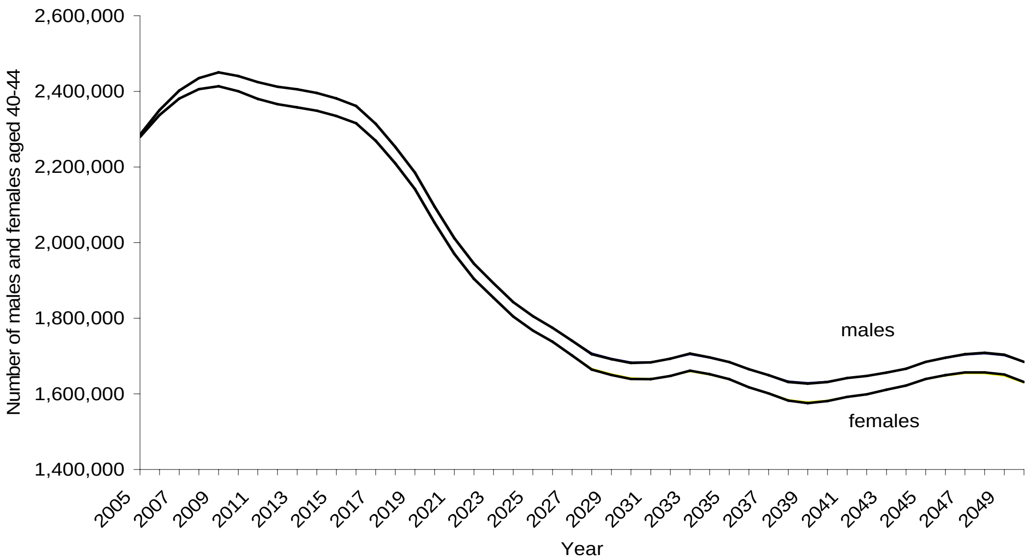


Figure 3.18: Projected number of males & females aged 45-49, Istat & Popgroup, 2005-2050

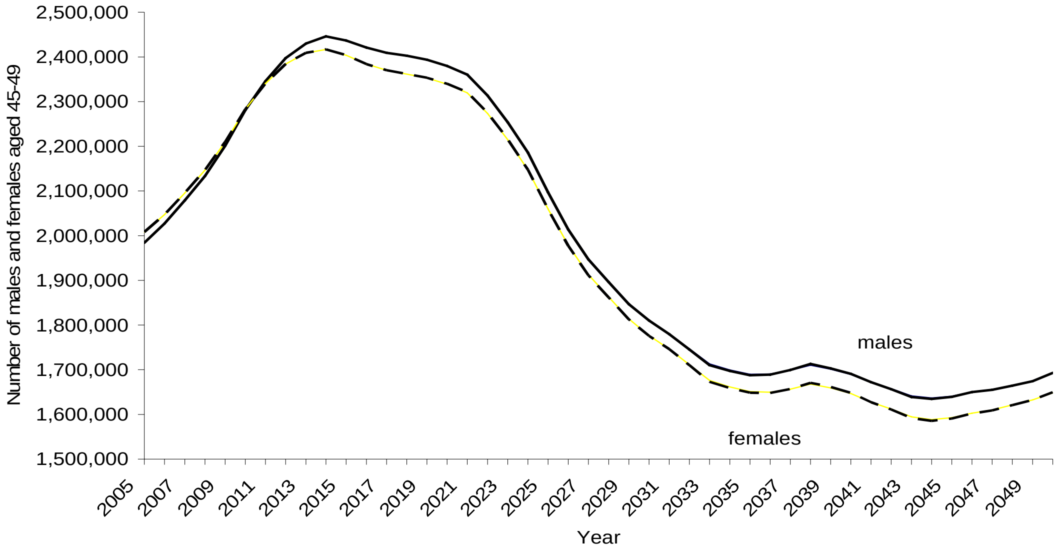


Figure 3.19: Projected number of males & females aged 50-54, Istat & Popgroup, 2005-2050

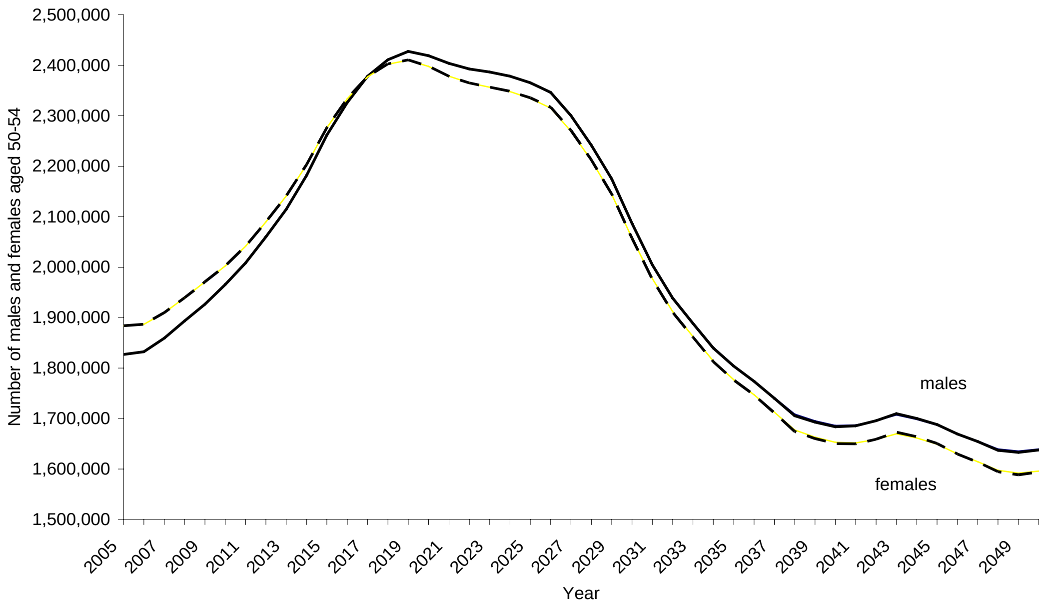


Figure 3.20: Projected number of males & females aged 55-59, Istat & Popgroup, 2005-2050

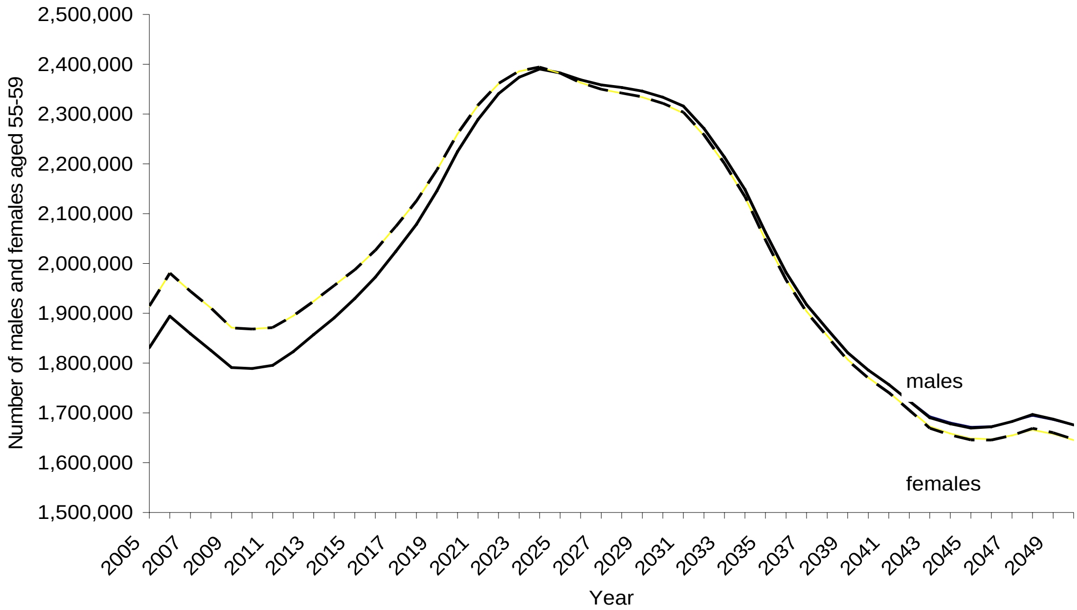


Figure 3.21: Projected number of males & females aged 60-64, Istat & Popgroup, 2005-2050

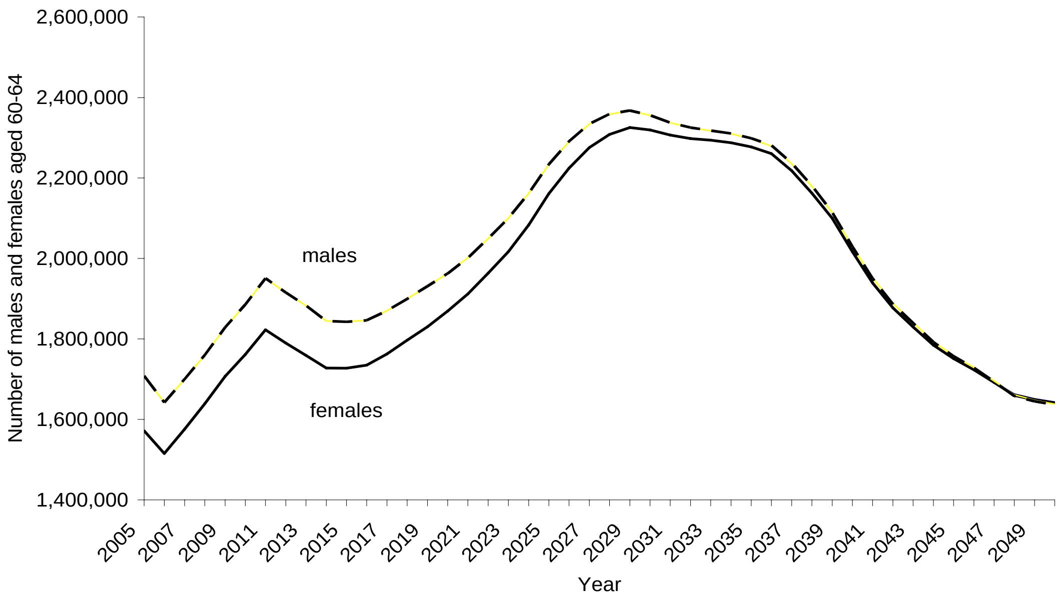


Figure 3.22: Projected number of males & females aged 65-69, Istat & Popgroup, 2005-2050

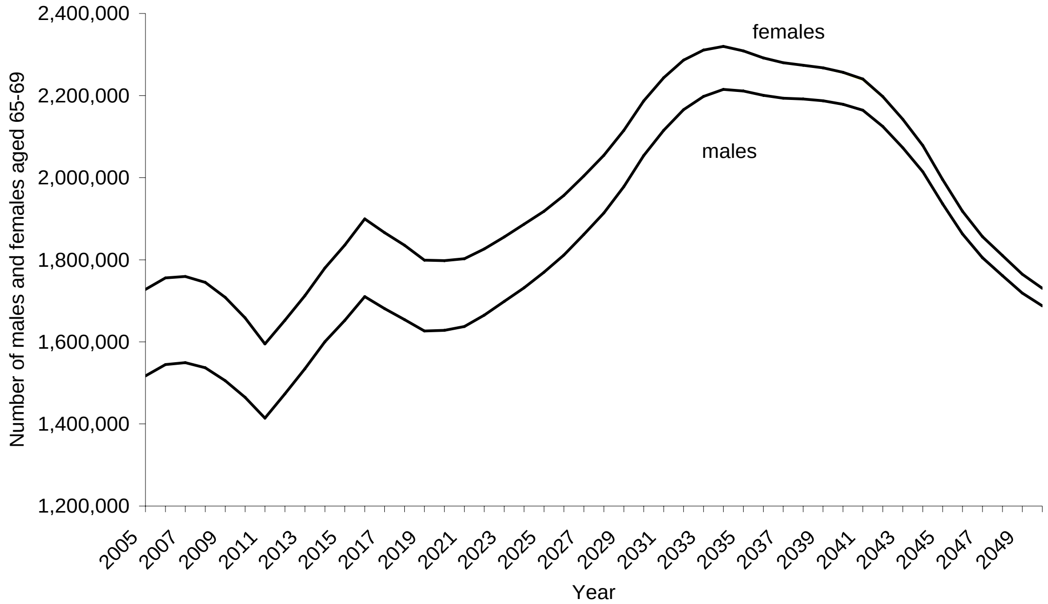


Figure 3.23: Projected number of males & females aged 70-74, Istat & Popgroup, 2005-2050

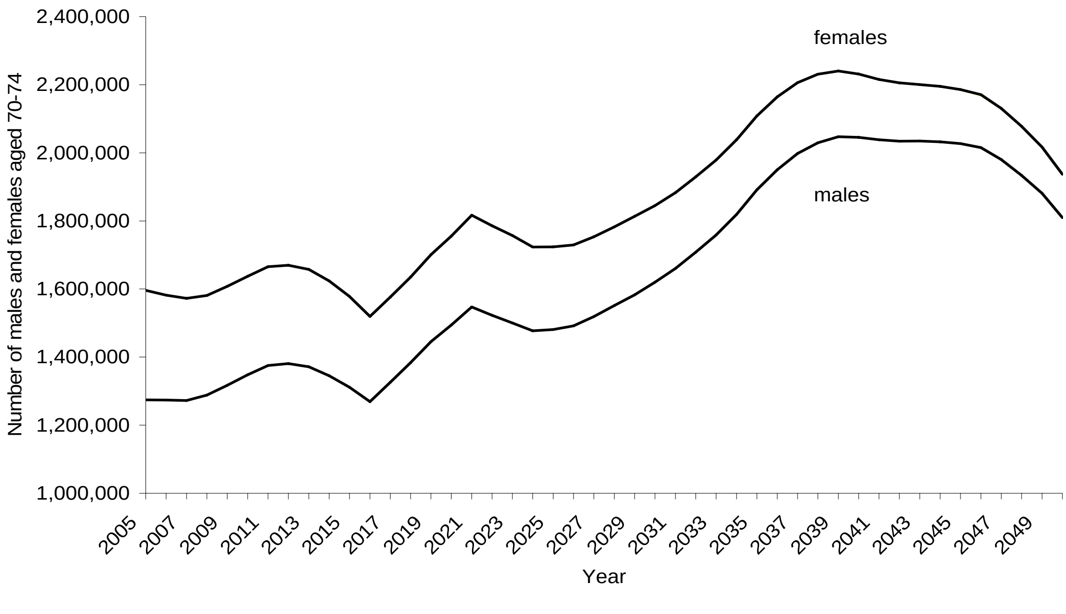


Figure 3.24: Projected number of males & females aged 75-79, Istat & Popgroup, 2005-2050

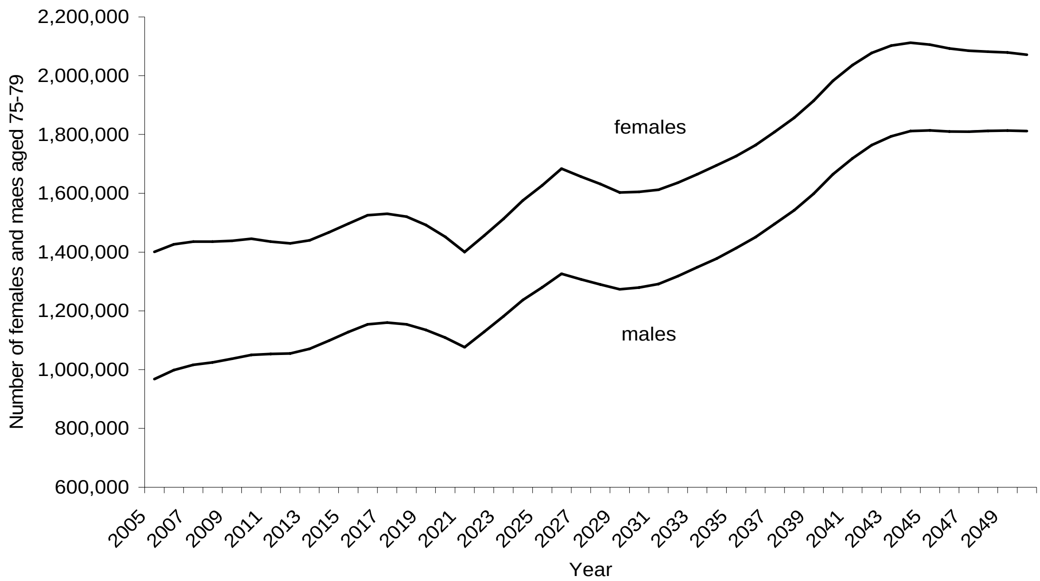
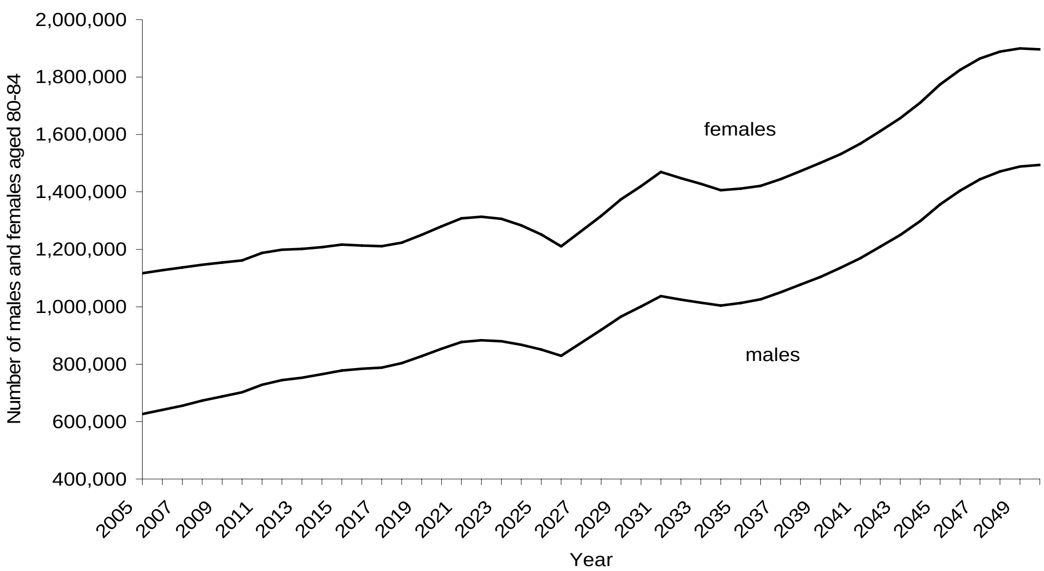


Figure 3.25: Projected number of males & females aged 80-84, Istat & Popgroup, 2005-2050



Istat population projections were also replicated using differentials instead of counts. Fertility, mortality and migration differentials were computed using Istat assumptions on fertility, mortality and migration rates for all the years of the projection period. Istat population projections were replicated less closely when using differentials. This is not unexpected: as explained aobve, Popgroup does not take into account that female net migrants can have children in the year they migrate. This "limitation" is overcome if Istat counts are plugged in Popgroup; it is not if differentials are entered.

Results are presented in Appendix A, where Popgroup population projections using counts and differentials are presented. The total female and male populations are slightly higher when using differentials in the first years of the projection period, and lower afterwards. The differences are more significant for younger age groups, i.e. groups aged 0-4, 5-9, 10-14, 15-19 and 20-24. However, the differences are relatively small (0.3% (in absolute value) at the maximum).

3.4 Migration sensitivity analysis

In its 2005-based population projections, Istat assumes that 150,000 net migrants - mostly young, as shown in Figure 2.33 - will move to Italy in each year of the projection period. Istat also assumes that the net migrants will not relocate to another country and will not return to their home countries after migrating to Italy. However, this will not be sufficient to counteract the phenomena of population ageing and labour force ageing and decline in Italy.

A set of alternative population projections are carried out in this Section in order to investigate if positive and increasing levels of young net migration could counteract the phenomena of population ageing and labour force ageing and decline in Italy. These alternative projections are based on fertility and mortality assumptions employed by Istat in their 2005-based principal projection. Using this as a base, migration assumptions are varied systematically upward, taking the zero net migration scenario as a benchmark. The zero net migration scenario is a useful 'baseline' since it provides information on how the size and age structure of the population will be changed by fertility and mortality alone.

The number of annual net migrants is not fixed at 150,000 net migrants per year as in Istat projections but it is allowed to vary. It ranges from 0 to 500,000 (i.e. 0, 50,000, 100,000, 200,000, 300,000, 350,000, 375,000, 400,000 and 500,000). The sex ratio is assumed to be balanced at 50:50.

For the age distribution of migrants, it is assumed that net migrants are younger than the general population. Clearly, if migrants' age distribution and mortality and fertility characteristics were the same as the general population, net migration would not help counteract the phenomenon of population ageing. More precisely, two different scenarios are taken into account:

- Scenario 1: all net migrants are under the age of 45, with 20% being under the age of 15. This can be thought of a positive net migration of "young migrants with children" and is similar to the age distribution of net migrants employed by Istat; and
- Scenario 2: all net migrants are aged 20 to 44. This can be thought of a positive net migration of "young migrants without children".

Figure 3.26 focuses on Scenario 1 and shows how the population share of the group including people aged more than 65 will change if increasing numbers of "young migrants with children" move to Italy in the next four and a half decades. The scenario which assumes zero net migration suggests that the percentage of the population aged at least 65 would increase by 18 percentage points, from 19.5% in 2005 to 37.5% in 2050. If 300,000 and 500,000 net migrants moved to Italy every year, the share of the population aged 65 and older would increase by 11.2 and 8.4 percentage points, respectively. It is important to note that the process of population ageing would not stop even if 500,000 net migrants per year moved to Italy. However, net migration with the assumed age structure described above would decelerate the process of population ageing significantly.

Figure 3.26: Percentage of population aged 65+, different net migration assumptions, Scenario 1, 2005-2050

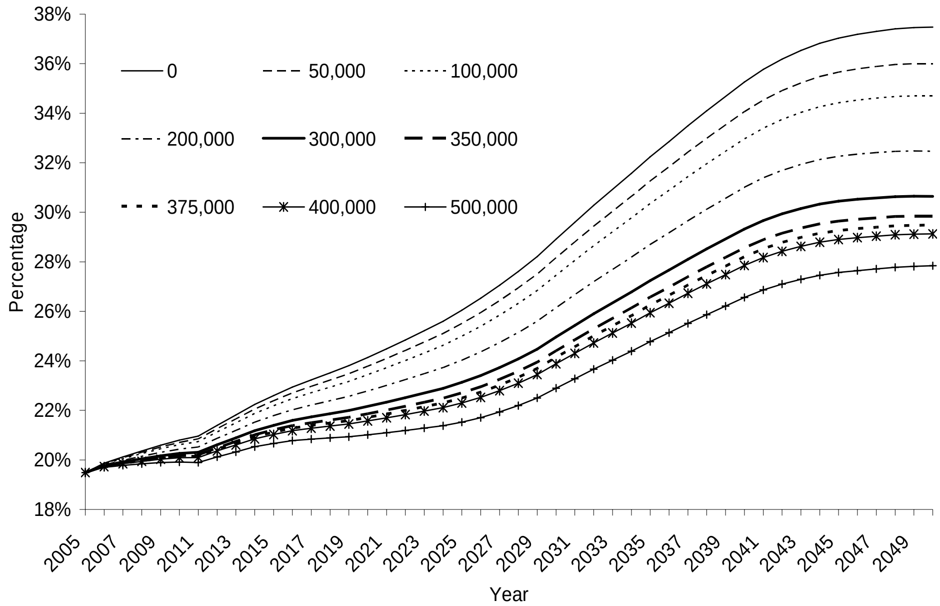


Figure 3.27 shows that the Italian working age population would shrink quite dramatically between 2005 and 2050 if less than 200,000 net migrants, all aged less than 45, migrated to the country in each year of the projection period. The working age population would decrease by 39.2% points in the zero net migration scenario. It would decrease by 33.8 and 17.8% points if 50,000 and 200,000 net migrants, respectively, moved to the country. The working age population would remain roughly stable in the long-term if 375,000 migrants moved to Italy every year. This would be equal to 1.04% of the Italian population as registered in 2005.

Figure 3.27: Working age population size, different net migration assumptions, Scenario 1, 2005-2050

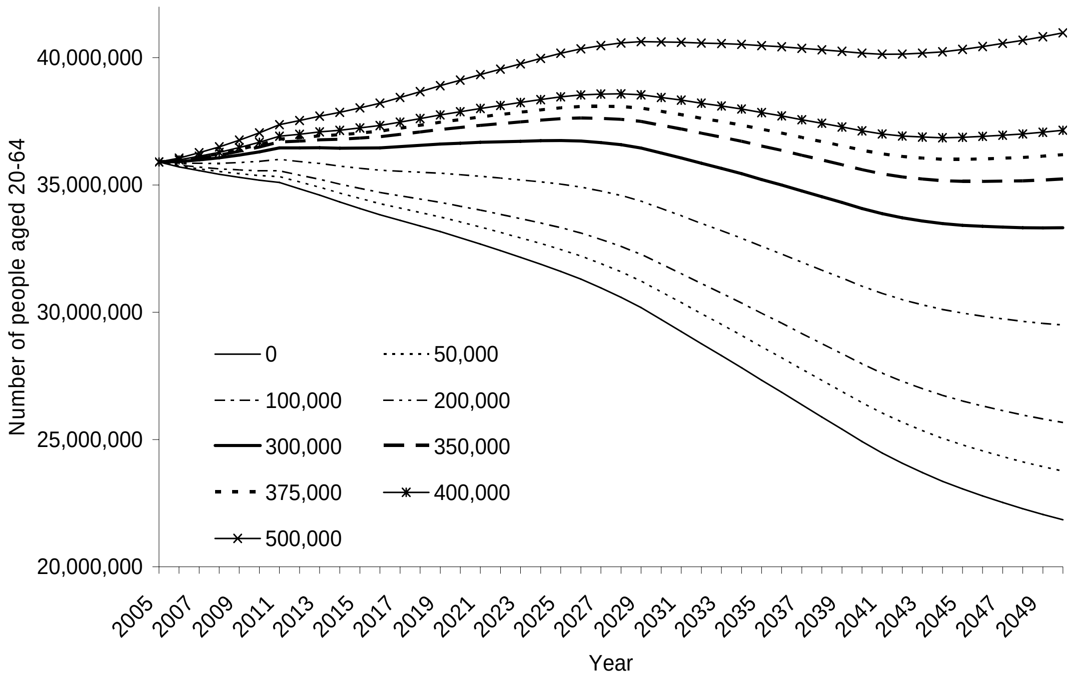


Figure 3.28 below shows the number of net migrants Italy would require in order for the working age population to remain at its 2005 value (i.e. 35,906,088 ± 50). The number of migrants required to keep the working population constant is computed manually for each year of the projection period.

The Figure shows that the number of net migrants required reaches a minimum in 2010 (91,300) and a maximum in 2036 (565,650). It is also required to be more than half a million for the whole decade between 2029 and 2039.

Figure 3.28: Number of net migrants needed to keep the working age population at its 2005 value, Scenario 1, 2005-2050

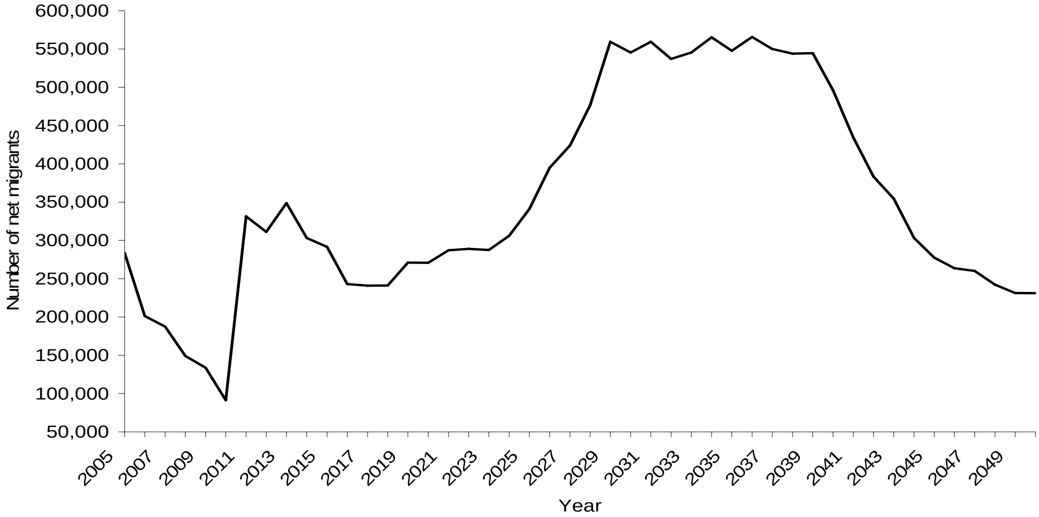


Figure 3.29 focuses on Scenario 2 and shows that the share of population aged at least 65 would increase by 13.2 and 11.3% points if 300,000 and 500,000 net migrants, respectively, moved to Italy every year. Net migration with the assumed age structure of Scenario 2 would still decelerate the process of population ageing, although to a lesser extent if compared to Scenario 1. An older age distribution of net migrants is now assumed.

Figure 3.29: Percentage of population aged 65+, different net migration assumptions, Scenario 2, 2005-2050

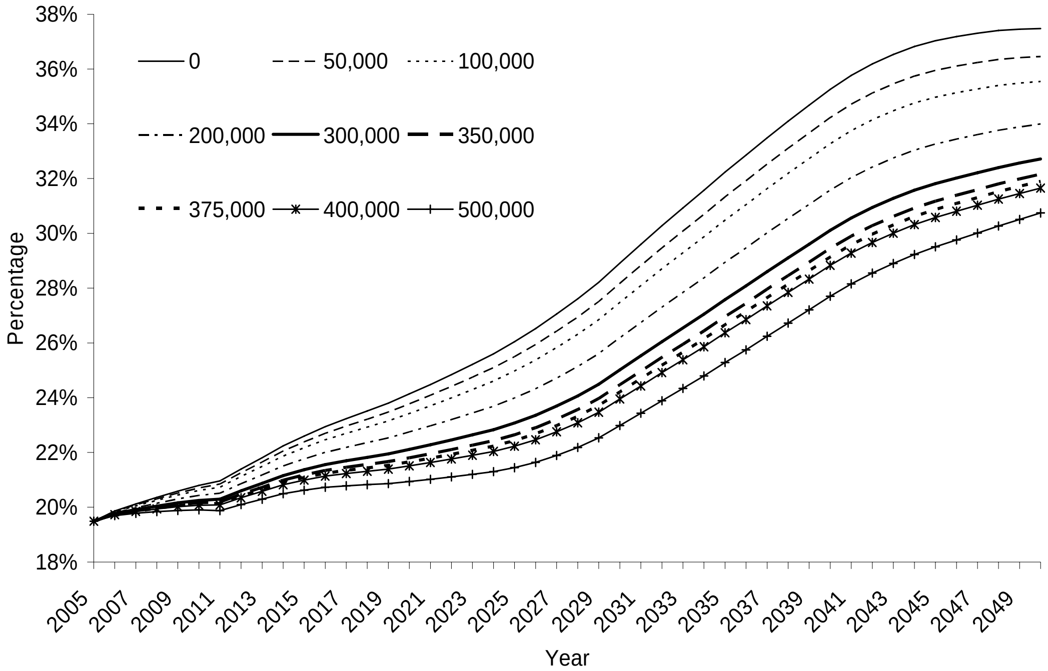


Figure 3.30 shows that the Italian working age population would still shrink significantly if less than 300,000 net migrants, all aged between 20 and 44, migrated to Italy every year. The working age population would decrease by 17.8 and 8.3% points if 200,000 and 300,000 net migrants moved to the country. The working age population would remain roughly stable in the long-term if 375,000 or 400,000 net migrants would migrate to Italy: the working age population would decrease by 0.5% points if 375,000 net migrants moved to the country and would increase by 2.0% points if 400,000 net migrants migrated to Italy every year (by the end of the projection period).

Figure 3.30: Working age population size, different net migration assumptions, Scenario 2, 2005-2050

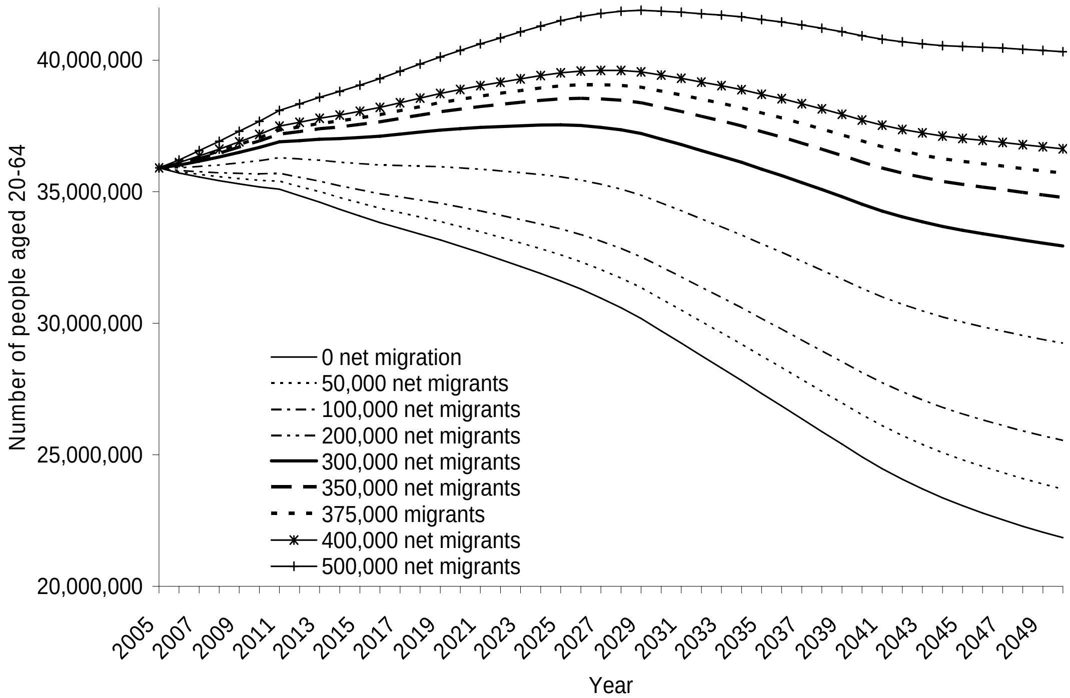


Figure 3.31 below shows the number of net migrants Italy would require in order for its working age population to remain at its 2005 value (i.e. 35,906,088 ± 50). The Figure shows that the number of net migrants required reaches a minimum in 2010 (84,850) and a maximum in 2039 (544,700). It is also required to be more than half a million between 2033 and 2040.

Figure 3.31: Number of net migrants needed to keep the working age population constant at its 2005 value, Scenario 2, 2005-2050

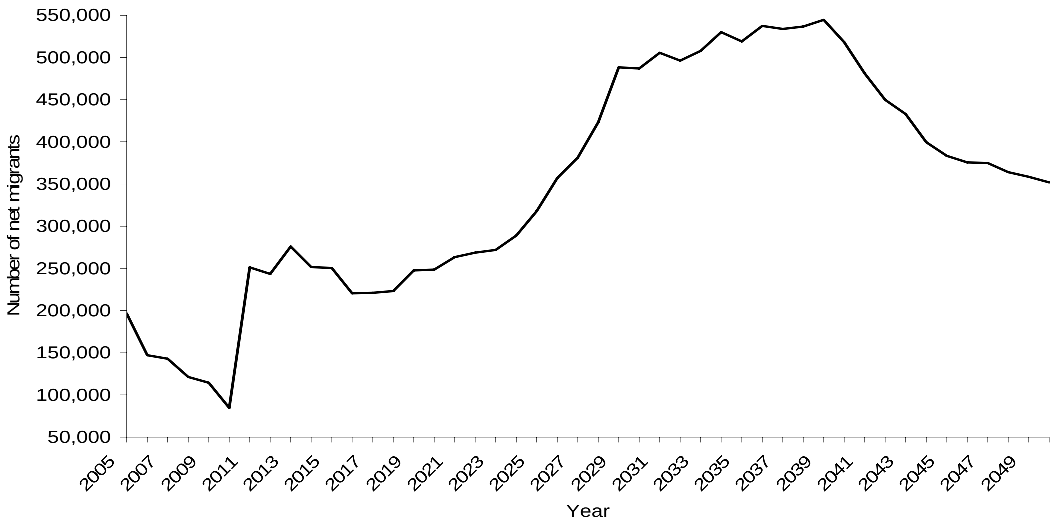


Figure 3.32 below summarises Figures 3.28 and 3.31, displaying the number of net migrants aged less than 45 and 20 to 44, respectively, that would be required to keep the working age population constant at its 2005 level. The two curves follow a similar pattern, also because the same fertility and mortality rates are applied in the projections' computations. However, the number of net migrants required in Scenario 1 is higher than the number of migrants required in Scenario 2 until 2038, and lower from 2039 onwards. This is easily understandable: the "very young" net migrants of Scenario 1 will not impact on the size of the working age population in the first part of the projection period. For example, net migrants aged 0 in 2005 will be aged 20 in 2025 and will impact on the size of the working age population from 2025 onwards. Conversely, a positive inflow of net migrants aged 20 to 44 will impact on the size of the working age population mostly in the first period. For example, net migrants aged 30 in 2005 will increase the working age population only between 2006 and 2039 (i.e. until they are aged 64).

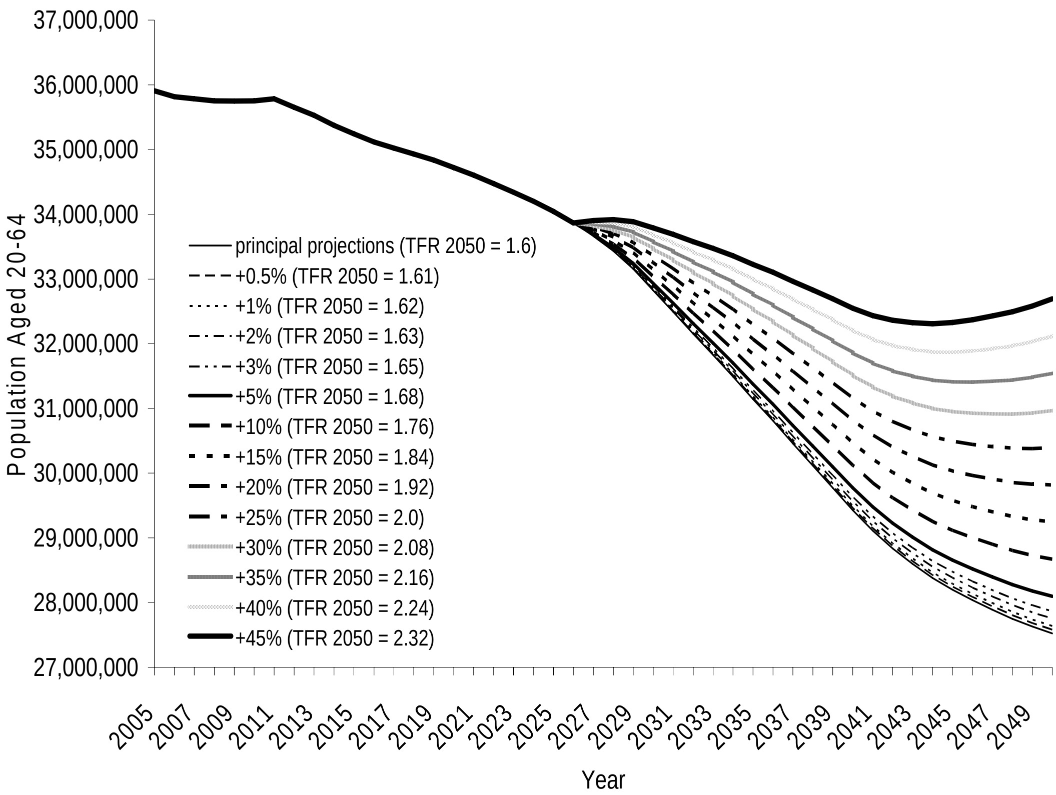
Figure 3.32: Number of net migrants aged 20 to 44 and less than 45 needed to keep the working age population constant at its 2005 value

3.5 Fertility sensitivity analysis

In its 2005-based population projections, Istat assumes that the total fertility rate will reach 1.6 children per woman by 2050. However, this increase in fertility will not be sufficient to counteract the phenomena of population ageing and labour force ageing and decline in Italy. Alternative fertility scenarios are then explored, assuming that fertility increases at a higher rate than in the principal scenario (Scenario 3). The assumptions relating to mortality and migration are identical to those used in Istat 2005-based principal population projections.

In Scenario 3, single-year age-specific fertility rates are set to be 0.5%, 1%, 2%, 3%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% and 45% higher than in the principal scenario. This results in a TFR equal to 1.61, 1.62, 1.63, 1.65, 1.68, 1.76, 1,84, 1.92, 2.0, 2.08, 2.16, 2.24 and 2.32 by 2050. Figures 3.33 shows the impacts higher fertility levels would have on the working age population. Higher fertility rates would impact on the size of the working age population from 2025 onwards. Even if fertility boomed today, one would need to wait for two decades to see the impacts of larger cohorts of new-borns on the size of the working age population. It is interesting to note that the working age population would still decrease significantly even if TFR reached 2.32 by 2050 - 32,694,006 in 2050 compared to 35,906,088 in 2005, a decrease of 8.9%.

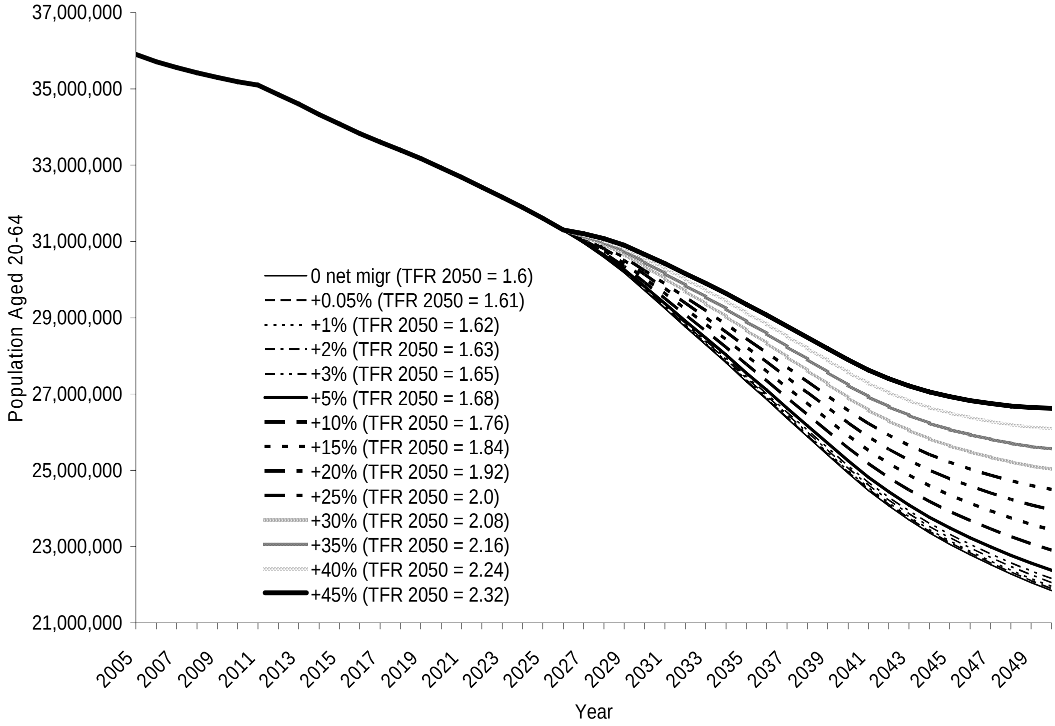
Figure 3.33: Working age population size, higher fertility assumptions, Scenario 3, 2005-2050



3.5.1 Fertility sensitivity analysis in the zero net migration scenario

Migration and fertility sensitivity analyses are now combined. I explore what would happen if fertility increased at a higher rate than in the principal scenario and net migration was set to zero (Scenario 4). This is an important exercise to understand by how much *fertility alone* would need to increase to counteract the phenomenon of population ageing in Italy. This is shown in Figure 3.35. Once again, the working age population would still decrease significantly even if the TFR reached 2.32 by 2050 - 32,694,006 in 2050 compared to 26,625,002 in 2005, a decrease of 25.8%.

Figure 3.34: Working age population size, higher fertility and zero net migration assumptions, Scenario 4, 2005-2050



3.6 Conclusions

According to Istat 2005- and 2007-based population projections, the Italian population and labour force will age significantly in the next four and a half decades. However, Istat population projections are restrictive giving their limited fertility and migration assumptions. This Chapter investigates if and the extent to which the phenomena of population ageing and labour force ageing and decline could be counteracted if future levels of fertility and migration were (significantly) higher than what projected by Istat. Before investigating alternative scenarios, Istat population projections are replicated closely using Popgroup, confirming that Popgroup is an appropriate software to carry out population projections.

Alternative migration and fertility projections are conducted with Popgroup and investigate a much wider range of assumptions. In the alternative migration scenarios, the number of annual net migrants are not fixed at 150,000 net migrants per year as in Istat projections but is allowed to vary between 0 and 500,000. In the alternative fertility scenarios, the total fertility rate is allowed to vary between 1.61 and 2.08. In Istat projections, the total fertility rate is simply assumed to reach 1.6 children per woman by 2050.

The different scenarios presented in this Chapter are not predictions. The main aim is to show how severe the phenomenon of population ageing will be if fertility does not increase to substantially higher levels or if net migration does decrease to lower levels in the next few decades.

The results of the alternative migration and fertility scenarios show that higher level of migration and fertility could counteract the phenomena of population ageing and labour force ageing and decline, but only if they were *substantially* higher.

The simulations of Scenarios 1 ("young migrants with children") and 2 ("young migrants without children") show that the working age population would remain roughly stable in the long-run if 375,000 – 400,000 young net migrants (aged less than 45 or 20 to 44) migrated to Italy every year and did not leave the country afterwards. With the exclusion of 2006 and partially of 2008, the figures computed in the alternative population projections appear to be significantly higher than those computed in the 1998 Law and set by the Italian President of the Council of Ministers and the Parliament every year. However, they also seem to be in line with the migration figures registered by Istat in the last few years.

The results of the migration simulations seem to suggest that high levels of young net migration could counteract population ageing and labour force ageing and decline in Italy. However, this does not mean that higher levels of migration is "the" solution to population and labour force ageing. Large levels of net migrations are likely to be associated with a number of problems, primarily social tensions with the native population. Also, positive and large levels of net migration are not a long-term solution. Even if substantial numbers of net migrants were to relocate to Italy, these will also grow old eventually: young net migrants quickly grow themselves from being a rejuvenating factor to being mature members of the population This leaves their main demographic impetus to be their enhancing effects on future fertility (Fertig and Schmidt, 2003, p.23).

The results of the fertility simulations show that even if fertility boomed today, one would need to wait for two decades to see the impacts of larger cohorts of new-borns on the size of the working age population (delayed effect of number of births on number of labour market entrants). Even if TFR reached 2.32 by 2050 (a value well above the replacement rate), the working age population would still decrease in size. Hence, an increase of fertility on its own would not be sufficient to counteract the declining labour force, at least in the short-term. However, it could have more significant impacts in the long-term.

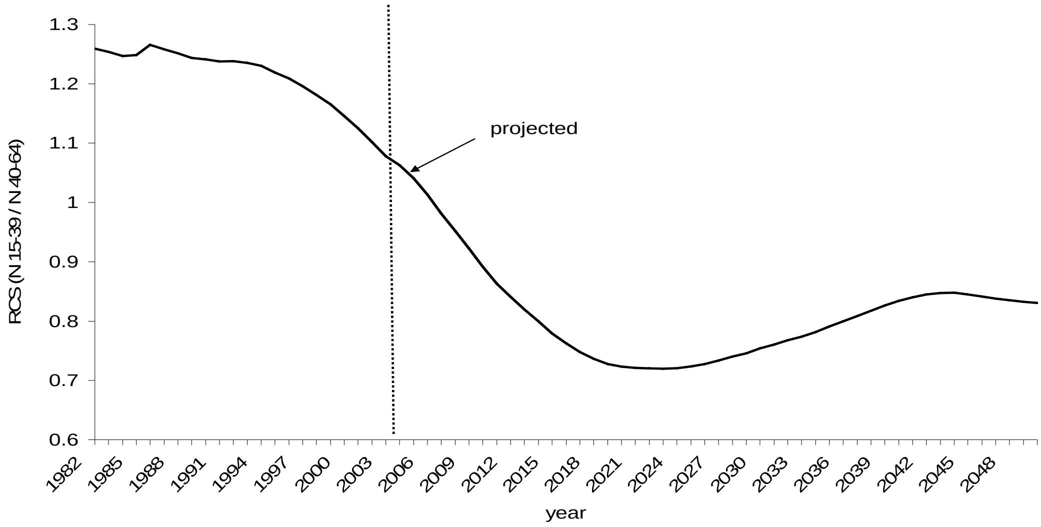
Chapter 4 The effect of cohort-size on age-earnings and age-employment profiles

4.1 Introduction

Throughout the last decades the structure of the Italian population has changed to a significant extent, following the post-war baby boom and the subsequent baby bust. While the baby boom cohorts have moved through the age pyramid, declining fertility has caused the trends of population and labour force ageing. In terms of its economic repercussions, labour force ageing is associated with both a decline in the potential labour supply and a decline in the labour supply of younger relative to that of older workers.

According to Istat 2005-based population projections, population ageing will increase in Italy in the next decades. Coupled with a relatively stable total population, this will induce a further decrease in the size of the working age population. A decrease in the potential supply of labour will also be accompanied by a decline in the relative labour supply of younger to older workers. The change in the ratio of younger to older workers can be summarised using the relative cohort size measure (RCS), given here as the ratio of males aged 15-39 to the number of males aged 40-64. Figure 4.1 displays the estimated and projected RCS index for the time period 1982 to 2050. The projected RCS index is computed using Istat 2005-based population projections. The figure shows that the relative cohort size is projected to decrease sharply up to 2023: in 1982 there were around 1.25 persons aged 15 to 39 for each person aged 40 to 64 – the corresponding figure for 2023 is around 0.7. The RCS is then projected to increase in the period 2024 to 2044 (reaching 0.85) and then to decrease again, suggesting an overall significant *decrease* (from 1.05 in 2005 to 0.8 in 2050) in the number of younger to older workers. In other terms, the age structure of the work force is going to be altered significantly.

Figure 4.1: Relative Cohort Size (N 15-39 / N 40-64), 1982-2050



Source: Istat

If older (more experienced) and younger (less experienced) workers are not perfect substitutes in production and perform different tasks, this will have implications for age-earnings and age-employment profiles. Chapter 4 investigates whether changes in the relative supply of younger to older workers in the Italian labour market will affect their earnings and employment profiles. Although the phenomenon of population and labour force ageing is particularly strong in Italy, no research has been carried out to investigate this particular issue in Italy.

The remainder of the Chapter is structured as follows. Section 4.2 reviews the existing literature on the effects of cohort size on age-earnings (Section 4.2.1) and age-employment (Section 4.2.2) profiles. The main conclusions emerging from the literature review are summarised in Section 4.3. Section 4.4 describes the empirical model used to investigate the effects of cohort size on age-earnings and employment profiles in the Italian labour market. The data used to perform the analysis are investigated in Section 4.4.1 and the main results are summarised in Sections 4.4.2 to 4.4.5. Section 4.5 concludes.

4.2 Cohort crowding literature review

The literature on the effects of cohort size on age-earnings and employment profiles outside Italy is vast, especially in the United States (Freeman (1979), Welch (1979), Levenson (1980), Ahlburg (1982), Alsalam (1985), Falaris and Peters (1985), Tan and Ward (1985) and Berger (1985 and 1989)), but also outside the US (see Martin and Ogawa (1988) for Japan, Ben-Porath (1988) for Israel, Dooley (1986) for Canada, Wright (1991) for the United Kingdom, Klevmarken (1993) and Dahlberg and Nahum (2003) for Sweden and Brunello (2010) for eleven European countries). The evidence on the relationship between cohort size and age employment profiles is somewhat scarcer (Wachter (1976), Levenson (1980), the OECD (1980), Ahlburg (1982), Russell (1982), Bloom and Freeman (1986), Ben-Porath (1988), Korenman and Neumark (1997), Schimer (2001) and Fertig and Schmidt (2003)).

The studies belonging to the so called “cohort crowding literature” investigate if the size of one’s cohort has repercussions on the level and shape of one’s earnings and employment profiles. In particular, the theory predicts that large cohorts suffer from lower earnings (and/or lower employment rates or higher unemployment rates) when entering the labour market. Most of the studies of the cohort crowding literature were published in the late 1970s, 1980s and 1990s and investigated the labour market opportunities of the 1950s baby boomers (individuals belonging to unusually large cohorts) when entering the labour market. One can use a similar approach to investigate the impact of labour force ageing on individuals’ age-earnings and employment profiles. The only difference is that, in the context of an ageing labour force, individuals entering the labour market belong to unusually small (rather than unusually large) cohorts.

The basic theory underlying the cohort crowding literature is rather intuitive and is based on one main assumption: workers of different ages (i.e. workers belonging to different cohorts) are, in effect, different factors of production, as compared to the more homogeneous factor capital. Put differently, workers of different ages are imperfect substitutes in production, especially in high skilled occupations. In a labour market undergoing labour force ageing, the scarcity of younger workers rises relative to older workers.

As long as workers of different ages are imperfect substitutes in production, an increase in the relative supply of one cohort will, by a simple supply-demand adjustment, have comparatively negative economic repercussions for that cohortt. Standard theories predict that in response to an increase in the supply of an input, its price and utilization rate will decline. This could mean either lower wages or higher unemployment rates (lower employment rates), in relative terms, for the factor of production which is now more abundant, i.e. older workers. The exact extent to which wages and (un)employment opportunities change depends on the degree of substitutability between younger and older workers in the production process and the institutional framework of the labour market.

If the labour market were to work without significant frictions and wage rates were free to move both upwards and downwards, the labour market would simply adjust through the wage mechanism: the relative wages of the scarcer factor of production (young workers in the context of an ageing population) would rise. Since income from work is the main income source for most individuals and families, this would imply a higher per-capita income in the young generation.

However, if the labour market were imperfectly competitive and to some extent rigid (as often is the case in industrialised countries due to labour unions, minimum wage laws and other legislation aimed at making it complicated and costly to hire and fire workers), the wage structure would be prevented from adjusting completely to variations in relative factor scarcities. The consequences would arise in terms of employment and unemployment and one would expect a negative relationship between the individual probability of being employed and the size of her cohort.

4.2.1 Cohort size and age-earnings profiles

Two path breaking papers were published in the US in the late 1970s, by Freeman (1979) and Welch (1979). Following the 1950s baby boom, Freeman (1979) and Welch (1979) investigate if individuals belonging to large cohorts (i.e. baby boomers) suffer from depressed earnings when entering the labour market and if such (negative) effect tends to become weaker or stronger as individuals age and gain more experience.

Welch (1979) uses nine waves of the Current Population Survey (CPS) - from 1967 to 1975 – and focuses on men aged 14 to 65. In his 1979 paper, Welch develops a simple "career-phase" model according to which individual work histories are viewed as a progression of fairly rigid work phases. More specifically Welch (1979) divides an individual’s professional career in two main phases: a learning phase and an experienced phase. Young and inexperienced workers tend to be concentrated in the former, old and experienced workers in the latter. Each activity is productive and marginal productivities are determined by the number of workers engaged in all activities. The law of diminishing returns implies that the increase in the relative size of one group will decrease its relative productivity. For example, an increase in the relative size of younger workers will decrease their productivity (there will be more inexperienced workers assisting older workers) and their relative earnings, if earnings are a positive function of productivity.

Welch (1979) regresses the logarithm of weekly earnings on a number of explanatory variables, including: years of experience (also squared), cohort size, early career spline, interaction between cohort size and spline, the national aggregated unemployment rate for white males (a proxy variable used for business cycles which varies between, but not within, surveys), a linear time trend and a dummy variable capturing the share of those working part-time (included as partial control for hours worked). Welch (1979) uses a measure of potential experience where experience is imputed using data on age, year of birth and years of schooling (see Welch (1979), pp.68-69). Smith and Welch (1978) note that for the CPS data, wage profiles are not adequately described by the commonly used quadratic, experience and experience squared (see Welch (1979), pp.83). The early career spline is then added to allow more flexibility to the wage path flucutations and to take into account that earnings typically grow at a faster rate at the beginning of a career[16]. Welch (1979) believes that the wages of a particular cohort are affected by its own size and by the size of the surrounding (two preceding and two following) cohorts. Cohort size is thus computed using a moving average with inverted V weights (being equal to 1/9, 2/9, 3/9, 2/9 and 1/9) of the fraction of those who are in a specific year of experience.

In order to control for selectivity bias in reporting income, Welch (1979) also includes as explanatory variable the fraction of observations lost in computing mean earnings because of the imputation problem. For example, if those who do not report income have above-average income, the mean wage of those reporting income will be lower the higher the proportion of those not reporting. Welch (1979) finally includes as an explanatory variable the fraction of observations who do not have valid income observations (most of those excluded appear to have worked but are coded as having no earnings or have very low earnings so that it is likely that their earnings were coded incorrectly (less than $10)). Presumably, those excluded on this basis have below-average earnings and thus as their proportion increases, also the mean wage of those included should increase[17].

Welch's main objective is to estimate the effects of own cohort size on earnings. Welch (1979) looks at education levels separately, assuming that individuals compete mainly with others in the same level of education. Substitution between schooling classes is ignored in favour of a sharpened focus within classes. He considers four different schooling completion groups: 8-11, 12, 13-15 and 16+ years of education completed. The regression observations are means computed within survey year for single-year experience intervals. In order to control for

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[16] SPLINE = 1 – EXPER/EXPER' if EXPER≤EXPER' and SPLINE=0 if EXPER>EXPER' where EXPER' is assumed to be exogenous and is given a value that ranges from six for high school dropouts to nine for college graduates. For example, SPLINE=0 for a college graduate with at least six years of experience, SPLINE=0.33 for a college graduate with four years of experience and SPLINE=0.66 for a college graduate with two years of experience.

[17] $$\ln(WKEARN) = b_0 + b_1 EXPER + b_2 EXPER^2 + b_3 SPLINE + b_4 COHORT + b_5 COHORT \cdot SPLINE + b_6 UNEMP + b_7 YEAR + b_8 NON\_WORK + b_9 INC\_IMP + b_{10} PART\_TIME + e$$

heteroskedasticity, which often affects grouped data, Welch (1979) weights each observation by the number of earners in each experience cell.

Welch (1979) finds that the relationship between cohort size and earnings is negative but also that most of the negative effect comes early in the career, implying a rapid earnings recovery for the baby boom cohorts. Finally, he finds evidence of more rapid earnings growth amongst the more educated.

Freeman (1979) uses earnings by age from the Current Population Survey of the Bureau of the Census for 1968 and 1977. He first regresses weekly (annual) earnings of workers belonging to a specific education and age group on educational, age and racial dummy variables[18]. He also regresses the ratio of the income of old and young workers on the logarithm of the ratio of number of old and young workers, a measure of the state of business cycle (i.e deviation of the logarithm of real gross national product (GNP) from its trend level) and a time trend, introduced to control for those factors that might impact on the demand for young and old male workers and thus on the relevant income ratios[19]. He runs the model separately for four-year college graduates and high school graduates.

Freeman (1979) finds significant evidence that the age-earnings profiles of male workers are negatively related to cohort size, especially for college graduates. He also finds that early recovery amongst baby boom cohorts has been relatively weak. Finally, he finds no evidence of more rapid earnings growth amongst the more educated. Freeman (1979) also investigates the age-earnings profile of female workers, finding little evidence of a relationship between cohort size and age-earning profiles. This result is probably due to a higher degree of substitutability between younger and older women, given their often intermittent career path.

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18 $\ln W_{ij} = \alpha + \sum_{ij} \beta_{ij} E_i \cdot A_j + \delta R_{ij} + \mu_{ij}$ where W_{ij} = weekly or annual earnings of workers in the ith education and jth age group (where i = 0-8, 9-11, 12- 13-15, 16, 17 or 17+ years of schooling and j=18-24, 25-29, 30-34, 35-44, 45-54 and 55-64 years of age); E_i = dichotomous dummy variable that takes the value of 1 for persons in the i-th education group and 0 otherwise; A_j = dichotomous dummy variable taking the value of 1 for persons in the jth age group and 0 otherwise; and R_{ij} = dummy variable that takes the values of 1 for blacks. μ_{ij} is assumed $N(0, \sigma^2)$.

19 $$\ln E\left(\frac{45-54}{25-34}\right) = \alpha + \beta\left(\frac{N45-54}{N20-24}\right) + \gamma BUSINESS\_CYCLE + \delta TIME\_TREND + \mu$$

Following these two path-breaking papers, a number of scholars have investigated the relationship between cohort size and age-earnings profiles, especially in the US. Most of these studies are reviewed below.

Levenson (1980) uses time series US data for the period 1967 to 1977 to regress real income on relative cohort size and a constructed variable which captures the effects of secular productivity growth and business cycle fluctuations. These regressions are run separately for different race-gender groups and for both all workers and full-time workers only. Levenson (1980) finds evidence of a negative relationship between cohort size and earnings for full-time male and female college graduates. However, the estimated effects are less uniform for high school graduates.

Ahlburg (1982) regresses the median income received by 14-24 year old American males (and 25-34 year olds) to 45-54 year olds on the ratio of the male population aged 16-29 to the male population aged 30-64. He uses data for the time period 1953 to 1976. Ahlburg (1982) finds evidence of a negative association between the ratio of the income received by younger and older workers and the ratio of the numbers of younger and older individuals in the population.

Berger (1985) claims that Welch's theoretical framework is restrictive when assuming exogenous – independent of cohort size - speed of transition from the learning to the experienced phase. According to Welch (1979), large and small cohorts proceed through the career at the same speed. However, Berger (1985) disagrees on this and argues that larger cohort size might delay the transition from inexperienced to experienced worker, mainly due to congestion and lower-quality (or higher-cost) learning activities.

Berger (1985) initially uses the same data used by Welch (i.e. CPS in the period 1967 to 1975) and then extends his analysis to the period 1967 to 1979. Following Welch (1979), Berger (1985) regresses the logarithm of weekly earnings on a number of explanatory variables, including: years of experience (also squared), cohort size, interaction between cohort size and experience, the national aggregated unemployment rate for white males, a linear time trend, a dummy variable capturing the share of those working part-time, the fraction of observations lost in computing mean earnings because of the imputation problem and the fraction of observations who did not work and therefore have no reported earnings[20].

Following Welch (1979), Berger (1985) weights his observations by cell frequencies of earners. As in Welch (1979), Berger (1985) constructs the exogenous variable EXPER', ranging from six for high school dropouts to nine for college graduates. However, Berger (1985) splits the observations in two sub-samples: individuals with experience lower than EXPER' and individuals with experience higher than EXPER'. This is equivalent to running separate equations for younger and older worker sub-samples. Berger (1985) focuses his analysis on the younger subsample. He argues that estimates for older workers are less interesting since these individuals have already been fully absorbed into the labour force and have made any necessary adjustment in response to cohort size. He also argues that the likely presence of uncontrolled vintage effects (other than cohort size effects) makes it inadvisable to project the future experiences the baby-boom cohorts based on the current experience of older workers (see Berger (1985), p. 569).

Berger's results of the younger cohort sub-sample indicate that cohort size generally has a negative effect on earnings levels (coefficient of cohort size is negative), but also appears to slow down earnings growth (coefficient of the interaction between cohort size and experience is negative). This finding is directly opposite the conclusion reached by Welch (1979). Berger (1985) claims that the lower observed rates of earnings growth in large cohorts are consistent with slower speed of transition between the learning and fully trained stages of the career (see Berger (1985), p.573).

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$$\ln(WKEARN) = a_{0i} + a_{1i}EXPER + a_{2i}EXPER^2 + a_{3i}COHORT + a_{4i}COHORT \cdot EXPER + a_{5i}UNEMP + \\ + a_{6i}YEAR + a_{7i}NON\_WORK + a_{8i}INC\_IMP + a_{9i}PARTTIME + e$$

Alsalam (1985) uses data from the US Current Population Survey, for the time period 1968 to 1984. Alsalam (1985) develops a theoretical model that builds on the work of Freeman (1979) and estimates separate experience-earnings profiles equations for workers with different levels of education. The model estimates the elasticities of substitution between different types of labour, but also imposes the restriction that workers with similar experience are closer substitutes than workers with different amounts of experience. Alsalam (1985) finds evidence that members of large-sized cohorts earn less than members of relatively small cohorts. This result is particularly strong for college graduates.

Falaris and Peters (1985) use panel data from the National Longitudinal Surveys of Young Men and Women and from the Panel Study of Income Dynamics to estimate regression equations in which the regressants are completed education, age at completion of schooling and hourly wages upon entry into the labour force.
Falaris and Peters (1985) find evidence that the direct effect of cohort size on entry earnings is negative.

Tan and Ward (1985) use data from the 1968 to 1981 Current Population Surveys (March) to regress the weekly wages and annual earnings of white US males on cohort size (where individuals belonging to the same cohort are individuals entering the labour force during the same period of time), years of experience, real GNP, unemployment rate, and labour force size. Tan and Ward (1985) find that a 1 percent increase in cohort size is associated with a 0.25-0.35 percent reduction in the weekly wages of labour force entrants. They also find that this negative cohort size effect falls to 0.1-0.15 percent as experience increases.

Berger (1989) uses data for white males from the Current Population Survey for the time period 1968 to 1984 (March). Berger (1989) captures the individual's position in the demographic cycle by including both the measure of own cohort size and the size of the surrounding cohorts (preceding and following). He regresses the average logarithm of the real weekly earnings on: experience (measured as age minus age of entry to the labour market) and its square; relative cohort size for own, preceding and following cohorts, also interacted with experience and experience squared; the proportion in each age-education cell working part-time; the aggregate unemployment rate for white males; the proportion of each cell excluded from the average earnings calculation; a time trend; and a constant[21]. The model is estimated within each schooling group and the observations are weighted by cell frequencies to correct for heteroskedasticity.

In contrast to Welch (1979), Berger (1989) finds a positive effect on the earnings level and a negative effect on the return to experience, resulting in flatter (less concave) earnings profiles for large cohorts. He uses a human capital approach to interpret his results, claiming that those in larger cohorts possibly make smaller investments in human capital than those in smaller cohorts. Those belonging to larger cohorts have higher earnings at labour market entry but also slower earnings growth during their career due to smaller investments in human capital. Holding constant own cohort size, those with larger cohorts preceding or following them have on average steeper (more concave) earnings profiles. As the sizes of the surrounding cohorts increase, the members of the cohort opt for greater investment in human capital. They initially have lower earnings but then experience more rapid earnings growth than cohorts of the same size that are not surrounded by larger cohorts. Berger (1989) therefore concludes that large cohorts invest less in post-schooling human capital, while cohorts surrounded by large cohorts invest more.

There are also a few studies of cohort size and relative earnings in other countries than the United States. These include Japan (Martin and Ogawa ,1988,, Israel (Ben-Porath, 1988), Canada (Dooley, 1986), the United Kingdom (Wright, 1991), Sweden (Klevmarken, 1993 and Dahlberg and Nahum, 2003) and 11 European countries (Brunello, 2010).

21

$$\ln(EARN) = b_0 + b_1 EXPER + b_2 EXPER^2 + b_3 COHORT + b_4 (COHORT \cdot EXPER) + b_5 (COHORT * EXPER^2) +$$
$$+ b_6 COHLEAD + b_7 (COHLEAD * EXPER) + b_8 (COHLEAD * EXPER^2) + b_9 COHLAG + b_{10} (COHLAG * EXPER) +$$
$$+ b_{11} (COHLAG * EXPER^2) + b_{12} PARTTIME + b_{13} UNEMPL + b_{14} YEAR + b_{15} PCTPUT + e$$

Dooley (1986) uses the Survey of Consumer Finances data for six different years (1971, 1973, 1975, 1977, 1979 and 1981). Individual data are provided only for the head of the census family and spouse. Dooley (1986) focuses his analysis only on men who are in employment - aged 20 to 64 - and excludes self-employed and unpaid family workers.

Dooley (1986) follows Welch's (1979) approach in many ways but expresses his final equation in terms of change between two time periods (i.e. t (1971-1973) and t+k (1979-1981)) to avoid any bias given that the Survey of Consumer Finances is based only on family heads. He replaces experience with age and uses population rather than sample weights. He identifies four different education categories: eight years or less of elementary schooling; nine to thirteen years of elementary and secondary schooling; some post-secondary education, but not a University degree; and university degree[22].

Dooley (1986) finds that larger cohort size leads to lower earnings at entry (coefficient of cohort size is negative) and that this effect weakens with age (coefficient of interaction between cohort size and age in positive). However, he finds that the negative effect of cohort size is stronger for those with a secondary education than for those with a university degree. This finding suggests that the declining return to schooling is partly a demand-driven phenomenon.

Martin and Ogawa (1988) use the Japanese basic survey of wage structure (BSWS) - which collects data on firms with more than 10 employees every year – for the time period 1962 to 1981. They regress the natural logarithm of the ratio of earnings of workers aged 40-49 to earnings of workers aged 20-24 on: a constant; the deviation of the logarithm of GDP from its trend – this is expected to reflect the influence of changes in the general economic situation on the age-earnings profile -; and the natural logarithm of the ratio of the labour force aged 40-49 to that of 20-24 – this is

22

$$\ln(E)_{i,t+k} - \ln(E)_{i,t} = \beta_1(U_{t+k} - U_t) + \beta_2(t+k-t) + \beta_3(t+k-t)AGE_i + \beta_4(CS_{i,t+k} - CS_{i,t}) +$$
$$+ \beta_5 AGE_i(CS_{i.t+k} - CS_{i,t}) + \beta_6(PTM_{i,t+k} - PTM_{i,t}) + (\varepsilon_{i,t+k} - \varepsilon_{i,t})$$

expected to represent the effect of age structure changes on relative wages. Martin and Ogawa (1988) do not include educational attainment due to data unavailability[23]. They repeat their analysis for a number of different industries, ranging from finance and insurance to mining and transportation and communication. Martin and Ogawa (1988) find evidence that both demand pressure and decreases in cohort size of young males and females – and particularly the former - increase their relative wages.

Ben-Porath (1988) uses Israeli data for the time period 1970 to 1982. He regresses the relative earnings of men aged 18-24 to those aged 35-64 on: a constant; the overall rate of unemployment of men aged 35-54; and the relative size of the age group 18-34. He then runs a similar regression replacing the relative size of the age group 18-34 with the relative size of the age group 65+. Ben-Porath (1988) finds significant negative effects on earnings of both the unemployment rate and own cohort size.

Wright (1991) uses a time-series of cross-sections constructed from the British General Household Survey, for the time period 1973-1982. Wright (1991) regresses the logarithm of weekly earnings on a number of explanatory variables, including: age (also squared), cohort size, interaction between cohort size and age, the national aggregated unemployment rate for males, a linear time trend (also squared) and a dummy variable capturing the share of those working part-time (included as partial control for hours worked)[24].

Following Welch (1979), Wright (1991) computes the cohort size measure by using a moving average with inverted V weights (1/9, 2/9, 3/9, 2/9 and 1/9), based on the idea that the earnings of a particular age group are affected by both the size of its own cohort and the size of the surrounding cohorts. Welch (1979) - and then Berger

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23 $WR = a + b_1 CYCLE + b_2 LABOR + u$

24
$$\ln(E)_{it} = a_0 + a_1 AGE_i + a_2 AGE_i^2 + a_3 \ln(CS)_{it} + a_4 \ln(CS)_{it} \cdot AGE_i + a_5 PT_{it} + a_6 U_t + a_7 t + a_8 t^2 + e_{it}$$

(1985) and Dooley (1986) - define the cohort size variable in terms of individuals with a certain level of education. However, Wright (1991) claims that such a cohort size measure is not exogenous and hence biased. This would be the case if the members of a particular large cohort invested more in education than they would otherwise do in order to avoid negative crowding out effects on their earnings. Accordingly, Wright (1991) opts for a cohort size measure which is not education specific.

Wright (1991) finds that changes in cohort size do not affect the earnings of British males with no qualifications beyond base school level (coefficients of cohort size and interaction between cohort size and age are not statistically significant). He claims that this could mean that workers with no qualifications are perfect substitutes in production or that the labour market has adjusted to cohort size changes through a change in the relative (un)employment rate. However, Wright (1991) also finds that larger cohort size does depress the earnings of British males with intermediate or higher qualifications when they enter the labour market (the coefficient of cohort size is negative and statistically significant) and that this negative effect weakens with age / experience (the interaction between cohort size and age is positive and statistically significant). In other terms, according to Wright (1991) the earnings disadvantage of being a member of a large cohort affects only workers with medium or high qualifications and does not appear to persist over the life-cycle.

Klevmarken (1993) uses three waves of the Swedish HUS-panel data (1984, 1986 and 1988) and regresses the logarithm of male hourly earnings on a wide number of explanatory variables, including: years of schooling (also squared); experience; the interaction between schooling and experience; age (also squared); seniority; relative cohort size (also interacted with schooling); investments; change in investments since career start; the interaction between investment change and schooling; and the interaction between cohort size and age. He computes cohort size by using a moving average with inverted V weights (1/9, 2/9, 3/9, 2/9 and 1/9) and plugs the size of the Swedish population in the age range 15-24 in the denominator. Klevmarken (1993) finds that all cohort variables are insignificant and therefore finds no support for the existence of a significant relationship between cohort size and age-earnings profiles in Sweden. However, he also claims that this might be due to an insufficient number of waves used (three)[25].

Also **Dahlberg and Nahum (2003)** focus on Sweden and use LINDA, a register-based longitudinal data base containing a three percent sample of the Swedish population.

In order to define the variable experience, they use a spline transformation where the earnings profiles are assumed to be linear within specific experience levels (experience is equal to age minus years in education minus seven). When constructing the spline, they divide the sample into three groups referring to experience levels 0-11, 12-24 and 25+ years, respectively. Cohort size is measured as the number of births per thousand inhabitants for each birth cohort. To control for time effects, they use both time dummies and macroeconomic variables, including GDP per capita (to control for the business cycle) and net migration (to control for the net inflow of working age migrants). Given that in the Swedish context unemployment and GDP per capita are not correlated for most of the period studied, they also include unemployment amongst the regressors. Dahlberg and Nahum (2003) then regress the logarithm of annual earnings on experience, cohort size, GDP per capita, unemployment and net migration. They estimate their equation on four levels of education separately (8-11 years, 12 years, 13-14 years and 15 and more).

Contrary to previous evidence in the literature, they find that cohort size has a significant positive effect on the level of earnings, irrespective of education level and sex.

25

$$\ln(E)_{it} = a_0 + a_1 SCHOOLING_{it} + a_2 SCHOOLING_{it}^2 + a_3 EXPER_{it} + a_4 DITTO_{it}^2 + a_5 SCHOOLING_{it} \cdot EXPER_{it} + a_6 AGE_{it} + a_7 AGE_{it}^2 + a_8 SENIORITY_{it} + a_9 CS + a_{10} CS \cdot SCHOOLING\_10\_15 + a_{11} CS \cdot SCHOOLING\_16 + a_{12} INV_{it} + a_{13} INV\Delta_{it} + a_{14}(INV\Delta \cdot SCHOOLING\_10\_15) + a_{15}(INV\Delta \cdot SCHOOLING\_16) + a_{16} CS \cdot AGE + a_{17} BORN\_1920_{it} + e_{it}$$

Brunello (2010) uses seven waves of the ECHP (European Community Household Panel), from 1995 to 2001, to investigate how changes in cohort size affect real earnings in 11 European countries. He follows Wright (1991) and finds that cohort size has a negative and statistically significant effect on earnings and that this effect is larger for the older age group (aged 35 to 54) than for the younger group (aged 20 to 34). He also finds that this negative effect is stronger in Southern European countries. He argues that this is due to higher employment protection laws which are in place in the Olive Belt of Europe. He concludes that the demographic shift away from the young and toward the old, a baby bust after a baby boom, is likely to tilt age-earnings profiles in favour of the young more in Southern than in Northern Europe (pp. 5-6).

4.2.2 Cohort size and age-employment profiles

Wachter (1976) uses 1948 to 1975 time-series data to regress the unemployment rates of US male and female teenagers on the unemployment rate of 25-54 year old men and the proportion of the working age population in the age group 16-24.
Watcher (1976) finds a strong positive relationship between unemployment and cohort size. However, one should bear in mind that the number of other control variables is limited in Watcher's model (1976).

The **OECD (1980)** carries out a comprehensive study where a simple economic-demographic model - which relates movements in youth unemployment rates to a set of cyclical, demographic and trend factors - is estimated separately for ten countries including Australia, Canada, Finland, France, Germany, Italy, Japan, Sweden, the United Kingdom and the United States (the time periods covered vary by country).

In the basic regression equation, the natural logarithm of unemployment rates of both male and female teenagers at different ages (e.g. 15-19, 20-24 and 15-24) are regressed on the logarithm of the adult unemployment rate (included as cyclical proxy), a linear time trend (included to capture the effects of factors such as rising school participation rates and other trended variables omitted from the equation) and the logarithm of a relative cohort size variable (population in the relevant age and sex-specific group as a proportion of the total population of working age), included to control for the effects of demographic shifts on youth unemployment[26]. The OECD study (1980) focuses only on the unemployment due to lack of time-series data on earnings for a large sample of countries.

The empirical results of the OECD study (1980) show that the explanatory power of the demographic variable (relative cohort size) is mixed. The cohort size variable has a small or statistically insignificant effect in most of the regressions for Australia, Finland, France and Sweden. However, the estimated cohort size effect tends to be positive and is often significant for youth cohorts in Canada, Germany, Italy, Japan, the United Kingdom and the United States. This supports the hypothesis that larger cohorts are disadvantaged – in terms of higher unemployment – when entering the labour market. In particular, the elasticity of relative cohort size with respect to the group-specific unemployment rate in Italy is 1.2 for males aged 20-24 and 1.8 for females aged 20-24.

Levenson (1980) uses time series US data for the period 1947–1979 to regress teenage unemployment rates on cohort size, adult unemployment rates and a minimum wage variable. Levenson (1980) finds evidence of a positive and statistically significant relationship between cohort size and unemployment rate for different time periods and different race-sex groups.

Ahlburg (1982) regresses the ratios of the unemployment rates of 20-24 year old American males (and 25-34 year olds) to 45-54 year olds on the ratio of the male population aged 16-29 to the male population aged 30-64. He uses data for the time period 1948-1976. Ahlburg (1982) finds evidence of a positive association between the number of unemployed younger workers relative to older workers and the ratio of younger to older individuals in the population. However, the empirical results of this study should be interpreted as simple correlation, and not as evidence of causal relationships.

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26 $\ln(UR)_{ij} = \alpha_0 + \alpha_1 \ln(UR) + \alpha_2 t + \alpha_3 \ln(POP)_{ij} + \varepsilon$, where i stands for sex and j for age group.

Bloom and Freeman (1986) investigate the extent to which the labour market problems faced by young workers in a number of industrialized countries in the 1970s and early 1980s are a consequence of their larger than normal cohort size. They use OECD data for a number of countries, including Australia, Canada, France, Japan, Sweden, the UK and the USA.

The dependent variable used in the model developed by Bloom and Freeman (1986) is the logarithm of expected relative wages, calculated as the product of the wages paid youths and one minus the youth unemployment rate divided by the product of the wages paid adults and one minus the adult unemployment rate. Bloom and Freeman (1986) argue that this dependent variable is able to capture cohort size effects that operate on either unemployment or wages. Bloom and Freeman (1986) regress this variable on a constant and five independent variables, including:

- cohort size, measured as the logarithm of the ratio of young to older men in the relevant age groups;
- a linear trend, included to capture any trend factors such as technological change that might affect youth unemployment or wages;
- the logarithm of the male adult unemployment rate, included to capture cyclical factors;
- the logarithm of female labour participation, included to capture the increased female work activism independent of demographic factors; and
- country dummy variables[27].

Bloom and Freeman (1986) find evidence for significant cohort, cycle, trend and country effects. The elasticity of expected relative wages to cohort size is significant and comparable in magnitude to the elasticities found in other studies (-0.22).

Bloom and Freeman (1986) also investigate the trade-off between relative wages and relative unemployment by regressing the logarithm of youth to adult unemployment

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27

$$\ln(EXP\_WAGE)_{it} = a_1 + \alpha_2 \ln(CS_{it}) + \alpha_3 \ln(U_t) + \alpha_4 t + \alpha_5 \ln(F\_LAB\_PART_t) + \alpha_6 D_{it} + \varepsilon_{it}$$

on the logarithm of relative wages, a time trend, the logarithm of the adult male unemployment rate and the logarithm of the female participation rate. They obtain a highly significant and sizeable positive coefficient on relative wages[28].

Bloom and Freeman's (1986) empirical results seem to indicate that cohort effects alter the relative economic position of young workers (the effect of cohort size on the expected relative earnings is negative) and that there exists a marked trade-off between unemployment and wages, with large cohort sizes reducing relative earnings in some countries and reducing relative employment in others.

Ben-Porath (1988) uses Israeli data for the time period 1970 to 1982. He regresses logged unemployment rates for young men on employment rates for older men and a relative (labour force) cohort variable. Ben-Porath (1988) finds evidence that relative cohort size has a positive effect on unemployment rates.

Korenman and Neumark (1997) estimate a series of regression models to isolate the effects of exogenous changes in potential youth labour supply on youth employment and unemployment rates using a panel data set on 15 countries (US, Canada, Australia, Japan and 11 European countries, including the UK, Italy, Norway, Spain, Sweden, Ireland Portugal) over more than 20 years.

In their basic model, Korenman and Neumark (1997) regress the logarithm of the youth unemployment (employment) rate on: the logarithm of the relative cohort size (aimed to capture supply influences); a number of cyclical controls - including the logarithm of the adult unemployment and employment rates –, aimed to capture demand influences; and a vector of dummy variables capturing the timing of changes in the definitions of various series in the dataset[29]. Relative cohort size is measured as the ratio of population aged 15-24 to population aged 25 -64. The cohort crowding hypothesis predicts the coefficient of cohort size to be negative in the employment regression and positive in the unemployment regression.

28

$\ln(REL\_U\_RATE_{it}) = a_1 + \alpha_2 \ln(U_t) + \alpha_3 t + \alpha_4 \ln(FLABPART_t) + \alpha_5 D_{it} + \alpha_6 \ln(REL\_WAGE)_{it} + \varepsilon_{it}$

29 $\ln(E)_{it} = \ln(RCS_{it})\beta + \ln(AE)_{it}\gamma + D_{it}\delta + \varepsilon_{it}$, where i indexes country and t indexes year.

In their preferred estimates (including fixed year and country effects and AR autocorrelation), Korenman and Neumark (1997) find that large youth cohorts lead to increases in the unemployment rate of youths, with elasticities ranging around 0.5 or 0.6. However, the estimates also indicate little effect of relative cohort size on employment rates of youths.

Schimer (2001) uses data from within the United States, for the time period 1970 to 1996. In the basic empirical model, Shimer (2001) regresses the unemployment rate in state i and year t on the youth share of the working age population, defined as the ratio of the number of 16 to 24 year olds to the number of 16 to 64 year olds. He also includes state and year effects. Schimer (2001) also estimates similar regressions where the dependent variable is given by the employment-population ratio or the labour market participation rate[30].

Shimer (2001) finds a negative relationship between the youth share of the population and the unemployment rate, with an elasticity of 1.5 (in absolute terms). Schimer (2001) claims that his results might be opposite to the results of the cohort crowding literature because young workers migrate to states with low unemployment rates.

Fertig and Schmidt (2003) use the 1999 wave of the European Community Household Panel (ECHP) for all EU-15 countries except Luxembourg and include only the economically active population (aged 15-64). Fertig and Schmidt (2003) estimate a probit model where the dependent variable is the individual employment status, taking the value of 1 if the individual is regularly employed and zero otherwise. The dependent variable is regressed on three different sets of regressors, including:

- individual characteristics, including the individual's gender, his/her level of educational attainment, a variable indicating whether or not an individual has any

[30] $\log(RATE)_{it} = \alpha_i + \beta_t + \gamma \log(SHARE)_{it} + \varepsilon_{it}$

chronic physical or mental health problem, illness or disability and the individual's age. Individuals are split into 3 age groups (15-29, 30-55 and 55-64);

- variables measuring the demographic change, expressed in terms of relative cohort size and its square. Relative cohort size is measured as the share of individuals in each five-year age-brackets relative to the total population. If wages do not (fully) respond to changes in cohort size, one can expect to find a negative relationship between the individual probability of being employed and the size of one's own cohort. Also a variable capturing the share of highly educated individuals in each cohort in included, in order to capture the effect on individuals of responses in a generation's average human capital accumulation to changes in its relative cohort size; and
- a full set of country indicators, acting as country fixed effects.

Fertig and Schmidt (2003) estimate an u-shaped relationship between the individual employment probability and the size of one's own cohort. For small cohorts, the employment probability is falling with increasing cohort size, whereas for large cohorts (larger than approximately 6% of the total population) employment probability is increasing with increasing cohort size. Fertig and Schmidt (2003) conclude that this could indicate that larger cohorts are able to exert enough influence in the labour market given their size or unfold activities to mitigate the negative labour market consequences of generational crowding. Fertig and Schmidt (2003) claim that "the market itself might mitigate the disadvantages of generational crowding. A related phenomenon concerns questions of political economy. Particularly in the corporatist economies of continental Europe, we might expect large cohorts to experience relatively favorable outcomes, since they can influence the working of the market to their advantage (p. 22).

The results of the cohort-crowding literature review are summarised in Table 4.1 below.

Table 4.1: Cohort-crowding literature review

Cohort-size and age-earnings profiles – evidence from the US		
Author(s) & Empirical Model	**Data**	**Conclusions**
Freeman (1979) regresses the weekly (annual) earnings of workers belonging to a specific education and age group on educational, age and racial dummy variables. Also regresses the ratio of the income of old and young workers on the logarithm of the ratio of number of old and young workers, on a measure of the state of business cycle and a time trend	Current Population Survey of the Bureau of the Census for 1968 and 1977 (US)	Finds significant evidence that the age-earnings profiles of male workers are negatively related to cohort size, especially for college graduates. Also finds that early recovery amongst baby boom cohorts has been relatively weak. Finally, finds no evidence of more rapid earnings growth amongst the more educated
Welch (1979) regresses the logarithm of weekly earnings on: years of experience (also squared), cohort size, early career spline, interaction between cohort size and spline, the national aggregated unemployment rate for white males, a linear time trend, a dummy variable capturing the share of those working part-time, the fraction of observations lost in computing mean earnings because of the imputation problem and the fraction of observations who do not work and therefore have no reported earnings. Looks at education levels separately. Cohort size is computed using a moving average with inverted V weights of the fraction of those who are in a specific year of experience	9 waves of the Current Population Survey - from 1967 to 1975. Focus is on men aged 14 to 65	Finds that the relationship between cohort size and earnings is negative but also that most of the negative effect comes early in the career, implying a rapid earnings recovery for the baby boom cohorts. Finally, contrary to Freeman (1979) finds evidence of more rapid earnings growth amongst the more educated
Levenson (1980) regresses real income on relative cohort size and a constructed variable which captures the effects of secular productivity growth and business cycle fluctuations. Regressions are run separately for different race-gender groups and for both all workers and full-time workers only	Uses time series US data for the period 1967 – 1977	Finds evidence of a negative relationship between cohort size and earnings for full-time male and female college graduates. However, the estimated effects are less uniform for high school graduates
Ahlburg (1982) regresses the median income received by 14-24 year old American males (and 25-34 year olds) to 45-54 year olds on the ratio of the male population aged 16-29 to the male population aged 30-64	Uses data for the time period 1953-1976	Finds evidence of a negative association between that the ratio of the income received by younger and older workers and the ratio of the numbers of younger and older individuals in the population. However, the empirical results of this study should be interpreted as simple correlation, and not as evidence of causal relationships
Falaris and Peters (1985) estimate regression equations in which the regressants are completed education, age at completion of schooling and hourly wages upon entry into the labour force	Use panel data from the National Longitudinal Surveys of Young Men and Women and from the Panel Study of Income Dynamics	Find evidence that the direct effect of cohort size on entry earnings is negative

Author(s) & Empirical Model	Data	Conclusions
Alsalam (1985) estimates separate experience-earnings profiles equations for workers with different levels of education. The model estimates the elasticities of substitution between different types of labour, but also imposes the restriction that workers with similar experience are closer substitutes than workers with different amounts of experience	Uses data from the US Current Population Survey, for the time period 1968 to 1984	Finds evidence that members of large-sized cohorts earn <u>less</u> than members of relatively small cohorts. This result is particularly strong for college graduates
Tan and Ward (1985) regress the weekly wages and annual earnings of white US males on cohort size (where individuals belonging to the same cohort are individuals entering the labour force during the same period of time), years of experience, real GNP, unemployment rate, and labour force size	Use data from the 1968 to 1981 Current Population Surveys (March)	Find that a 1 percent increase in cohort size is associated with a 0.25-0.35 percent reduction in the weekly wages of labour force entrants. Also find that this negative cohort size effect falls to 0.1-0.15 percent as experience increases
Berger (1985) claims that Welch's theoretical framework is restrictive when assuming exogenous – independent of cohort size - speed of transition from the learning to the experienced phase. Splits the observations in two sub-samples (younger and older workers). Following Welch, regresses the logarithm of weekly earnings on a number of explanatory variables, including: years of experience (also squared), cohort size, interaction between cohort size and experience, the national aggregated unemployment rate for white males, a linear time trend, a dummy variable capturing the share of those working part-time, the fraction of observations lost in computing mean earnings because of the imputation problem and the fraction of observations who did not work and therefore have no reported earnings	Initially uses the same data used by Welch (i.e. CPS in the period 1967 – 1975) and then extends analysis to the period 1967 – 79	The results of the younger cohort sub-sample indicate that cohort size generally has a negative effect on earnings levels (coefficient of cohort is negative), but also appears to slow down earnings growth (coefficient of the interaction between cohort size and experience is negative). This direct finding is directly opposite the conclusion reached by Welsh (1979)
Berger (1989) regresses the average logarithm of the real weekly earnings on experience and its square, relative cohort size for own, preceding and following cohorts, also interacted with experience and experiences squared, the proportion in each age-education cell working part-time, the aggregate unemployment rate for white males, the proportion of each cell excluded from the average earnings calculation, a time trend and a constant	Uses data for white males from the Current Population Survey for the time period 1968-1984 (March)	In contrast to Welch (1979), Berger (1989) finds a positive effect on the earnings level and a negative effect on the return to experience, resulting in flatter (less concave) earnings profiles for large cohorts. He uses a human capital approach to interpret his results, claiming that those in larger cohorts possibly make smaller investments in human capital than those in smaller cohorts

Cohort-size and age-earnings profiles – evidence from outside the US		
Author(s) & Empirical Model	**Data**	**Conclusions**
Dooley (1986) focuses his analysis only on men who are in employment, aged 20 to 64, and excludes self-employed and unpaid family workers. Follows Welch's (1979) approach in many ways but expresses his final equation in terms of change between 2 time periods (i.e. t (1971-1973) and t+k (1979-1981)). Replaces experience with age and uses population rather than sample weights. Identifies 4 different education categories	Uses the Survey of Consumer Finances data for 6 different years (1971, 73, 75, 77, 79 and 81)	Finds that larger cohort size leads to lower earnings at entry and that this effect weakens with age (coefficient of interaction between cohort size and age in positive). However, finds that the negative effect of cohort size is stronger for those with a secondary education than for those with a university degree
Ben- Porath (1988) regresses the relative earnings of men aged 18-24 to those aged 35-64 on: a constant; the overall rate of unemployment of men aged 35-54; and the relative size of the age group 18-34. Then runs a similar regression replacing the relative size of the age group 18-34 with the relative size of the age group 65+	Uses Israeli data for the time period 1970 – 1982	Fnds significant negative effects on earnings of both the unemployment rate and own cohort size. However, also finds the strange result that the relative size of the age group 65+ has a negative impact on the relative wage of young males
Wright (1991) regresses the logarithm of weekly earnings on: age (also squared), cohort size, interaction between cohort size and age, the national aggregated unemployment rate for males, a linear time trend (also squared) and a dummy variable capturing the share of those working part-time	Uses a time-series of cross-sections constructed from the British General Household Survey, for the time period 1973-1982	Finds that changes in cohort size do not affect the earnings of British males with no qualifications beyond base school level. Claims that this could mean that workers with no qualifications are perfect substitutes in production or that the labour market has adjusted to cohort size changes through a change in the relative (un)employment rate. Also finds that larger cohort size does depress the earnings of British males with intermediate or higher qualifications when they enter the labour market and that this negative effect weakens with age / experience
Klevmarken (1993) regresses the logarithm of male hourly earnings on: years of schooling (also squared); experience; the interaction between schooling and experience; age (also squared); seniority; relative cohort size (also interacted with schooling); investments; change in investments since career start; the interaction between investment change and schooling; and the interaction between cohort size and age	Uses 3 waves of the Swedish HUS-panel data (1984, 1986 and 1988)	Finds that all cohort variables are insignificant and therefore finds no support for the existence of a significant relationship between cohort size and age-earnings profiles in Sweden. Claims that this might be due to an insufficient number of waves used (3)
Dahlberg and Nahum (2003) regress the logarithm of annual earnings on experience, cohort size, GDP per capita, unemployment and net migration. Estimate equation on four levels of education separately	Use LINDA, a register-based longitudinal data base containing a 3% sample of the Swedish population	Contrary to previous evidence in the literature, find that cohort size has a significant positive effect on the level of earnings, irrespective of education level and sex

Author(s) & Empirical Model	Data	Conclusions
Brunello (2010) regresses real gross hourly earnings on cohort size, a time trend (also squared), age (also squared), the interaction between age and a time trend, a vector of country dummies (also interacted with the time trend), the Katz and Murphy index of relative demand shocks, the interaction between cohort size and a dummy variable for older workers and the interaction between cohort size and a dummy variable for Southern European countries	Uses 7 waves of the ECHP (European Community Household Panel), from 1995 to 2001	Finds that cohort size has a negative and statistically significant effect on earnings and that this effect is larger for the older age group (aged 35 to 54) than for the younger group (aged 20 to 34). Also finds that this negative effect is stronger in Southern European countries. He argues that this is due to higher employment protection laws which are in place in the Olive Belt of Europe
Cohort-size and age-employment profiles – evidence from the US		
Wachter (1976) regresses the unemployment rates of US male and female teenagers on the unemployment rate of 25-54 year old men and the proportion of the working age population in the age group 16-24	Uses 1948 – 1975 US time-series data	Finds a strong positive relationship between unemployment and cohort size. However, the number of other control variables is limited
Levenson (1980) regresses teenage unemployment rates on cohort size, adult unemployment rates and a minimum wage variable	Uses time series US data for the period 1947–1979	Finds evidence of a positive and statistically significant relationship between cohort size and unemployment rate for different time periods and different race-sex groups
Ahlburg (1982) regresses the ratios of the unemployment rates of 20—24 year old American males (and 25—34 year olds) to 45—54 year olds on the ratio of the male population aged 16-29 to the male population aged 30-64	Uses data for the time period 1948-76	Finds evidence of a positive association between the number of unemployed younger workers relative to older workers and the ratio of younger to older individuals in the population. However, the results should be interpreted as simple correlation, and not as evidence of causal relationships
Schimer (2001) regresses the unemployment rate in state i and year t on the youth share of the working age population. Also includes state and year effects. Also estimates similar regressions where the dependent variable is given by the employment-population ratio or the labour market participation rate.	Uses data from within the United States, for the time period 1970 to 1996	Finds a negative relationship between the youth share of the population and the unemployment rate, with an elasticity of 1.5 (in absolute terms). The elasticities of the participation rate and employment ratio are positive and significantly smaller in magnitude. Claims that his results might be opposite to the results of the cohort crowding literature because young workers migrate to states with low unemployment rates

Cohort-size and age-employment profiles – evidence from outside the US		
Author(s) & Empirical Model	**Data**	**Conclusions**
The **OECD (1980)** regresses the natural logarithm of unemployment rates of both male and female teenagers at different ages (e.g. 15-19, 20-24 and 15-24) on the logarithm of the adult unemployment rate, a linear time trend and the logarithm of a relative cohort size variable (population in the relevant age and sex-specific group as a proportion of the total population of working age)	Uses OECD data for Australia, Canada, Finland, France, Germany, Italy, Japan, Sweden, the UK and the US (time periods covered vary by country).	The explanatory power of the demographic variable (relative cohort size) is mixed: has a small or statistically insignificant effect in most of the regressions for Australia, Finland, France and Sweden but tends to be positive and often significant in Canada, Germany, Italy, Japan, the United Kingdom and the United States
Bloom and Freeman (1986) regress the logarithm of expected relative wages on cohort size, a linear trend, the logarithm of the male adult unemployment rate, the logarithm of female labour participation, and country dummy variables. Also investigate the trade-off between relative wages and relative unemployment by regressing the logarithm of youth to adult unemployment on the logarithm of relative wages, a time trend, the logarithm of the adult male unemployment rate and the logarithm of the female participation rate	Use OECD data for a number of countries, including Australia, Canada, France, Japan, Sweden, the UK and the USA	Find evidence for significant cohort, cycle, trend and country effects. The elasticity of expected relative wages to cohort size is significant and comparable in magnitude to the elasticities found in other studies. Results seem to indicate that cohort effects alter the relative economic position of young workers and that there exists a marked trade-off between unemployment and wages, with large cohort sizes reducing relative earnings in some countries and reducing relative employment in others
Ben-Porath (1988) regresses logged unemployment rates for young men on employment rates for older men and a relative (labour force) cohort variable	Uses Israeli data for the time period 1970 – 1982	Finds evidence that relative cohort size has a positive effect on unemployment rates
Korenman and Neumark (1997) regress the logarithm of the youth unemployment (employment) rate on: the logarithm of the relative cohort size; a number of cyclical controls - including the logarithm of the adult unemployment and employment rates; and a vector of dummy variables capturing the timing of changes in the definitions of various series in the dataset	Use a panel data set on 15 countries over more than 20 years.	.Find in their preferred estimates that large youth cohorts lead to increases in the unemployment rate of youths, with elasticities ranging around 0.5 or 0.6. However, the estimates also indicate little effect of relative cohort size on employment rates of youths
Fertig and Schmidt (2003) estimate a probit model where the individual employment status is regressed on: individual characteristics (including the individual's gender, his/her level of educational attainment, a variable indicating whether or not an individual has any chronic physical or mental health problem and age); variables measuring the demographic change of one's own cohort, including cohort size, its square and a variable capturing the share of highly educated individuals in each cohort; and a full set of country indicators, acting as country fixed effects	Use the 1999 wave of the European Community Household Panel (ECHP) for all EU-15 countries except Luxembourg. Include only economically active population	Estimate an u-shaped relationship between the individual employment probability and the size of one's own cohort. For small cohorts, the employment probability is falling with increasing cohort size, whereas for large cohorts employment probability is increasing with increasing cohort size. Conclude that this could indicate that larger cohorts are able to exert enough influence in the labour market given their size or unfold activities to mitigate the negative labour market consequences of generational crowding

4.3 Conclusions from the literature review

4.3.1 Methodological considerations

The studies reviewed above are to some extent difficult to compare due to a number of underlying differences, including different definitions of the key variables and different empirical specifications and estimation techniques. However, a number of key conclusions can be drawn, especially when comparing older studies with more recent ones:

- The majority of studies stratify the underlying data by education (e.g. Wright (1991) and Welch (1979)), based on the assumption that workers mainly compete with people who have the same level of education;
- The position in the demographic cycle is captured through the cohort size measure. In more recent studies (Wright , 1991), a non-education-specific cohort size measure is substituted for an education-specific cohort size measure (Welch, 1979) and Berger, 1985). This is based on the assumption that endogeneity problems might arise if the education level attained by individuals depend on the size of their cohort;
- None of the papers of the cohort crowding literature review uses a measure of actual work experience. Welch (1979) uses a measure of potential experience where experience is imputed using data on age, year of birth and years of schooling (see Welch (1979), pp.68-69). Age is thus substituted for experience in more recent studies (Wright (1991). Age has the advantage of being directly measurable. Also, the age variable might capture differences in human capital at the time of graduation from school. Students do not graduate and join the labour force at the same age even if they have the same education level;
- Older studies, including Welch (1979) and Berger (1985), include an early career spline to allow more flexibility to the wage path and take into account that earnings grow at a faster rate at the beginning of the career. However, more recent studies (Wright (1991) and Dooley (1986)) drop the spline function claiming that earnings can simply be specified as a quadratic function of age

(earnings increase with age but at a diminishing rate). The use of a spline function seems to be equally arbitrary because one would need to choose at what age groups to place the knots;

- Both cohort and period effects are controlled for in most papers, the former through the cohort size variable, the latter through aggregated unemployment rates or time trends; and
- The majority of studies focus only on men (expecptions are OECD (1980), Falaris and Peters (1985) and Levenson (1980)). This is due to the intermittent career path of women.

Table 4.2 below summarises the most appropriate methods to adopt according to what emerged in the review of the articles focusing on the impact of generational crowding on the age-earnings and age-employment profiles published in the last thirty years:

Table 4.2: Main methodological conclusions from the literature review

Observations are to be split according to their level of education
Both cohort and period effects are to be controlled for
A measure of cohort size which is not education-specific is to be used
Age is to be substituted for experience
A quadratic specification of earnings is to be used instead of an early career-spline
The analysis is to be performed only on males

4.3.2 Key results

Although the studies reviewed above are to some extent difficult to compare as explained in Section 4.3.1, a number of key conclusions on the sign and magnitude of the impact of cohort size on age-earnings and age-employment profiles of males working in different countries can be drawn:

- In the US, Canada, the UK, Israel and Japan the labour market entry of relatively large cohorts has resulted in a decline of their relative earnings if compared to smaller cohorts. Also, cohort effects seem to be stronger for more educated workers;

- Sweden seems to be the only country in which the predictions of the cohort crowding literature are not fulfilled: the study by Klevmarken (1993) finds no support for the existence of a significant relationship between cohort size and age-earnings profiles and the study by Dahlberg and Nahum (2003) finds that cohort size has a significant *positive* effect on the level of earnings. Klevmarken (1993) claims that his insignificant results might be due to an insufficient number of waves used in his empirical analysis whereas Dahlberg and Nahum (2003) claim their results might be due to positive cohort size effects on aggregate demand, which in turn have positive effects on labour demand. Dahlberg and Nahum (2003) add that "we do not know much about these kinds of mechanisms, probably because it would be very difficult to isolate the effects. The only study on this we have come across is Macunovich (1999), who tries to separate the cohort effects on aggregate demand and labour supply with two different cohort size variables, in a large growth model. How the two measures separate between demand and supply is not clear. However, there is no doubt that demographic fluctuations must have some impact on both aggregate and labour demand" (p. 27);
- There is some uncertainty on the persistence of negative earnings effects for large cohorts later on in the career: some studies find evidence of more rapid earnings growth for large cohorts (e.g. Welch (1979) and Wright (1991)) while others find evidence of a slower earnings growth for large cohorts (e.g. Freeman (1979), Berger (1985)). Bloom and Freeman (1986) investigate in detail whether the adverse economic effects of generational crowding should be taken as temporary or permanent. Earnings of larger cohorts would grow more slowly if larger cohorts experienced slower promotions and earnings growth during their career due to a fiercer competition for a relatively fixed number of higher level jobs in company hierarchies. Conversely, earnings of larger cohorts would grow at a faster pace if large cohorts made labour market decisions which would help to reverse the negative effects of their size. For example, members of large cohorts could decide to invest more in on-the-job training during their career due to depressed wages and hence lower opportunity costs of on-the-job training at labour market entry; and

- The evidence on the effects of cohort size on age-employment profiles is mixed: the OECD (1980), Ben-Porath (1988) and Bloom and Freeman (1986) find evidence of a positive (negative) relationship between cohort size and unemployment (employment) profiles for Canada, Germany, Italy, Japan, the UK and the US. However, the OECD (1980) finds no evidence for Australia, Finland, France and Sweden. Finally, Fertig and Schmidt (2003) estimate a u-shaped relationship between the individual employment probability and the size of one's own cohort.

It is therefore reasonable to conclude that the cohort-crowding literature finds some evidence of an adverse effect of cohort size on larger cohorts' employment, unemployment and wages, across a number of countries.

4.4 The model

Following the cohort crowding literature, age-aggregated earnings and employment equations are estimated to investigate the effect of cohort size on earnings and employment opportunities of Italian males. The precise extent to which wages and (un)employment opportunities change following an increase/decrease in relative cohort size depends on the degree of substitutability between younger and older workers in the production process and the institutional framework of the labour market. If the Italian labour market were to work without significant frictions and the wage rates were free to move both upwards and downwards, the labour market would simply adjust through the wage mechanism. However, if the Italian labour market were imperfectly competitive and to some extent rigid, the consequences would also arise in terms of employment and unemployment. In order to investigate the manner and extent to which the Italian labour market is adjusting to changes in relative cohort size, both age-aggregated earnings and employment equations are estimated.

The following two simple models are estimated:

$$\ln(wage)_{it}^{s} = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \alpha_3 \ln(cs)_{it} + \alpha_4 \ln(cs)_{it} \cdot age_i + \alpha_5 \bar{u}_t + \alpha_6 t + \varepsilon_{it} \qquad [4.1]$$

$$\ln\left(\frac{e}{1-e}\right)_{it}^{s} = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \alpha_3 \ln(cs)_{it} + \alpha_4 \ln(cs)_{it} \cdot age_i + \alpha_5 \bar{u}_t + \alpha_6 t + \varepsilon_{it} \qquad [4.2]$$

where:

$(wage)_{it}^{s}$ = age-aggregated mean of (real gross) hourly earnings of age group i with education level s (s=1=medium-high education; s=2=low education) in year t;

$(e)_{it}^{s}$ = age-aggregated employment rate of age group i with education level s in year t[31];

age_i = age of group i where i=0=age 20, 1=age 21, 2=age 22, …, 34 = age 54[32];

cs_{it} = cohort size measure of age group *i* in year *t;*

$\bar{u}_t$ = aggregated unemployment rate in year t (per cent);

t = time trend where 0=1994, 1=1995,…,7=2001.

Following Dooley (1986, p.151) and Wright (1991, p.300), age is substituted for experience. As explained in Section 4.3.1, none of the papers of the cohort crowding literature review uses a measure of actual work experience. Welch (1979) uses a measure of potential experience where experience is imputed using data on age, year of birth and years of schooling (see Welch (1979), pp.68-69). Age has the advantage of being directly measurable. Also, the age variable might capture differences in human capital at the time of graduation from school. Students do not graduate and join the labour force at the same age even if they have the same education level.

Following Dooley (1986. p. 152) and Wright (1991, p. 300), an early career spline is not included in the model. In the literature, earnings are commonly specified as a quadratic function of age: earnings increase with age but at a diminishing rate. The use of a spline function would be equally arbitrary because the I would need to choose at what age groups to place the knots.

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[31] The logit specification is preferred to a simple logarithmic specification because it is not bounded.

[32] This implies a rescaling exercise where age 0 is age at labour market entry.

The position in the demographic cycle is captured through the cohort size measure (i.e. ln(cs)). Equation [4.3] shows that, following Welch (1979) and Wright (1991), cohort size is expressed as a moving average with inverted V weights of the age group *i*'s share in the total labour force, given here by males aged 15 to 64:

$$\ln(cs_{it}) = \ln\left(\frac{\sum_{k=-2}^{2}(w_k)(N_{i-k,t})}{\sum_{i=15}^{64} N_{it}}\right) \qquad [4.3]$$

where N_{it} denotes the number of Italian males aged i in year t and w_k denotes the set of V weights, equal to 1/9, 2/9, 3/9, 2/9 and 1/9. By definition, ln(cs) is always negative since it is the logarithm of a number between 0 and 1. In Welch (1979) and Berger (1985), the cohort size measure is education specific and therefore captures the share of males aged *i* with a specific education level in the labour force with the same education level. However, Wright (1991) claims this could lead to endogeneity problems if the education level attained by individuals depended on the size of their cohort. Following Wright (1991), the cohort size measure is demographically determined (not education specific). The data on the number of Italian males aged i in year t (N_{it}) are taken from Istat "Ricostruzione intercensuaria della popolazione per eta' e sesso al 1 Gennaio, Anni 1992-2001".

Following Welch (1979) and Wright (1991), the weighted moving average is used to incorporate the effects of the surrounding cohorts, based on the idea that the wages and employment profiles of a particular cohort (i.e. cohort 0) are affected by its own size, the size of the two preceding cohorts (i.e. cohorts -1 and -2) and the size of the two following cohorts (i.e. cohorts +1 and +2). The further away the cohorts, the less the degree of substitutability between workers belonging to different cohorts (the weights for cohorts ±2, ±1 and 0 are 1/9, 2/9 and 3/9, respectively). If measured through time, the relative cohort size measure of Equation [4.3] may change if, for example, the size of the cohort entering the labour force is not equal to the size of the cohort leaving the labour force.

In Equations [4.1] and [4.2] cohort size is also interacted with age. This interaction effect is introduced to investigate if the effect of cohort size on wages and employment profiles gets weaker or stronger as the individual gets older.

To test the possibility that changes in relative earnings and employment rates are dominated by cyclical rather than demographic factors, the aggregate unemployment rate is included as covariate. It is a proxy variable used for business cycles which vary between but not within surveys. Also a time trend is included to control for those other factors that might impact on workers' wages and employment profiles.

The signs and magnitudes of the parameters of Equation [4.1], and in particular of α_1, α_2, α_3 and α_4, provide information on how age and cohort size affect the shape of age-earnings profiles. α_1 and α_2 are expected to be positive and negative, respectively, given that earnings grow with age, but at a diminishing rate. Different possibilities of the sign of α_3 and α_4 are displayed in Figure 4.2 below.

If cohort size does not have any impact on earnings at labour market entry, α_3 is equal to 0. Similarly, if cohort size does not have any impact on earnings growth during the individual's career, α_4 is equal to 0. This outcome (α_3=α_4=0) is represented by the solid line (i). It is also convenient to think of this solid line as representing the age-earnings profile of individuals born into "normal" size cohorts.

The cohort crowding literature predicts that α_3 is negative, meaning that earnings opportunities of members belonging to large cohorts are depressed at labour market entry (age 20). Since the model is expressed in terms of age, this lower earnings at labour market entry is analogous to lower earnings for young workers belonging to large birth cohorts. This lower wages at labour market entry (α_3<0) is shown by the distance BC in Figure 4.2.

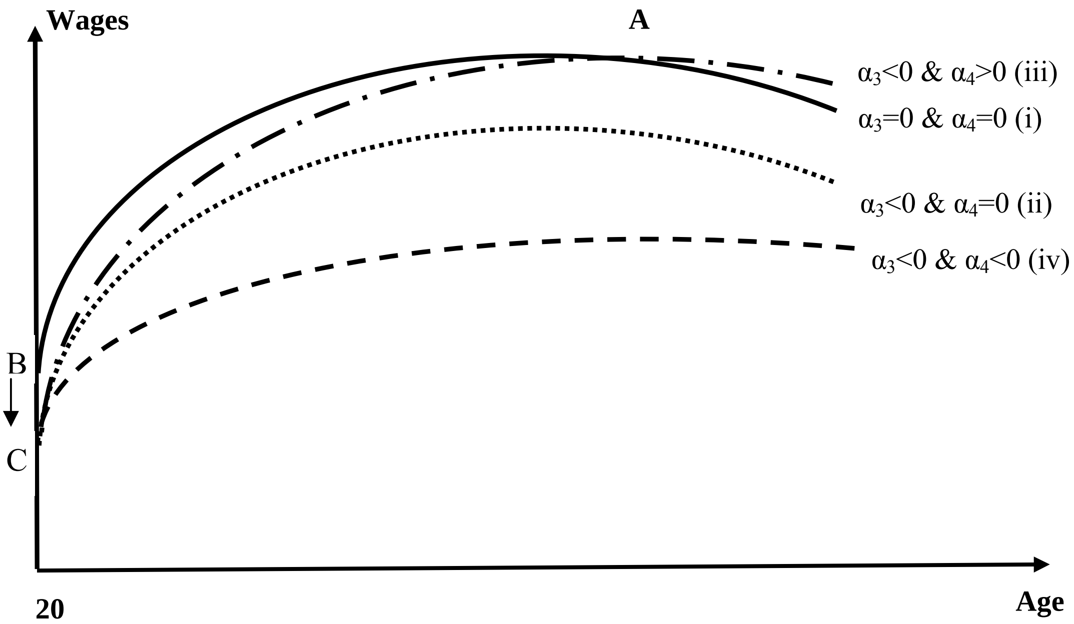
The sign of α_4 provides information on how cohorts size affects earnings growth. Three possibilities are displayed in Figure 4.2:

ii) if $\alpha_3<0$ and $\alpha_4=0$, then cohort size has no effect on earnings growth. Being a member of a large cohort depresses the level but does not tilt the shape of the cohort's earnings profile by age;

iii) if $\alpha_3<0$ and $\alpha_4>0$, then wages of large cohorts grow faster and overtake wages of "normal" cohorts in point A. Earnings of larger cohorts grow at a faster pace, possibly due to labour market decisions of members of large cohorts which help to reverse the negative effects of their size. For example, members of large cohorts invest more in on-the-job training during their career due to depressed wages and hence lower opportunity costs of on-the-job training at labour market entry; and

iv) if $\alpha_3<0$ and $\alpha_4<0$, wages of large cohorts grow more slowly than the wages of normal cohorts (flatter curve). Larger cohorts experience slower promotions and earnings growth during their career, possibly due to a fiercer competition for a relatively fixed number of higher level jobs in company hierarchies.

Figure 4.2: Possible cohort size effect on earnings of large cohorts



Note: α_1 is assumed to be positive and α_2 is assumed to be negative

The effect of cohort size on earnings and employment is likely to differ by education level. The gap between experienced and inexperienced workers is likely to be more marked in occupations that require higher skills. Following Welch (1979), Berger

(1985), Dooley (1986) and Wright (1991), the empirical analysis concentrates on earnings and employment within school-completion level. Individuals are split in two broad education categories: "medium or high education" and "low education". The former is given by individuals who have completed secondary or tertiary education[33], the latter by individuals with basic education[34]. Individuals with medium and high qualifications are merged due to a lack of data for the highly educated workers (i.e. insufficient number of observations). Appendix B shows that the results of a modified version of the Hausman test confirm strong evidence of statistically significant differences in the estimators for low and medium-high educated males aged 20 to 54.

4.4.1 Data and sample size

Two possible datasets can be used for the purpose of the analysis:

i) the European Community Household Panel (ECHP); and
ii) the Bank of Italy Survey on Household Income and Wealth (SHIW)

The European Community Household Panel (ECHP) is a longitudinal survey of households and individuals living in private households within the European Union. It includes eight waves (1994-2001). In its first wave, the ECHP covered around 130,000 individuals living in Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and the UK. The ECHP is coordinated by Eurostat, which sets a common questionnaire for all countries. The questionnaire includes a household register, a household questionnaire submitted to the household head or spouse/partner of the head and a personal questionnaire submitted to all eligible household members. The two major areas covered in the questionnaire concern the economic activity and personal income of the individuals

[33] "Diploma o qualifica di scuola media superiore di quattro o cinque anni", "diploma post-maturita' non universitario", "diploma universitario, laurea breve o laurea", "specializzazione post-laurea" or "dottorato di ricerca" in the Italian education system.
[34] "Licenza elementare", "licenza di scuola media inferiore" or "diploma o qualifica di scuola media superiore di due o tre anni" in the Italian education system.

concerned. However, a wider range of topics are investigated, including individuals' demographics, health, education and training.

In each country, the interviews are carried out by the National Data Collection Unit (NDU). National samples are selected through probability sampling. Within each country, the original sample of households and persons is followed over time at annual intervals. Individuals who move or form/join new households are followed up at their new location. Children in the original sample become eligible for the detailed personal interview when they turn 16 and children born to sample women are automatically included in the survey population. The detailed survey also covers all persons cohabiting with any of the original sample person in the same household.

The Bank of Italy Survey on Household Income and Wealth (SHIW) was conducted for the first time in 1965 and made available as microdata in 1977. It collects data on the economic activities of Italian households, with particular attention to income and real estate holdings. The questionnaire also includes information on demographics, housing, health, education and training. The sample used in the most recent surveys includes about 8,000 households (24,000 individuals) distributed over about 300 Italian municipalities. Since 1984, households to be interviewed are selected from the General Population Registers which are held by regional registry offices. Starting from the 1989 wave, a part of the sample is given by households with previous experience of SHIW participation (defined as "panel households").

In both the ECHP and the SHIW, individuals' wages are collected net of taxes. Net wages are then converted into gross wages in the ECHP through specific micro-simulation models (for more details, see European Commission (2004)). Net wages are not converted in gross wages in the SHIW. The ECHP is a preferable data source to investigate the impact of cohort size on earnings, giving the non linearity of income tax[35]. However, labour market variables are collected over a longer time span

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[35]The personal income tax (IRPEF - Imposta sui redetti delle persone fisiche) is a progressive tax which amounts to: 23% up to an annual gross income of €15,000; 29% between €15,001 and €29,000;

in the SHIW. Hence, the SHIW is a preferable data source to investigate the impact of cohort size on employment.

It follows that there are three possible options:

a. use the ECHP to investigate the impact of cohort size on wages (Equation [4.1]) and the SHIW to investigate the impact of cohort size on employment (Equation [4.2]);
b. use the ECHP to investigate the impact of cohort size on both wages and employment; and
c. use the SHIW to investigate the impact of cohort size on both wages and employment.

Due to the income tax system being non-linear in Italy, gross wages are preferred to net wages. Hence, option c is ruled out. Between options a and b, option b is preferred: using only one data source makes the analysis more homogeneous and enables a better comparison of both descriptive statistics and regressions' results. Also, the education variables are defined slightly differently in the two datasets under consideration. Employment results using the SHIW are presented for completeness in Appendix C. As explained in the Appendix, the results are similar to those obtained when using the ECHP. The SHIW is also used in Chapter 6, which investigates the impact of cohort size on labour market opportunities of Italian younger and older males.

Interval estimation is used to investigate if it is appropriate to use the employment rate sample mean (ECHP) as an estimate of the population mean, by constructing a 99% confidence interval for population average. The population mean is taken from Istat "Forze di Lavoro" ("Labour force"), which is the principal (and official) labour

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31% between €29,001 to €32,600; 39% between €32,601 and €70,000 and 45% for €70,001 and above.

market data source in Italy. 1.4% of the Italian population (around 800,000 individuals) are interviewed each year.

The 99% confidence interval for the population mean is computed as follows:

$$\overline{X} - 2.576 \cdot \left[\frac{S}{\sqrt{n}}\right] \leq \mu \leq \overline{X} + 2.576 \cdot \left[\frac{S}{\sqrt{n}}\right] \qquad [4.4]$$

lower bound upper bound

where:

S is the sample standard deviation;

$\overline{X}$ is the sample mean;

μ is the population mean; and

n is the sample size; and

2.576 is the critical t value

The probability is 0.99 that the random interval that goes from the lower to the upper bound contains the true μ. In other words, if 100 intervals are constructed, then 99 out of 100 such intervals will include the true μ.

Examples of confidence intervals computed for different education levels and age groups for years 2000 and 2001 are presented in Tables 4.3 and 4.4 below. The true population mean (i.e. Istat employment rate) lies in the computed confidence intevals for most of the age groups under consideration. Hence, the ECHP is an appropriate data source for the purpose of the analysis.

Table 4.3: ECHP employment confidence intervals, 2000

Age	Sample mean (ECHP)	Sample standard deviation (ECHP)	Sample size (ECHP)	Critical t value (99% confidence level – 2 tailed)	Lower bound	Upper Bound	Population mean (Istat)	Does the population mean lie in the 99% confidence interval?
Medium-high educated workers:								
20-24	0.371	0.484	432	2.576	0.311	0.431	0.305	No
25-29	0.626	0.484	450	2.576	0.567	0.685	0.621	Yes
30-39	0.791	0.407	338	2.576	0.734	0.848	0.868	No
35-39	0.914	0.280	271	2.576	0.871	0.958	0.950	Yes
40-44	0.979	0.145	296	2.576	0.957	1.000	0.962	Yes
45-49	0.956	0.205	267	2.576	0.924	0.988	0.965	Yes
50-54	0.941	0.236	198	2.576	0.898	0.984	0.913	Yes
Low educated workers:								
20-24	0.594	0.492	191	2.576	0.503	0.686	0.600	Yes
25-29	0.724	0.448	216	2.576	0.646	0.803	0.748	Yes
30-34	0.860	0.348	260	2.576	0.804	0.915	0.859	Yes
35-39	0.920	0.272	292	2.576	0.879	0.961	0.885	Yes
40-44	0.943	0.231	253	2.576	0.906	0.981	0.893	No
45-49	0.884	0.321	279	2.576	0.835	0.934	0.881	Yes
50-54	0.783	0.413	248	2.576	0.715	0.851	0.750	Yes

Sources : ECHP (wave 7) and Istat Forze di Lavoro (2000)

Table 4.4: ECHP employment confidence intervals, 2001

Age	Sample mean (ECHP)	Sample standard deviation (ECHP)	Sample size (ECHP)	Critical t value (99% confidence level – 2 tailed)	Lower bound	Upper Bound	Population mean (Istat)	Does the population mean lie in the 99% confidence interval?
Medium-high educated workers:								
20-24	0.379	0.486	389	2.576	0.316	0.442	0.319	Yes
25-29	0.646	0.479	447	2.576	0.588	0.705	0.636	Yes
30-39	0.813	0.391	409	2.576	0.763	0.862	0.876	No
35-39	0.903	0.297	342	2.576	0.861	0.944	0.949	No
40-44	0.980	0.139	303	2.576	0.960	1.001	0.961	Yes
45-49	0.980	0.139	268	2.576	0.958	1.002	0.966	Yes
50-54	0.914	0.281	185	2.576	0.861	0.967	0.919	Yes
Low educated workers:								
20-24	0.625	0.486	171	2.576	0.529	0.721	0.603	Yes
25-29	0.755	0.431	252	2.576	0.685	0.825	0.763	Yes
30-34	0.858	0.350	290	2.576	0.805	0.910	0.856	Yes
35-39	0.929	0.257	315	2.576	0.891	0.966	0.886	No
40-44	0.927	0.260	252	2.576	0.885	0.970	0.898	Yes
45-49	0.917	0.277	254	2.576	0.872	0.961	0.881	Yes
50-54	0.845	0.363	224	2.576	0.782	0.907	0.759	No

Sources : ECHP (wave 8) and Istat Forze di Lavoro (2001)

Data on gross wages by gender and age groups (other than the ECHP) are not collected in Italy, so interval estimation can not be performed.

In the ECHP, income is imputed for non-reporting individuals. However, imputation indexes are available only at household level and do not give enough information to distinguish between reported and imputed income at the personal level (for more details, see European Commission (2002)). Hence, I include individuals belonging to households for which income is imputed. Earnings - and employment rates in Equation [4.2] - are weighted using the normalised base weight for interviewed sample persons (see European Commission (2003a and 2003b)).

The ECHP provides data on current gross nominal monthly wages (000s of Liras) and number of hours worked per week (in main job). Weekly nominal gross wages are computed as the ratio of gross nominal monthly wages and number of weeks per month. Hourly gross nominal wages are computed as the ratio of weekly gross nominal wages and the total number of hours worked per week (in main job). Nominal gross hourly gross wages are finally converted into real gross hourly wages using CPI data (base year=1994).

The analysis is restricted to males given the intermittent career path of women. In the earnings model, males who are in self-employment or in unpaid family work are excluded. Only individuals aged 20-54 are included in the model: individuals aged more than 54 are excluded due to potential selection bias resulting from the non-randomness of retirement decisions (see Berger (1985) and Wright (1991)). For each education level (s=1 and s=2) there are 35 age groups (i.e. 0=age 20, 1=age 21, … 34= age 54) and 8 years of data (i.e. from 1994 to 2001). The model is then estimated on 280 observations (i.e. 35 age groups times 8 time periods).

Also, the regression model is assessed through a number of tests. To correct for heteroskedasticity, which often accompanies grouped data and also the model estimated in this analysis, White-corrected standard errors are estimated. The earnings and employment models are thus estimated using OLS with robust standard errors. These standard errors are asymptotically valid in the presence of any kind of heteroskedasticity and suitable for a standard inference procedure.

Ramsey's regression specification error test is used to detect general functional form misspecification. The test adds polynomials in the fitted values to Equations [4.1] and [4.2] to detect general kinds of functional form misspecification. The null hypothesis is that Equations [4.1] and [4.2] are correctly specified. The test enables me to determine that the earnings and employment models are correctly specified.

Multicollinearity exists whenever there is a non-zero correlation between two regressors (or linear combinations of regressors) in the model being estimated. Given that the likelihood of all covariates being perfectly uncorrelated with one another is close to zero, multicollinearity nearly always exists when doing applied research. In an extreme case, perfect multicollinearity is said to exist when two regressors (or linear combinations of regressors) exhibit *perfect correlation* in the sample data set. If this happens, the estimator will break down. Intuitively, parameter estimates are unobtainable as OLS is unable, in this extreme case, to identify the contributions that any individual variable makes to explaining the dependent variable. If correlation is not perfect but "very high", this will tend to lead to the standard errors of the estimators being large (relative to what they would be if regressors had a low degree of correlation). As a result, confidence intervals will tend to be large and the precision of the estimation and testing will be adversely affected.

In Equations [4.1] and [4.2] including both age and its square does not violate the "no perfect collinearity" assumption: although age squared is an exact function of age, it is not an exact linear function of age. It could be argued that including also the interaction term $age \cdot \ln(cs)$ increases multicollinearity (and hence the size of the standard errors). This may be true but does not justify the omission of the interaction term. As Brambon *et al* (2005) point out when discussing multicollinearity in presence of interaction terms, "even if there is high multicollinearity and this leads to large standard errors on the model parameters, it is important to remember that these standard errors are never in any sense ''too'' large: they are always the ''correct'' standard errors" (p. 70).

4.4.2 Preliminary analysis

Before turning to the regression results, the ECHP data are investigated more closely. Table 4.5 below shows that between 4,215 and 5,696 males aged 20 to 54 were interviewed each year between 1994 and 2001. In the first waves, around half of the defined population sample have a medium-high level of education. This slightly increases by the end of the sample period. Slightly more than three quarters of males aged 20 to 54 with low and medium-high qualifications are in employment. As expected, average wages of Italian medium-high educated workers are higher than average wages of low-educated workers. On average, low educated workers earn around 80% of medium-high educated workers.

Table 4.5: A closer inspection of the ECHP data (not weighted), 1994-2001

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
N males	5,696	5,710	5,680	5,263	5,078	4,908	4,627	4,215
% with low education	49.3%	48.1%	48.5%	49.0%	45.9%	45.5%	44.6%	43.2%
% with medium-high education	49.7%	49.1%	48.5%	47.7%	54.0%	54.4%	55.4%	56.8%
% in employment - low education	80.4%	77.1%	75.1%	73.2%	78.2%	78.9%	81.3%	82.6%
% in employment - medium-high education	72.5%	74.0%	76.0%	78.7%	76.6%	75.1%	76.1%	76.9%
average monthly wage - medium-high education (nominal)	2,736	2,722	2,821	2,944	2,972	3,065	3,139	3,257
average monthly wage - low education (nominal)	2,132	2,194	2,251	2,332	2,371	2,463	2,466	2,551
average monthly wage - medium-high education (real)	2,736	2,588	2,579	2,638	2,614	2,651	2,660	2,685
average monthly wage - low education (real)	2,132	2,086	2,058	2,089	2,085	2,131	2,089	2,103

Notes: the sum of the shares of low and medium-high educated workers is not 100% due to a number of individuals not reporting their highest level of education attained. Wages are expressed 000s of Liras. The base year used in the computation of real wages is 1994. Self-employed and those in unpaid work are excluded in the wage computations.

Also, before investigating the full model, earnings and employment data are smoothed by regressing the logarithm of real hourly gross wages and the logit of the employment rate on a constant, age and age squared.

Predicted wages are calculated as the *exponential value* of the predicted natural logarithm of wages, where predicted $\ln(wages) = \hat{\alpha}_0 + \hat{\alpha}_1 age + \hat{\alpha}_2 age^2$. The return to age is positive until $\frac{-\alpha_1}{2\alpha_2}$ (maximum of the function) and negative afterwards.

Predicted employment rates are calculated as $e = \frac{1}{1 + \exp[-\log it(e)]}$ where predicted $\log it(e) = \hat{\alpha}_0 + \hat{\alpha}_1 age + \hat{\alpha}_2 age^2$.

The results of the smoothed earnings and employment rates for males aged 20 to 54 in the first, fourth and last period (1994, 1997 and 2001) are presented in Figures 4.3 to 4.5 below.

Wages of older medium-high educated workers first decreased and then increased, showing an overall small change between 1994 and 2001. On the contrary, wages of older (younger) low-educated workers decreased (increased) in real terms between 1994 and 2001. The return of earnings to age is always positive for medium-high educated workers, whereas it turns negative at age 51 (in 2001) for low educated workers. Figure 4.4 shows that employment rates of medium-high educated workers increased at the beginning and end of the career and decreased in the remaining period between 1994 and 2001. Employment rates of low educated workers seem to have first decreased and then increased at all ages (Figure 4.5).

Figure 4.3: Smoothed earnings of Italian males aged 20 to 54; 1994, 1997 & 2001

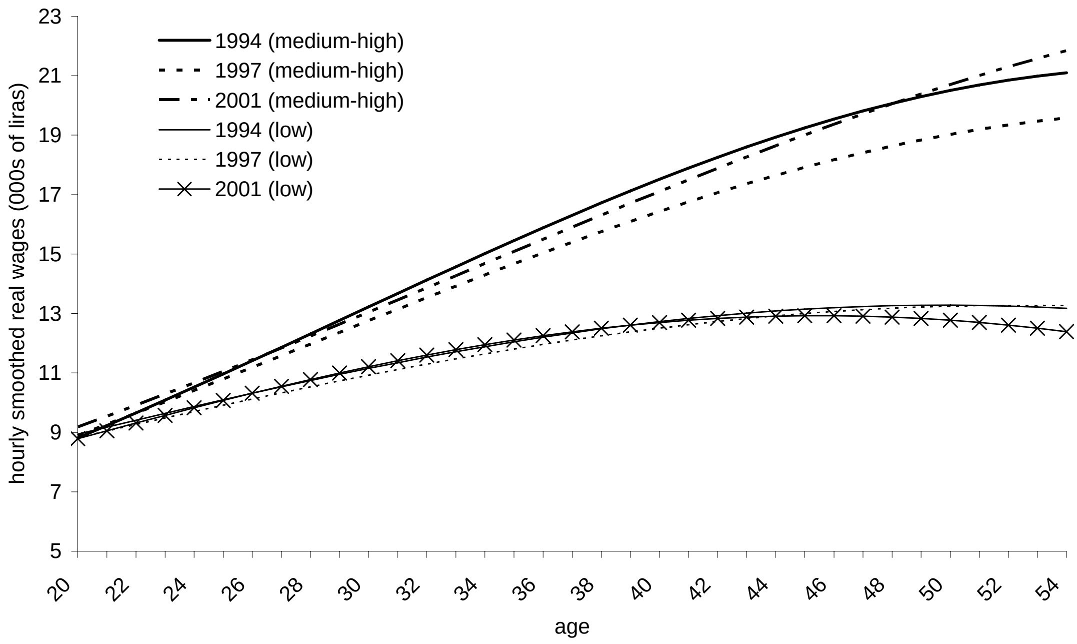


Figure 4.4: Smoothed employment rates of Italian males aged 20 to 54 with medium-high education; 1994, 1997 & 2001

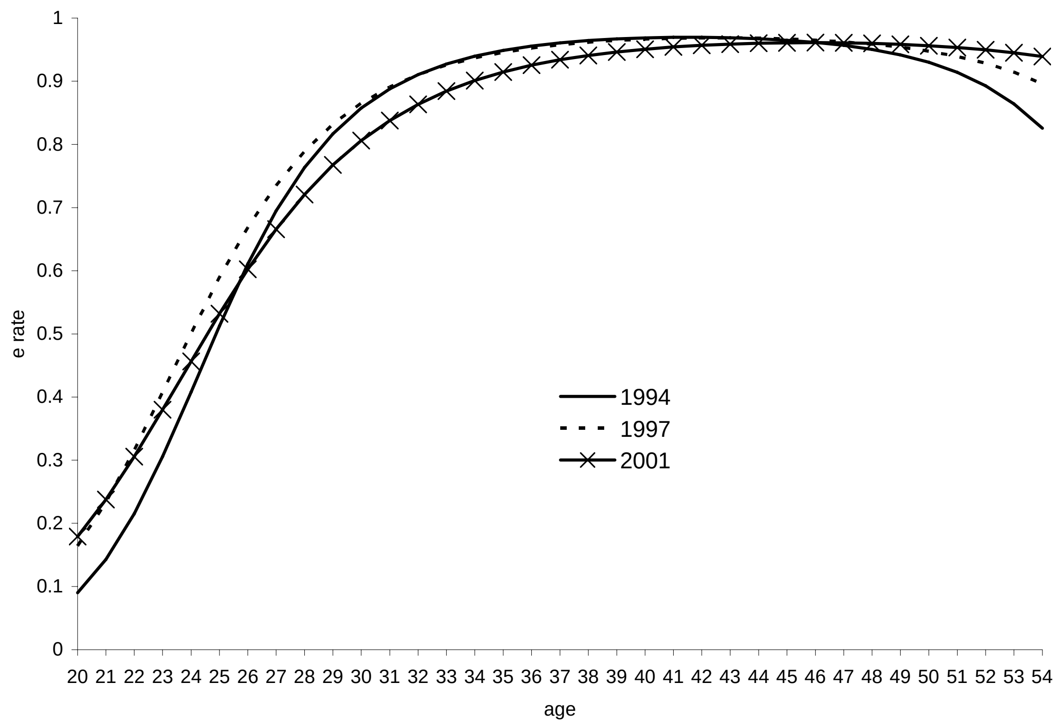
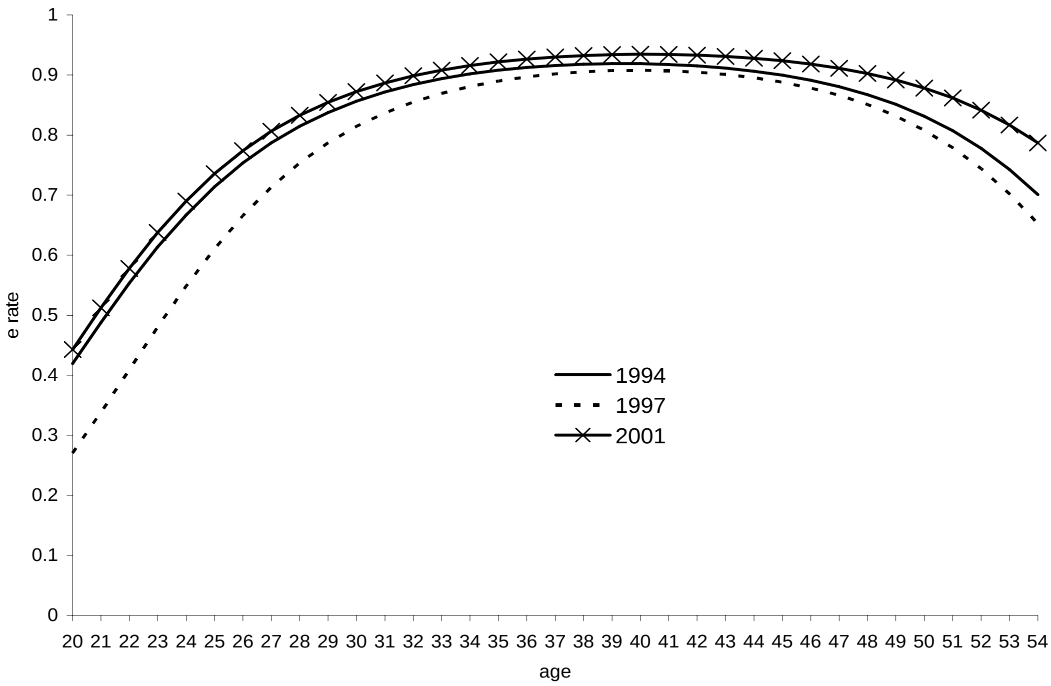


Figure 4.5: Smoothed employment rates of Italian males aged 20 to 54 with low education; 1994, 1997 & 2001



4.4.3 Results

Tables 4.6 to 4.9 report the estimates of Equations [4.1] and [4.2] for the two education levels identified (i.e. low education and medium-high education). Each table reports six specifications: specification 1 includes only age and age squared as regressors; specification 2 also includes ln(cs); the interaction between age and ln(cs) is added in specification 3; the aggregate unemployment rate is also included in specification 4; specification 5 drops the aggregated unemployment rate and includes the time trend instead; and specification 6 includes all the independent variables listed in Equations [4.1] and [4.2]. The R^2 for each specification is added at the bottom of the table. A table summarising the mean, standard deviation, minimum and maximum of all variables is also presented (Table 4.10).

Table 4.6: Parameter estimates of earnings equations, low educated Italian males aged 20-54, 1994-2001

Specification:	1	2	3	4	5	6
Age	0.024	0.023	0.017	0.007	0.002	0.001
	[14.7]	[14.4]	[0.8]	[0.3]	[0.1]	[0.1]
Age^2	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
	[8.7]	[7.2]	[6.6]	[6.8]	[6.8]	[6.8]
ln(cs)		0.034	0.053	0.079	0.087	0.090
		[0.5]	[0.5]	[0.8]	[0.9]	[0.9]
ln(cs)·age			-0.002	-0.005	-0.006	-0.006
			[0.3]	[0.8]	[0.9]	[1.0]
$\overline{u}$				-0.007		-0.004
				[1.6]		[0.7]
t					0.003	0.002
					[1.7]	[0.9]
α_0	2.203	2.334	2.404	2.584	2.526	2.583
	[173.3]	[9.2]	[6.4]	[6.7]	[6.7]	[6.8]
R^2	0.766	0.767	0.767	0.769	0.769	0.769
N	280	280	280	280	280	280

Notes: absolute value of t-statistics given in parentheses. The dependent variable is the natural logarithm of real gross hourly earnings. The estimation method is OLS with robust standard errors.

Table 4.7: Parameter estimates of employment equations, low educated Italian males aged 20-54, 1994-2001

Specification:	**1**	**2**	**3**	**4**	**5**	**6**
Age	0.299	0.310	0.701	0.438	0.565	0.527
	[28.3]	[27.4]	[6.2]	[4.0]	[5.1]	[4.9]
Age^2	-0.008	-0.008	-0.007	-0.008	-0.008	-0.008
	[26.0]	[23.0]	[18.5]	[20.0]	[18.3]	[19.0]
ln(cs)		-0.822	-1.922	-1.252	-1.602	-1.447
		[2.2]	[4.1]	[2.7]	[3.5]	[3.2]
ln(cs)·age			0.105	0.034	0.068	0.058
			[3.5]	[1.2]	[2.3]	[2.0]
$\overline{u}$				-0.180		-0.235
				[4.9]		[5.4]
t					0.027	-0.033
					[2.0]	[2.3]
α_0	-0.570	-3.718	-7.902	-3.317	-6.782	-3.311
	[7.8]	[2.6]	[4.5]	[1.8]	[3.9]	[1.8]
R^2	0.756	0.759	0.767	0.791	0.770	0.794
N	280	280	280	280	280	280

Notes: absolute value of t-statistics given in parentheses. The dependent variable is the natural logarithm of the employment rate divided by one minus the employment rate. The estimation method is OLS with robust standard errors.

Table 4.8: Parameter estimates of earnings equations, medium-highly educated Italian males aged 20-54, 1994-2001

Specification:	1	2	3	4	5	6
Age	0.042	0.043	0.13	0.107	0.114	0.111
	[22.1]	[20.4]	[6.2]	[4.6]	[4.9]	[4.7]
Age^2	-0.0005	-0.0006	-0.0004	-0.0005	-0.0005	-0.0005
	[8.9]	[8.1]	[5.8]	[6.4]	[6.1]	[6.1]
ln(cs)		-0.113	-0.358	-0.300	-0.319	-0.307
		[1.8]	[4.4]	[3.4]	[3.7]	[3.4]
ln(cs)·age			0.023	0.017	0.019	0.018
			[4.2]	[2.8]	[3.1]	[2.9]
$\overline{u}$				-0.016		-0.018
				[2.6]		[2.2]
t					0.003	-0.001
					[1.4]	[0.4]
α_0	2.201	1.767	0.837	1.236	0.973	1.236
	[177.5]	[7.2]	[2.7]	[3.3]	[3.0]	[3.3]
R^2	0.909	0.909	0.914	0.917	0.915	0.917
N	280	280	280	280	280	280

Notes: absolute value of t-statistics given in parentheses. The dependent variable is the natural logarithm of real gross hourly earnings. The estimation method is OLS with robust standard errors.

Table 4.9: Parameter estimates of employment equations, medium-highly educated Italian males aged 20-54, 1994-2001

Specification:	**1**	**2**	**3**	**4**	**5**	**6**
Age	0.459	0.507	1.313	1.534	1.567	1.586
	[28.7]	[30.4]	[6.9]	[8.3]	[8.3]	[8.4]
Age^2	-0.010	-0.012	-0.011	-0.010	-0.010	-0.010
	[21.2]	[21.4]	[15.6]	[15.8]	[15.1]	[15.2]
ln(cs)		-3.45	-5.722	-6.285	-6.231	-6.399
		[6.7]	[7.7]	[8.4]	[8.4]	[8.6]
ln(cs)·age			0.217	0.277	0.286	0.291
			[4.2]	[5.5]	[5.5]	[5.6]
$\overline{u}$				0.151		0.119
				[3.2]		[2.1]
t					-0.050	-0.020
					[3.5]	[1.1]
α_0	-1.900	-15.121	-23.758	-27.614	-25.854	-27.610
	[18.4]	[7.6]	[8.5]	[9.1]	[9.2]	[9.1]
R^2	0.842	0.862	0.872	0.878	0.876	0.878
N	280	280	280	280	280	280

Notes: absolute value of t-statistics given in parentheses. The dependent variable is the natural logarithm of the employment rate divided by one minus the employment rate. The estimation method is OLS with robust standard errors.

Table 4.10: Descriptive statistics of aggregated variables in earnings and employment equations, 1994-2001

Variable	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
Real hourly gross wage *w* (000s of Liras) - medium-high educated workers	15.475	3.861	8.454	28.000
Real hourly gross wage *w* (000s of Liras) - low educated workers	11.765	1.464	7.571	15.539
Employment rate ***e*** - medium-high educated workers	0.794	0.230	0.092	0.998
Employment rate ***e*** - low educated workers	0.789	0.150	0.207	0.985
Age	17	10.118	0	34
Age^2	391	355.903	0	1156
Natural logarithm of cs *ln(cs)*	-3.824	0.105	-4.055	-3.663
Interaction between ln(cs) and age ln(*cs)·age*	-65.628	40.240	-137.873	0
Aggregated unemployment rate $\overline{u}$ (per cent)	11.363	0.860	9.50	12.20
Time trend *t*	3.5	2.295	0	7

Turning first to the cohort size variables in the earnings equations for low educated workers (Table 4.6), both the main effect (ln(cs)) and the interaction between cohort size and age are *not* significant at conventional levels. However, the cohort size measure and its interaction with age seem to have an impact on the age-aggregated employment rate: Table 4.7 shows that the coefficient of ln(cs) is negative and significant in specifications 2 to 6 and the interaction of ln(cs) with age is significant and positive in specifications 3, 5 and 6. These results seem to show that in the Italian labour market, any adjustment due to cohort size change of low educated males is through the employment rate, rather than through the relative wage. These results are in line with the findings of the "cohort crowding literature". For example, also Wright (1991) finds the large cohorts of low skilled individuals do not suffer from depressed earnings.

Turning then to the cohort size variables in the earnings equations for workers with medium and high qualifications, the main effect (ln(cs)) is negative and significant in specifications 2 to 6 and the interaction between cohort size and age is positive and significant at conventional levels in specifications 3 to 6 (Table 4.8). Similar conclusions apply to the employment equations (Table 4.9), in which both the main cohort size effect and its interaction with age are significant and negative and positive, respectively, in all the specifications. These results seem to show that in the Italian labour market, any adjustment due to cohort size change of medium and highly educated males is both through their relative wages and employment rates.

4.4.4 Partial effects of cohort size

To capture the magnitude of the effect of cohort size on age-earnings and employment profiles, the elasticities of earnings and employment with respect to cohort size are calculated. The estimates of Specification 3 are used[36]. For simplicity purposes, the subscripts i and t and the superscript s are not reported in the elasticity calculations.

The elasticity of earnings with respect to cohort size is the percentage change in wages following a 1% increase in cohort size. It is given by:

$$\varepsilon(wage, cs) = \frac{\partial \ln(wage)}{\partial \ln(cs)} = \alpha_3 + \alpha_4 \cdot age \qquad [4.5]$$

Equation [4.5] shows that the effect of cohort size on wages depends on the value of age. At labour market entry (i.e. i=0=age 20), the elasticity of cohort size with respect to wages is simply given by α_3.

The elasticity of employment with respect to cohort size is the percentage change in employment rate following a 1% increase in cohort size. This elasticity is more difficult to compute. I start by calculating $\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial \ln(cs)}$, which, applying the Chain Rule, is given by:

[36] The reason behind the choice of Specification 3 instead of Specifications 4, 5 or 6 will be clearer in Chapter 5, footnote 38.

$$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial \ln(cs)} = \frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial e} \frac{\partial e}{\partial \ln(cs)} \qquad [4.6]$$

The first term of the right-hand side of Equation [4.6] is given by:

$$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial e} = \frac{\left(\frac{1}{1-e} + \frac{e}{(1-e)^2}\right)[(1-e)]}{e} = \frac{\left(\frac{((1-e)+e)(1-e)}{(1-e)^2}\right)}{e} = \frac{\frac{(1-e)}{(1-e)^2}}{e} = \frac{1}{e(1-e)} \qquad [4.7]$$

The left-hand side of Equation [4.6] is given by:

$$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial \ln(cs)} = \alpha_3 + \alpha_4 age \qquad [4.8]$$

Substituting [4.7] and [4.8] in [4.6] gives:

$$\alpha_3 + \alpha_4 age = \frac{1}{e(1-e)} \frac{\partial e}{\partial \ln(cs)} \qquad [4.9]$$

Equation [4.9] can be rearranged and expressed as:

$$\frac{\partial e}{\partial \ln(cs)} = \frac{\alpha_3 + \alpha_4 age}{\frac{1}{e(1-e)}} = (\alpha_3 + \alpha_4 age)e(1-e) \qquad [4.10]$$

The elasticity of employment with respect to cohort size is given by $\frac{\partial \ln(e)}{\partial \ln(cs)}$ which, applying the Chain Rule and using the results of Equation [4.10] can be expressed as:

$$\varepsilon(e, cs) = \frac{\partial \ln(e)}{\partial \ln(cs)} = \frac{\partial \ln(e)}{\partial e} \frac{\partial e}{\partial \ln(cs)} = \frac{1}{e}(\alpha_3 + \alpha_4 age)e(1-e) = (\alpha_3 + \alpha_4 age)(1-e) \qquad [4.11]$$

where e is the fitted value of the employment rate as obtained in Equation [4.2], Specification 3:

$$\hat{e} = \frac{1}{1 + \exp\left[-(\hat{\alpha}_0 + \hat{\alpha}_1 age + \hat{\alpha}_2 (age^2) + \hat{\alpha}_3 \ln(cs) + \hat{\alpha}_4 \ln(cs) \cdot age)\right]} \qquad [4.12]$$

The elasticity of employment with respect to cohort size depends on both age and cohort size. One can calculate the elasticity of employment with respect to cohort size at different ages (i.e. age 20=0, age 21=1, .., age 54=34) and for different cohort sizes (e.g. average and large). The average and large cohort size indexes are computed as the mean and maximum value of the cohort size measure of Equation [4.3].

The computed elasticities values are presented in Table 4.11 below, for ages 20, 25, 30, 35, 40, 45, 50 and 54. Also the take-over point (e.g. point where the effect of cohort size turns from negative to positive) is calculated.

Table 4.11: Earnings and employment elasticity calculations for medium-high and low educated workers

	Age:	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**54**	**Take over point**
Medium-high educated workers:										
ε(wage,cs)		-0.36	-0.24	-0.12	-0.01	0.11	0.23	0.34	0.44	36
ε(e,cs)	average cohort	-4.96	-2.01	-0.47	-0.12	-0.04	-0.01	0.04	0.19	46
ε(e,cs)	large cohort	-5.39	-2.86	-0.76	-0.18	-0.05	-0.01	0.04	0.15	46
Low educated workers:										
ε(e,cs)	average cohort	-1.22	-0.45	-0.14	-0.03	0.01	0.07	0.19	0.46	38
ε(e,cs)	large cohort	-1.35	-0.52	-0.15	-0.03	0.01	0.06	0.16	0.38	38

Notes: Specification 3 is used in the elasticities computations. Fitted values of α_3 and α_4 are used to compute the elasticity of wages with respect to cohort size. Fitted values of α_3, α_4 and e are used to compute the elasticity of employment with respect to cohort size.

Turning first to the earnings results for medium and highly educated males, the elasticity of wages with respect to cohort size at labour market entry (i.e. age 20=0) is equal to -0.36 (α_3). This is in line with other studies of the cohort crowding literature - for example, Wright (1991) computes an elasticity of -0.35 for high skilled workers. This means that at labour market entry, wages decrease by 0.36% following a 1% increase in cohort size. Put differently, smaller cohorts of young males entering the labour market will experience higher wages in relative terms. However, the elasticity turns from negative to positive at age 36.

The elasticity of employment with respect to cohort size at labour market entry is -4.96 for average cohorts and -5.39 for large cohorts. At labour market entry, the employment rate decreases by 4.96% for average cohorts and 5.39% for large cohorts following a 1% increase in cohort size. The impact of cohort size on employment at entry is hence negative and greater in magnitude for large cohorts. The elasticity turns from negative to positive at age 46.

Turning finally to the employment results for low educated males, the elasticity of cohort size with respect to employment at labour market entry is -1.22 for average cohorts and -1.35 for large cohorts. Once again, the impact of cohort size on employment at entry is negative and greater in magnitude for larger cohorts. However, the effect of cohort size on employment turns positive at age 38.

Given that the model used in the analysis includes an interaction term (i.e. $\ln(cs)\cdot age$), one could argue that it is necessary to go beyond the partial effect / elasticity calculations and compute the corresponding *standard errors* across the full range of the age variable (see Brambor *et al*, 2006). For completeness, these are computed and reported in Appendix D. The elasticity of wages with respect to cohort size is statistically insignificant at all ages for low educated workers, implying that low educated workers of different ages are substitutable in production, as predicted in the literature. The elasticity of $\frac{e}{1-e}$ with respect to cohort size is higher in absolute terms and statistically significant at 1% level at younger ages. This means that most of the (negative) effects of cohort size on employment opportunities come early in the career. Put differently, younger smaller cohorts will experience higher employment rates in relative terms.

The elasticities of wages and $\frac{e}{1-e}$ with respect to cohort size for medium-high educated workers are higher in absolute terms and statistically significant at 1% level at younger ages. Once again, the (negative) impact of cohort size on earnings and employment opportunities is stronger at the beginning of the career.

The results of Table 4.11 are shown graphically in Figures 4.6 – 4.8 below, which display the predicted earnings and employment rates of members belonging to average and large cohorts. Figure 4.6 shows that the earnings of medium and highly educated males increase with age, but at a decreasing rate. Also, large cohorts are disadvantaged at entry (this is shown by the vertical distance between the solid and dotted line at age 20) but also have faster earnings growth. The take-over point occurs at age 36.

Figures 4.7 and 4.8 show that the employment rate of both medium-high and low educated males have an inverted u-shape. The pattern is more marked for the latter group. Members of large cohorts are disadvantaged at entry (again, this is shown by the vertical distance between the solid and dotted line at age 20). However, the employment rate of large cohorts of medium-high and low educated males overtake the employment rate of average cohorts at age 46 and 38, respectively.

Figure 4.6: Predicted real gross hourly wages (000s Liras) of large and average cohorts of medium and highly educated Italian males, 1994-2001

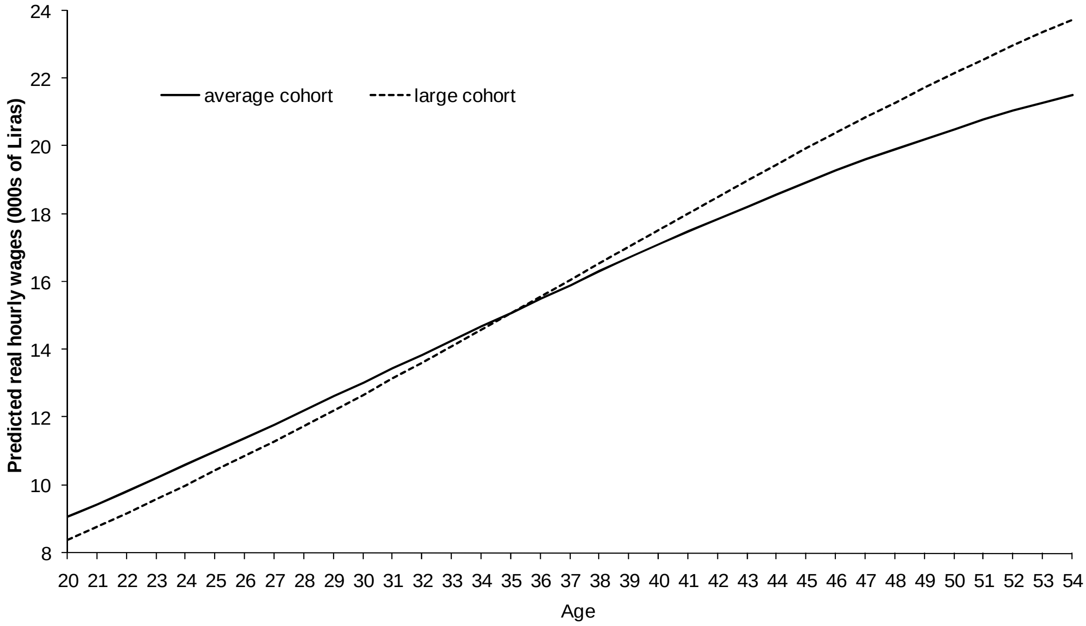


Figure 4.7: Predicted employment rate of large and average cohorts of medium and highly educated Italian males, 1994-2001

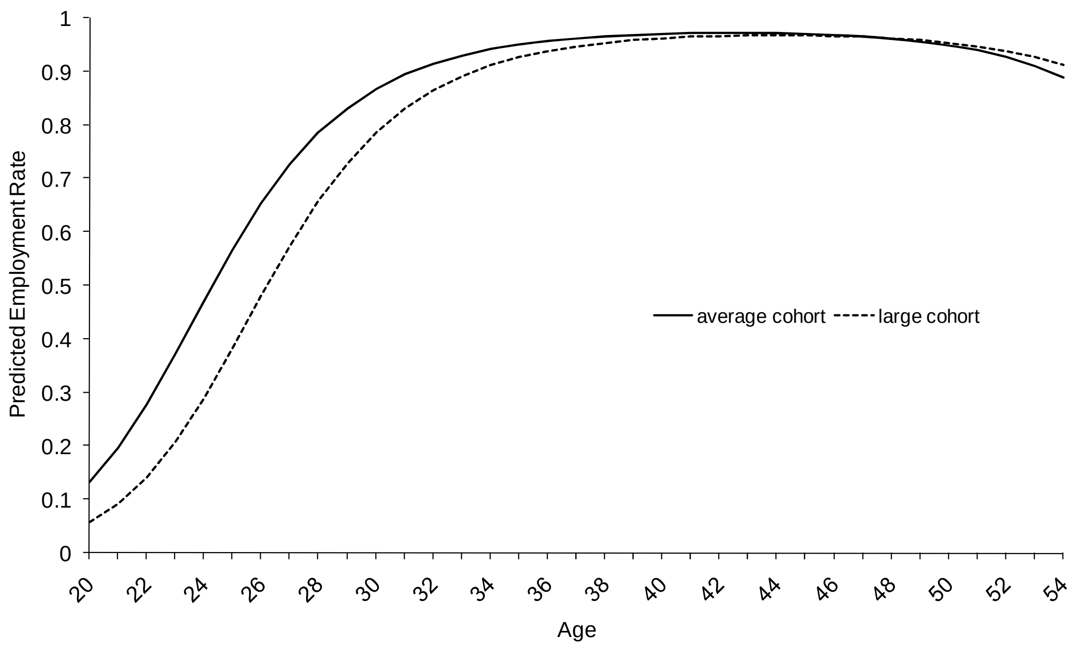
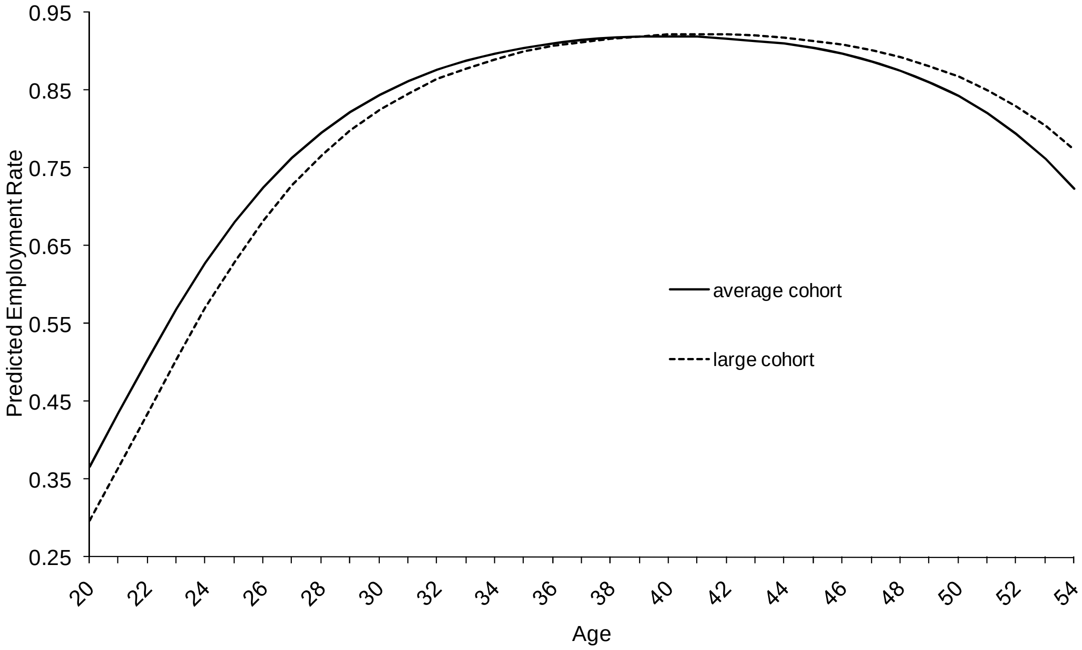


Figure 4.8: Predicted employment rate of large and average cohorts of low educated Italian males, 1994-2001



4.4.5 Partial effects of other independent variables

To capture the effect of age on wages, the partial derivative of earnings with respect to age is computed as follows:

$$\frac{\partial \ln(wage)}{\partial age} = \alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs) \qquad [4.13]$$

The effect of age on wages depends on both the values of age and cohort size. Following Wooldridge (2006, p.198), the exact percentage change in wages following a unit increase in age is computed as $100 \cdot \left[\exp\left(\frac{\delta \ln(wage)}{\delta age} \right) - 1 \right]$.

Also the partial derivative of employment with respect to age is calculated. I start by computing $\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial age}$, which, applying the Chain Rule, is given by:

$$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial age} = \frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial e}\frac{\partial e}{\partial age} \quad [4.14]$$

The first term of the right-hand side of Equation [4.14] is given by $\frac{1}{e(1-e)}$ (see Equation [4.7] above).

The left-hand side of Equation [4.14] is given by:

$$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial age} = \alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs) \quad [4.15]$$

So that:

$$\alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs) = \frac{1}{e(1-e)}\frac{\partial e}{\partial age} \quad [4.16]$$

Equation [4.16] can be rearranged and expressed as:

$$\frac{\partial e}{\partial age} = \frac{\alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs)}{\frac{1}{e(1-e)}} = (\alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs))e(1-e) \quad [4.17]$$

It follows that:

$$\frac{\partial \ln(e)}{\partial age} = \frac{\partial \ln(e)}{\partial e}\frac{\partial e}{\partial age} = \frac{1}{e}(\alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs))e(1-e) = (\alpha_1 + 2\alpha_2 age + \alpha_4 \ln(cs))(1-e)$$

[4.18]

where e is defined as in Equation [4.12]. Also the partial effect of age on employment depends on both age and cohort size. Again, following Wooldridge

(2006, p.198), the exact percentage change in employment following a unit increase in age is computed as $100 \cdot \left[\exp\left(\frac{\delta \ln(e)}{\delta age} \right) - 1 \right]$.

Results are summarised in Table 4.12 below. The Table shows that earnings of medium-high educated workers increase with age, but at a diminishing rate. At labour market entry an additional year of age increases earnings by 4.14% for large cohorts and 4.53% for average cohorts. The positive effect of age on earnings is stronger for large cohorts, in line with the results of Table 4.11. Large cohorts are disadvantaged at labour market entry but then have a faster earnings growth. Similarly, earnings of low educated workers increase with age but at a diminishing rate and finally decrease.

The employment rates of members of both average and large cohorts with low and medium-high education have a humped-u shape: they first increase and then decrease with age. The turning point is 42 years of age for average cohorts and 43 for large cohorts with medium-high education and 40 for average cohorts and 42 for large cohorts with low education.

Table 4.12: Partial effect of age on wages and employment

	Age:	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**54**	**Turning point**
Wages (low educated workers)	average cohort	2.50%	2.09%	1.68%	1.27%	0.87%	0.47%	0.06%	-0.25%	- **51**
	large cohort	2.46%	2.05%	1.65%	1.24%	0.84%	0.43%	0.03&	-0.29%	-51
Wages (medium -high educated workers)	average cohort	4.14%	3.68%	3.21%	2.75%	2.29%	1.83%	1.38%	1.02%	-
	large cohort	4.53%	4.07%	3.60%	3.14%	2.68%	2.22%	1.76%	1.40%	-
Empl'nt (medium -high educated workers)	average cohort	45.33%	15.52%	3.17%	0.69%	0.11%	-0.19%	-0.82%	-2.61%	42
	large cohort	52.60%	24.13%	5.54%	1.13%	0.21%	-0.14%	-0.65%	-1.91%	43
Empl'nt (low educated Workers)	average cohort	20.84%	7.42%	2.36%	0.72%	0.00%	-0.72%	-2.32%	-5.63%	40
	large cohort	24.81%	9.33%	2.96%	0.92%	0.13%	-0.50%	-1.74%	-4.27%	42

Note: Specification 3 is used in the partial effects computations. Fitted values of α_1, α_2 and α_4 are used to compute the partial effects of age on wages. Fitted values of α_1, α_2, α_4 and e are used to compute the partial effects of age on employment. The values are exact percentage changes, computed as $100 \cdot \left[\exp\left(\frac{\delta \ln(wage)}{\delta age} \right) - 1 \right]$ and $100 \cdot \left[\exp\left(\frac{\delta \ln(e)}{\delta age} \right) - 1 \right]$.

The effect of the other two independent variables, i.e. aggregated unemployment rate and time trend, on wages and employment rates is finally investigated. The coefficient of the unemployment rate is negative (-0.018) in the earnings equation for medium-high educated workers (Table 4.8, specification 6), meaning that an increase in the aggregate unemployment decreases earnings of medium-high educated workers. The coefficient of the time trend is not significant at conventional levels.

Turning to the employment model, the aggregated unemployment rate is significant and positive in the regression focusing on medium-high educated workers (Table 4.9, specification 6) and significant but negative in the regression focusing on low educated workers (Table 4.7, specification 6). This could mean that in the Italian labour market an increase in the aggregate unemployment negatively affects the employment opportunities of low educated workers, rather than of medium and highly educated workers. In other terms, low skilled workers are more likely to be hit by negative fluctuations of the business cycle than more skilled workers. The time trend is negative in both regressions (Tables 4.7 and 4.9, specification 6), indicating an overall decrease in the employment rates of Italian workers in the period under consideration.

4.5 Conclusions

The Italian labour force will decrease in size and age in the next decades. The relative supply of younger workers will decrease whereas the relative supply of older workers will increase. If older (more experienced) and younger (less experienced) workers are not perfect substitutes in production and perform different tasks, this will have implications for age-earnings and age-employment profiles. There already exists a vast literature on the effects of cohort size on age-earnings and employment profiles. The existing cohort-crowding literature finds some evidence of an adverse effect of cohort size on large cohorts' employment and wages, across a number of countries. However, until now there has been no evidence on Italy (with the only exception of OECD, 1980).

An empirical model aimed at investigating the effect of cohort size on age-earnings and employment profiles of Italian male workers is developed in Section 4.3. Evidence that over the life cycle cohort size depresses employment opportunities of individuals with low education and earnings and employment rates of males with intermediate and high qualifications born into large cohorts is found.

In line with most studies of the cohort crowding literature, the effect of cohort size on earnings of medium-highly educated workers is negative at entry. In line with some studies of the cohort crowding literature (for example Welch (1979), Wright (1991) and Dooley (1986)), earnings of large cohorts grow faster and overtake the earnings of normal (average) cohorts. This happens at age 36 in the analysis performed in this Chapter (compared, for instance, to age 46 for men with intermediate qualifications in Wright (1991, p. 303) and to ages 35 to 45 in Dooley (1986, p.153). As already explained, the basic argument behind this catching-up effect centres on the increased incentive to invest in human capital. For example, members of large cohorts might invest more in on-the-job training during their career due to depressed wages and hence lower opportunity costs of on-the-job training at labour market entry.

Similarly, the effect of cohort size on employment opportunities of medium-highly educated workers is negative at entry but then turns positive. This happens at age 46. The negative effect of cohort size on employment at labour market entry and during the career is stronger than the negative effect of cohort size on earnings. This means that in the Italian labour market, any adjustment due to cohort size change of medium and highly educated males is both through their relative wages and employment rates, but particularly through the latter.

Any adjustment due to cohort size change of low educated males is through the employment rate, rather than through the relative wage. The effect of cohort size on employment is negative at entry, but then turns positive. This means that the employment rates of members of large cohorts are lower at entry but then increase faster than those of normal (average) cohorts. The take-over point occurs at age 38. The negative effect of cohort size on employment at entry is stronger for medium-highly educated males if compared to low educated males.

The results of the empirical model are in line with the literature: large cohorts of low-skilled workers are less likely to suffer from depressed earnings both at labour market entry and during the career, due to their high substitutability with workers belonging to other cohorts. Conversely, medium-high educated workers are less substitutable in production and hence more affected by their position in the demographic cycle.

The results of the empirical analysis show that changes in the population and labour force age structure have the potential to affect the economic prosperity of individuals. The relative scarcity of younger generations seems to have an overall positive effect on their labour market outcomes. New unusually small cohorts are going to experience higher relative earnings and employment opportunities and put older workers at relative disadvantage.

Chapter 5 Simulations of average future wages of Italian male workers

5.1 Introduction

The European Community Household Panel survey finished in 2001. However, it has been progressively replaced with data collection under the EU-SILC regulations (no.1177/2003 Community Statistics on Income and Living Conditions). The project was formally launched in 2004 and is expected to become the reference source of statistics on income and social exclusion in the European Union.

In Italy, the ECHP has been replaced by the survey “Reddito e Condizioni di Vita” (“Income and Living Conditions”), which includes around 20,000 families and 60,000 individuals. The survey is carried out by Istat and investigates, amongst other issues, respondents’ labour market status and wages. Respondents are asked to provide information on their current *gross* monthly wage, current labour market status and highest level of education attained. The classification of the educational categories is identical in the ECHP and Income and Living Conditions surveys. Up to date, the survey has been carried out on four occasions (2004-2007).

Individual data from the second wave of Income and Living Conditions, the employment and earnings elasticities computed in Chapter 4 and the outcome of Italian population projections for the period 2005–2050 are used to carry out a simple simulation in which average future wages of Italian men aged between 20 and 54 are projected for the next 4 ½ decades. In Section 5.2, the results of the *baseline* population projections are used to compute the first set of wage figures and four different effects (i.e. compositional (population) effect; wage cohort size effect; employment cohort size effect; and wage and employment cohort size effect) are taken into account. Alternative sets of wage figures based on alternative fertility and migration assumptions are computed in Section 5.3. Section 5.4 concludes.

5.2 Simulations in the baseline scenario

Four different simulations are initially computed in the baseline scenario:

Scenario I - compositional (population) simulation
Scenario II - wage cohort size simulation
Scenario III - employment cohort size simulation
Scenario IV - wage and employment cohort size simulation

Scenario I - compositional (population) simulation: for each education level s (where s=1=medium-high education and s=2=low education) and each year of the projection period t, the average employment rate of males aged 20 to 54 - given as the ratio of number of males in employment $\left[\sum_{i=20}^{54}(N_{i,s}^{t} \cdot e_{i,s}^{2005})\right]$ to the number of males in the population $\left[\sum_{i=20}^{54} N_{i,s}^{t}\right]$ - is computed. The number of males in the population is taken from the baseline population projections, which are based on Istat "official" fertility and mortality assumptions and zero net migration assumptions[37]. For simplicity, it is assumed that the shares of low and medium-high educated males in the population remain constant at their 2005 level throughout the projection period, so that $N_{i,s}^{t} = N_{i}^{t} \cdot \left[\frac{N_{i,s}^{2005}}{N_{i}^{2005}}\right]$. The number of males in employment is given as the summation, for all ages between 20 and 54, of the product of the number of males in the population and the 2005 employment rate. Data on 2005 age-aggregated employment rates are taken from the second wave of "Income and Living Conditions"[38].

[37] As discussed in Chapter 2, the main fertility assumption of Istat "official" 2005-based population projections is that the total fertility rate (TFR) increases slightly to 1.6 births per woman by the end of 2049. With respect to mortality, the main assumption is that male/female life expectancy at birth gradually increases to 83.6/88.8 years by the end of 2049. Once again, the zero net migration scenario is only taken as a benchmark.
[38] Summary descriptive statistics of the second wave of "Income and Living Conditions" are presented in Appendix E.

For each education level s and each year of the projection period t, the average wage of males aged 20 to 54 - given as the ratio of the total wage bill $\left[\sum_{i=20}^{54}(N_{i,s}^{t} \cdot e_{i,s}^{2005} \cdot w_{i,s}^{2005})\right]$ to the number of males in employment – is then computed. The total wage bill is given by the summation, for all ages between 20 and 54, of the product of the number of males in the population, the 2005 employment rate and the 2005 wage rate. Data on 2005 age-aggregated wages are taken from the second wave of "Income and Living Conditions". The average wage (not education specific) for each year of the projection period is finally computed as the weighted average of the wage of medium-high and low educated workers (s=1 and s=2) as follows:

$$av\_wage^{t} = \frac{\left[\frac{\sum_{i=20}^{54}(N_{i,1}^{t} \cdot e_{i,1}^{2005} \cdot w_{i,1}^{2005})}{\sum_{i=20}^{54}(N_{i,1}^{t} \cdot e_{i,1}^{2005})}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,1}^{t} \cdot e_{i,1}^{2005}\right] + \left[\frac{\sum_{i=20}^{54}(N_{i,2}^{t} \cdot e_{i,2}^{2005} \cdot w_{i,2}^{2005})}{\sum_{i=20}^{54}(N_{i,2}^{t} \cdot e_{i,2}^{2005})}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,2}^{t} \cdot e_{i,2}^{2005}\right]}{\left[\sum_{i=20}^{54}(N_{i,1}^{t} \cdot e_{i,1}^{2005}) + \sum_{i=20}^{54}(N_{i,2}^{t} \cdot e_{i,2}^{2005})\right]}$$

[5.1]

Scenario II - wage cohort size simulation: the second set of future average men's wages is computed taking into account future changes in population structure and wages. Future changes in wages are computed using the elasticity of earnings with respect to cohort size, as computed in Chapter 4. The same steps of scenario *I)* are followed, but $w_{i,s}^{2005}$ is replaced with $w_{i,s}^{t}$, where $w_{i,s}^{t}$ is given by the age-specific wage in year t-1 $\left[w_{i,s}^{t-1}\right]$ augmented by the wage change in year t, given as the product of the elasticity of wages with respect to cohort size and the change in cohort size in year t (times 100):

$$w_{i,s}^{t} = w_{i,s}^{t-1} + \left(w_{i,s}^{t-1} \cdot \Delta w_{i,s}^{t}\right) = w_{i,s}^{t-1} + \left(w_{i,s}^{t-1} \cdot \left(\frac{\Delta cs_{i}^{t} \cdot \varepsilon(wage, cs)_{s}}{0.01}\right)\right) \qquad [5.2]$$

where $\Delta cs_{i}^{t} = \frac{(cs_{i}^{t} - cs_{i}^{t-1})}{cs_{i}^{t-1}}$. The elasticity of cohort size with respect to earnings computed is the % change in wages following a 1% increase in cohort size. The following proportion is applied: $\Delta cs_i^t : 0.01 = \Delta w_{i,s}^t : \varepsilon(wage, cs)_s$. Also, $\varepsilon(wage, cs)_s$ is set to zero for s=2 because the empirical analysis of Chapter 4 concluded that cohort size does not impact on wages of low educated workers.

The computation of $w_{i,s}^t$ in Equation 5.2. is clarified in the following example. Let us suppose I want to compute the average wage of males aged 20 (i=20) with a medium-high level of education (s=1) in year 2006 (t=2006 and t-1=2005), knowing that their average gross monthly wage at the end of 2005 $\left(w_{i,s}^{t-1}\right)$ is Euro 1,014.38. The average wage figure is taken from the second wave of "Income and Living Conditions".

At the end of 2005, the relative cohort size of males aged 20 is 1.598% (cs_i^{t-1}). According to the baseline population projections, it is expected to decrease to 1.572% by the end of 2006 (cs_i^t). Hence, the relative cohort size of males aged 20 is expected to decrease by 1.627% $\left[= \frac{1.572\% - 1.598\%}{1.598\%} \right]$ in 2006. Δcs_i^t is then equal to -1.627% in Equation 5.2.

The elasticity of earnings with respect to cohort size at labour market entry (i.e. at age 20), as computed in Chapter 4, is -0.358% (see Table 4.11). $\varepsilon(wage, cs)_s$ is then equal to -0.358% in Equation 5.2.

The average wage of medium-highly educated workers is expected to increase by 0.582% $\left[= \frac{-1.627\% \cdot (-0.358\%)}{0.01} \right]$ in 2006. $\Delta w_{i,s}^t$ is then equal to 0.582% in Equation 5.2.

It follows that $w_{i,s}^t$ is equal to Euro 1,020.4 $\left[= 1014.38 + (1014.38 \cdot 0.582\%\right]$ in Equation 5.2. Hence, the average wage of highly-educated males aged 20 is expected to increase from 1,014.38 at the end of 2005 to 1,020.4 at the end of 2006 when changes in population structure (relative cohort size) and wages (elasticity of earnings with respect to cohort size) are taken into account.

The same computation is applied to medium-highly educated workers aged 21 to 54. Clearly, the relative cohort size in 2005 and 2006, the initial average wage and the elasticity values will differ at each year of age. The procedure is then applied iteratively to all the years of the simulation period. The same computation is then applied to low educated workers aged 20 to 54. However, $\varepsilon(wage, cs)_s$ is set to zero for s=2 because the empirical analysis of Chapter 4 concluded that cohort size does not impact on wages of low educated workers.

The average wage (not education specific) for each year of the projection period is computed as the weighted average of the wage of low and medium-high educated workers as follows:

$$av\_wage^t = \frac{\left[\frac{\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^{2005} \cdot w_{i,1}^t}{\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^{2005})}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^{2005}\right] + \left[\frac{\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^{2005} \cdot w_{i,2}^t}{\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^{2005})}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^{2005}\right]}{\left[\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^{2005}) + \sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^{2005})\right]}$$

[5.3]

Scenario III - employment cohort size simulation

The third set of future average men's wages is computed taking into account future changes in population structure and employment rates. Future changes in employment are computed using the elasticity of employment with respect to cohort size, as computed in Chapter 4. The same steps of scenario *I)* are followed, but $e_{i,s}^{2005}$ is replaced with $e_{i,s}^t$, where $e_{i,s}^t$ is given by the age-specific employment rate in year t-1 $\left[e_{i,s}^{t-1}\right]$ augmented by the employment rate change in year t, given as the product of the elasticity of employment with respect to cohort size and the change in cohort size in year t (times 100):

$$e_{i,s}^{t} = e_{i,s}^{t-1} + \left(e_{i,s}^{t-1} \cdot \Delta e_{i,s}^{t}\right) = e_{i,s}^{t-1} + \left(e_{i,s}^{t-1} \cdot \left(\frac{\Delta cs_i^t \cdot \varepsilon(e,cs)_s}{0.01} \right) \right) \qquad [5.4]$$

The elasticity of cohort size with respect to employment is the % change in employment following a 1% increase in cohort size. The following proportion is applied: $\Delta cs_i^t : 0.01 = \Delta e_{i,s}^t : \varepsilon(e,cs)_{i,s}^{t-1}$[39]. The average wage (not education specific) for each year of the projection period is computed as follows:

$$av\_wage^t = \frac{\left[\frac{\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^t \cdot w_{i,1}^{2005})}{\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^t)}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^t\right] + \left[\frac{\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^t \cdot w_{i,2}^{2005})}{\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^{2005})}\right] \cdot \left[\sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^t\right]}{\left[\sum_{i=20}^{54}(N_{i,1}^t \cdot e_{i,1}^t) + \sum_{i=20}^{54}(N_{i,2}^t \cdot e_{i,2}^t)\right]}$$

[5.5]

Scenario IV - wage and employment cohort size simulation: the fourth set of future average men's wages is computed taking into account future changes in population structure, wages and employment rates. Future changes in wages and employment are computed using the results of the elasticities of earnings and employment with respect to cohort size. The average wage (not education specific) for each year of the projection period is computed as follows:

[39] Following Equation 4.11, the elasticity of employment with respect to cohort size is given by

$$\varepsilon(e,cs) = \frac{\partial \ln(e)}{\partial \ln(cs)} = \frac{\partial \ln(e)}{\partial e}\frac{\partial e}{\partial \ln(cs)} = \frac{1}{e}(\alpha_3 + \alpha_4 age)e(1-e) = (\alpha_3 + \alpha_4 age)(1-e)$$

where e is the fitted value of the employment rate as obtained in Equation [4.2], Specification 3:

$$\hat{e} = \frac{1}{1+\exp\left[-(\hat{\alpha}_0 + \hat{\alpha}_1 age + \hat{\alpha}_2(age^2) + \hat{\alpha}_3 \ln(cs) + \hat{\alpha}_4 \ln(cs)\cdot age)\right]}.$$

If Specification 4 were used instead, future values of $\overline{u}$ would need to be chosen and plugged into the following equation:

$$\hat{e} = \frac{1}{1+\exp\left[-(\hat{\alpha}_0 + \hat{\alpha}_1 age + \hat{\alpha}_2(age^2) + \hat{\alpha}_3 \ln(cs) + \hat{\alpha}_4 \ln(cs)\cdot age) + \hat{\alpha}_5\overline{u}\right]}.$$

This would make the computation of $\hat{e}$ more complicated.

$$av\_wage^{t} = \frac{\left[\frac{\sum_{i=20}^{54}(N_{i,1}^{t}\cdot e_{i,1}^{t}\cdot w_{i,1}^{t}}{\sum_{i=20}^{54}(N_{i,1}^{t}\cdot e_{i,1}^{t})}\right]\cdot\left[\sum_{i=20}^{54}(N_{i,1}^{t}\cdot e_{i,1}^{t}\right]+\left[\frac{\sum_{i=20}^{54}(N_{i,2}^{t}\cdot e_{i,2}^{t}\cdot w_{i,2}^{t}}{\sum_{i=20}^{54}(N_{i,2}^{t}\cdot e_{i,2}^{t})}\right]\cdot\left[\sum_{i=20}^{54}(N_{i,2}^{t}\cdot e_{i,2}^{t}\right]}{\left[\sum_{i=20}^{54}(N_{i,1}^{t}\cdot e_{i,1}^{t})+\sum_{i=20}^{54}(N_{i,2}^{t}\cdot e_{i,2}^{t})\right]}$$

[5.6]

5.2.1 Baseline scenario results

I start by investigating what would happen to the average wages of Italian male workers in Scenario *I*, as shown in Figure 5.1. A horizontal line reflecting what would happen if the average wage remained constant (2005 level) is also added. According to this simulation, the average wage of Italian males will increase in the first part of the projection period (i.e. 2006 to 2018), decrease in the central part (i.e. 2019 to 2033) and increase again in the final part, although to a lesser extent.

Figure 5.2 shows that these results are in line with the outcome of the baseline population projections: in the first part of the projection period, the number of older workers is projected to increase whereas the number of younger workers is projected to decrease. In the central part, both numbers of younger and older workers are projected to decrease. However, the number of older workers is projected to decrease to a greater extent. In the final part, both numbers of younger and older workers are projected to decrease. However, the number of younger workers is projected to decrease to a greater extent.

Figure 5.1: Average gross monthly wage of Italian males aged 20 to 54 in Scenario I), baseline population projections, 2005-2049

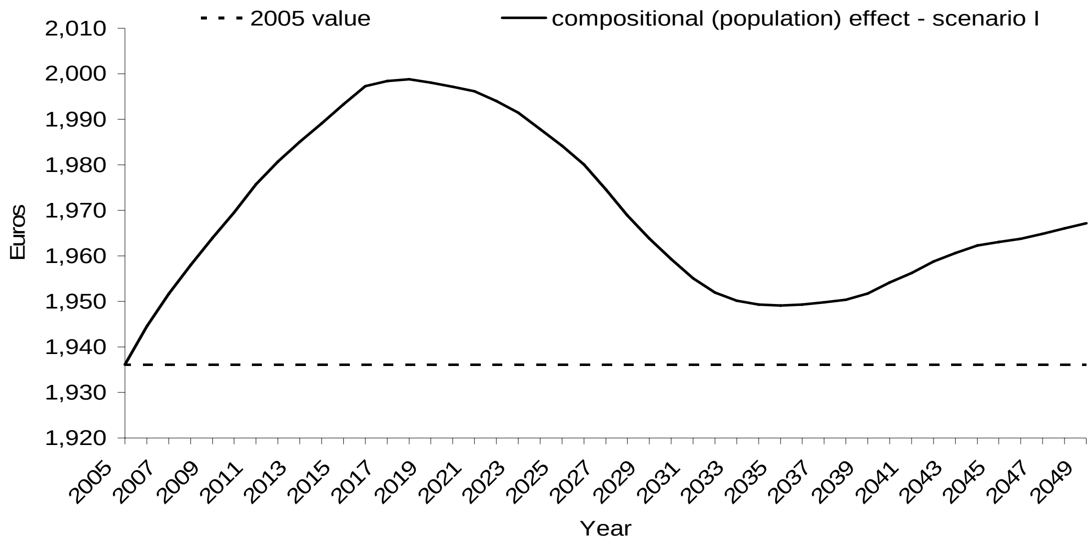


Figure 5.2: Projected number of younger (aged 20-30) and older (aged 45-54) male workers, baseline population projections, 2005-2049

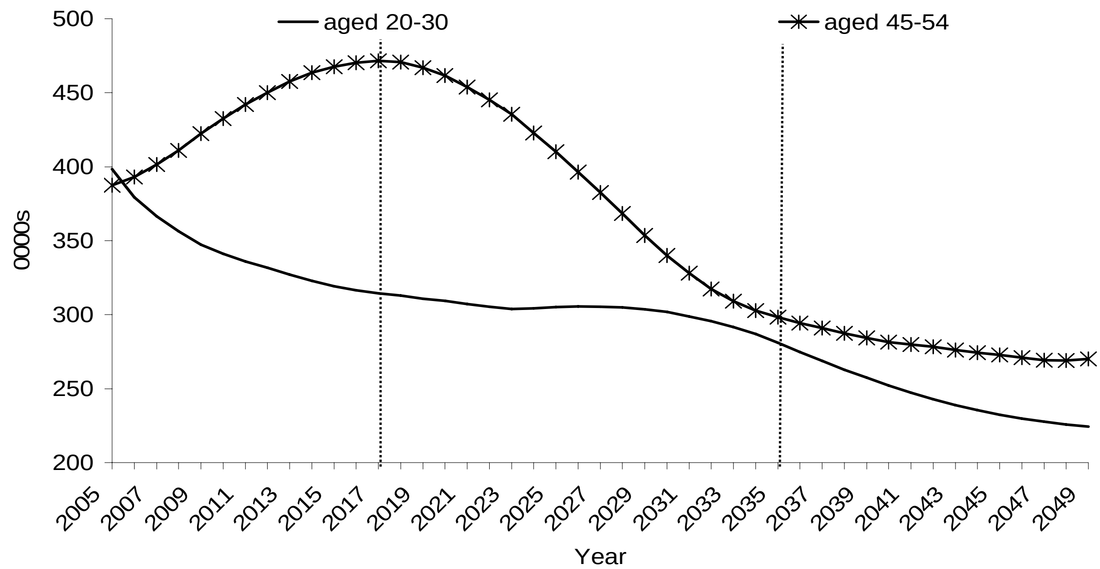
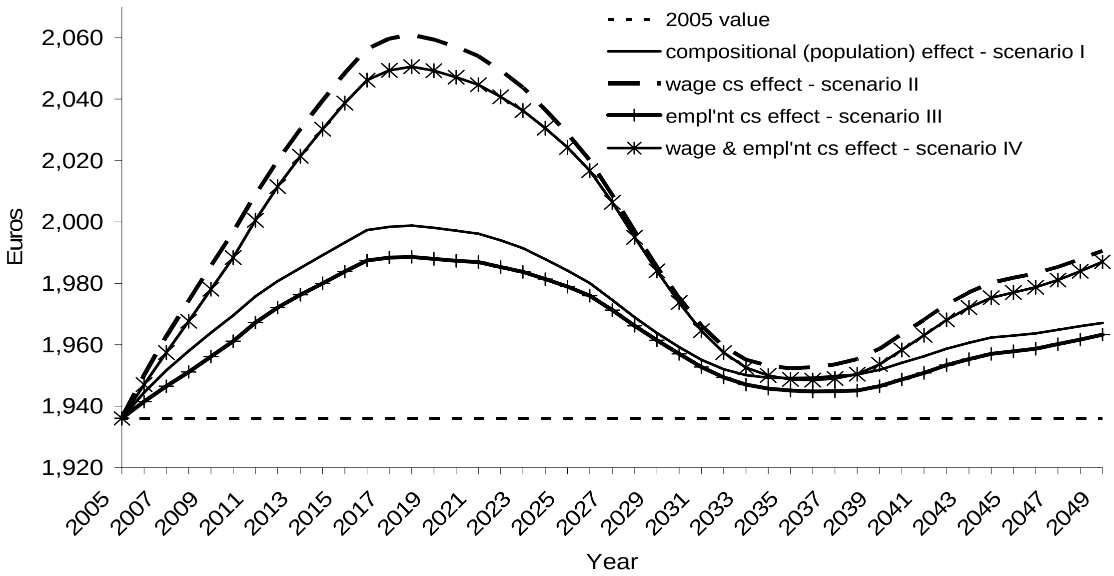


Figure 5.3 shows the results of the four different scenarios. The four average wage patterns are similar, but differ in magnitude. Wages seem to be highest when the cohort size effect on wages is taken into account (scenario *II*), lowest when the cohort size effect on employment is taken into account (scenario *III*).

Figure 5.3: Average gross monthly wage of Italian males aged 20 to 54 in scenarios I, II, III and IV, baseline population projections, 2005-2049



The results of Figure 5.3 might seem counterintuitive, because wage and employment effects work in opposite directions. Wages in Scenario I (compositional (population) simulation) are lower than wages in Scenario II (wage cohort size simulation) but higher than wages of Scenario III (employment cohort size simulation). This depends on the size of the earnings and employment elasticities.

The example of Table 6.1 might help to clarify this point. 2005 single year of age wages and employment rates of medium-highly educated males (s=1) are reported. These figures are taken from the second wave of "Income and Living Conditions". The 2006 average wage of medium-highly educated workers (Scenario I) is Euro

$$2{,}177.96 \left[= \frac{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2005} \cdot w_{i,1}^{2005}\right)}{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2005}\right)} \right].$$

If wage cohort size effects are taken into consideration (Scenario II), the 2006 average wage increases to Euro 2,187.97 $\left[= \frac{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2005} \cdot w_{i,1}^{2006}\right)}{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2005}\right)} \right]$. The value of $w_{i,1}^{2006}$ depends on $\varepsilon(w,cs)_1$, which is negative until age 35 and then positive, as shown in Table 4.11.

If employment cohort size effects are taken into account (Scenario III), the 2006 average wage figure decreases to Euro 2,171.64 $\left[= \frac{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2006} \cdot w_{i,1}^{2005}\right)}{\sum_{i=20}^{54}\left(N_{i,1}^{2006} \cdot e_{i,1}^{2006}\right)} \right]$. $e_{i,1}^{2006}$ depends on $\varepsilon(e,cs)_1$, which is negative (and greater in magnitude – in absolute value - than $\varepsilon(w,cs)_1$) until age 45 and then positive.

The results of Table 5.1 then show with an example that wage and employment effects work in different directions (a result that might seem counterintuitive) due to the size of earnings and employment elasticities.

Table 5.1: Computation of average wage of medium-highly educated workers in 2006, Scenarios I, II and III

	$w_{i,1}^{2005}$	$e_{i,1}^{2005}$	$N_{i,1}^{2006}\cdot e_{i,1}^{2005}$	$N_{i,1}^{2006}\cdot e_{i,1}^{2005}\cdot w_{i,1}^{2005}$	cs_i^{2005}	cs_i^{2006}	$\varepsilon(w,cs)_1$	$w_{i,1}^{2006}$	$N_{i,1}^{2006}\cdot e_{i,1}^{2005}\cdot w_{i,1}^{2006}$	$\varepsilon(e,cs)_1$	$e_{i,1}^{2006}$	$N_{i,1}^{2006}\cdot e_{i,1}^{2006}$	$N_{i,1}^{2006}\cdot e_{i,1}^{2006}\cdot w_{i,1}^{2005}$
20	1,014.4	23.3%	51,285	52,022,854	1.60%	1.57%	-0.36%	1,020.4	52,332,734	-2.99%	24.4%	53,836	54,610,447
21	1,056.1	28.5%	59,555	62,894,725	1.64%	1.60%	-0.33%	1,063.9	63,361,708	-2.51%	30.0%	62,869	66,395,138
22	1,224.1	27.8%	58,003	70,999,853	1.68%	1.65%	-0.31%	1,232.8	71,504,533	-2.10%	29.1%	60,779	74,398,046
23	1,181.7	41.9%	90,886	107,400,358	1.73%	1.69%	-0.29%	1,189.6	108,117,820	-1.74%	43.6%	94,546	111,724,657
24	1,331.4	47.6%	100,939	134,391,015	1.78%	1.73%	-0.26%	1,340.3	135,284,148	-1.43%	49.3%	104,563	139,216,391
25	1,471.1	62.1%	131,110	192,879,693	1.84%	1.78%	-0.24%	1,483.0	194,432,877	-1.20%	64.6%	136,350	200,588,984
26	1,495.8	62.5%	142,484	213,124,437	1.92%	1.84%	-0.22%	1,509.5	215,075,250	-1.02%	65.2%	148,606	222,281,733
27	1,522.0	65.6%	158,769	241,650,960	2.01%	1.91%	-0.19%	1,536.7	243,987,746	-0.89%	68.5%	165,789	252,336,477
28	1,570.1	69.3%	169,277	265,787,181	2.11%	2.00%	-0.17%	1,583.8	268,109,382	-0.77%	72.0%	175,943	276,253,980
29	1,575.6	81.9%	203,960	321,358,867	2.22%	2.10%	-0.15%	1,587.7	323,819,562	-0.67%	84.7%	211,020	332,483,239
30	1,627.9	80.5%	210,100	342,022,530	2.31%	2.21%	-0.12%	1,637.1	343,946,611	-0.56%	82.5%	215,471	350,765,998
31	1,752.3	76.5%	208,643	365,605,588	2.39%	2.31%	-0.10%	1,758.4	366,883,653	-0.46%	77.7%	211,993	371,474,927
32	1,979.6	86.2%	235,671	466,541,052	2.44%	2.39%	-0.08%	1,982.7	467,266,620	-0.37%	86.8%	237,401	469,965,691
33	2,029.3	85.0%	218,940	444,295,028	2.46%	2.44%	-0.05%	2,030.4	444,544,794	-0.28%	85.3%	219,584	445,602,237
34	2,032.7	88.2%	236,806	481,350,258	2.49%	2.47%	-0.03%	2,033.1	481,457,849	-0.22%	88.4%	237,184	482,118,912
35	1,980.3	86.7%	227,912	451,337,274	2.50%	2.49%	-0.01%	1,980.4	451,354,979	-0.17%	86.8%	228,122	451,752,457
36	1,954.0	90.8%	238,868	466,741,546	2.52%	2.51%	0.02%	1,953.8	466,695,620	-0.13%	90.9%	239,063	467,121,097
37	2,255.6	89.1%	221,888	500,498,351	2.54%	2.52%	0.04%	2,255.2	500,411,141	-0.10%	89.2%	221,990	500,729,741
38	2,330.7	86.7%	203,477	474,240,835	2.55%	2.54%	0.06%	2,329.8	474,066,416	-0.08%	86.8%	203,575	474,471,029
39	2,108.9	94.0%	258,333	544,796,923	2.57%	2.55%	0.09%	2,107.7	544,479,380	-0.07%	94.0%	258,449	545,039,998
40	2,308.7	94.0%	241,524	557,593,466	2.57%	2.57%	0.11%	2,309.0	557,668,607	-0.05%	94.0%	241,508	557,557,939
41	2,457.7	92.9%	245,201	602,617,285	2.54%	2.58%	0.13%	2,462.1	603,696,264	-0.04%	92.9%	245,068	602,292,263
42	2,307.7	92.5%	234,797	541,836,969	2.47%	2.55%	0.16%	2,318.9	544,470,654	-0.03%	92.4%	234,577	541,329,130
43	2,471.2	92.8%	226,631	560,060,212	2.39%	2.47%	0.18%	2,487.0	563,632,066	-0.02%	92.7%	226,453	559,620,269
44	2,293.4	93.3%	218,512	501,136,043	2.31%	2.39%	0.20%	2,309.5	504,661,353	-0.02%	93.3%	218,396	500,870,034
45	2,489.1	97.4%	224,219	558,112,855	2.25%	2.32%	0.23%	2,507.3	562,186,745	-0.01%	97.4%	224,154	557,951,369
46	2,619.1	89.6%	182,973	479,219,889	2.18%	2.25%	0.25%	2,639.4	482,930,749	0.00%	89.5%	182,959	479,184,195
47	2,904.2	91.7%	176,166	511,619,009	2.12%	2.19%	0.27%	2,928.5	515,908,369	0.01%	91.7%	176,194	511,699,494
48	2,587.4	93.9%	188,004	486,442,181	2.08%	2.12%	0.30%	2,605.5	489,852,207	0.01%	93.9%	188,069	486,609,095
49	2,451.8	92.6%	182,499	447,450,548	2.04%	2.08%	0.32%	2,467.8	450,369,695	0.03%	92.7%	182,599	447,696,187
50	2,588.0	92.4%	165,865	429,262,068	2.00%	2.04%	0.34%	2,606.2	432,280,673	0.04%	92.5%	166,015	429,649,384
51	2,792.8	91.4%	166,506	465,013,404	1.96%	2.00%	0.37%	2,817.5	469,125,702	0.07%	91.6%	166,782	465,783,276
52	3,719.6	95.2%	193,339	719,142,808	1.91%	1.96%	0.39%	3,756.5	726,268,880	0.10%	95.5%	193,853	721,057,172
53	2,942.2	95.1%	146,421	430,801,244	1.89%	1.92%	0.41%	2,960.1	433,417,994	0.16%	95.3%	146,758	431,790,809
54	2,588.5	88.8%	135,684	351,220,151	1.89%	1.90%	0.44%	2,590.5	351,490,871	0.23%	88.8%	135,738	351,360,764
Σ			6,355,247	13,841,467,460					13,905,093,652			6,416,256	13,933,782,559
av_wage^{2006}:			Scenario I =13,841,467,460/6,355,247 = **Euro 2,177.96**				Scenario II =13,905,093,652/6,355,247 = **Euro 2,187.97**			Scenario III =13,933,782,559/6,416,256 = **Euro 2,171.64**			

5.3 Migration and fertility sensitivity analyses

Up to now, the results of the *baseline* population projections have been used to compute the future wages of Italian male workers aged between 20 and 54. The baseline projection is based on the assumptions that TFR will reach 1.6 children per woman by 2050, male and female life expectancies will reach 83.5 and 88.5, respectively, by 2050 and there will be zero net migration. To conclude the analysis, the results of the different migration and fertility scenarios investigated in Chapter 3 are used to compute alternative sets of future wages.

5.3.1 Migration sensitivity analysis

Chapter 3 investigated the role higher levels of (young) net migration could play to decelerate or counteract the phenomena of population ageing and labour force ageing and decline in Italy. A set of alternative population projections were carried out. Fertility and mortality assumptions were the same of those employed in Istat 2005-based population projections. Migration assumptions were varied systematically upward and the number of annual net migrants ranged from from 0 to 500,000. For the age distribution of migrants, two scenarios were taken into account:

- all net migrants are under the age of 45, with 20% being under the age of 15 ("young workers with children").
- all net migrants are aged between 20 and 44 ("young workers without children").

The results of the migration population projections are now used to compute a new set of future wages. N_i^t is now given by the projected number of males there would be in Italy if 0; 100,000; 200,000; 300,000; 400,000; and 500,000 annual net migrants aged either less than 45 or between 20 and 44 were to immigrate to Italy between 2005 and 2049.

Figure 5.4 below shows the average wage reflecting both future changes in the population structure and the impact of cohort size changes on both wages and employment rates in different migration scenarios.

The decrease in the average wage is significantly less marked in the second half of the projection period if a consistent number of net migrants (i.e. 300,000; 400,000 or 500,000) aged 20 to 44 are to immigrate to Italy. Figure 5.5 shows that, especially in the second half of the projection period, a substantial net migration of people aged 20 to 44 would result in a lower number of younger males and a higher number of older males. This would result in a higher average wage.

Figure 5.4: Projected average monthly gross wage of Italian males aged 20 to 54 according to different migration scenarios, 2005-2049

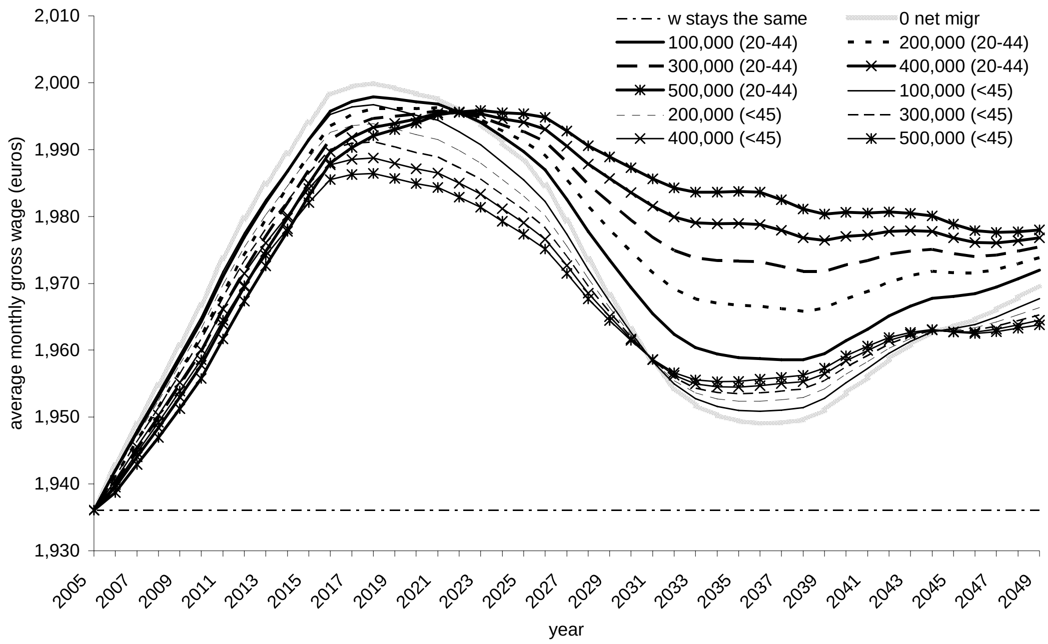
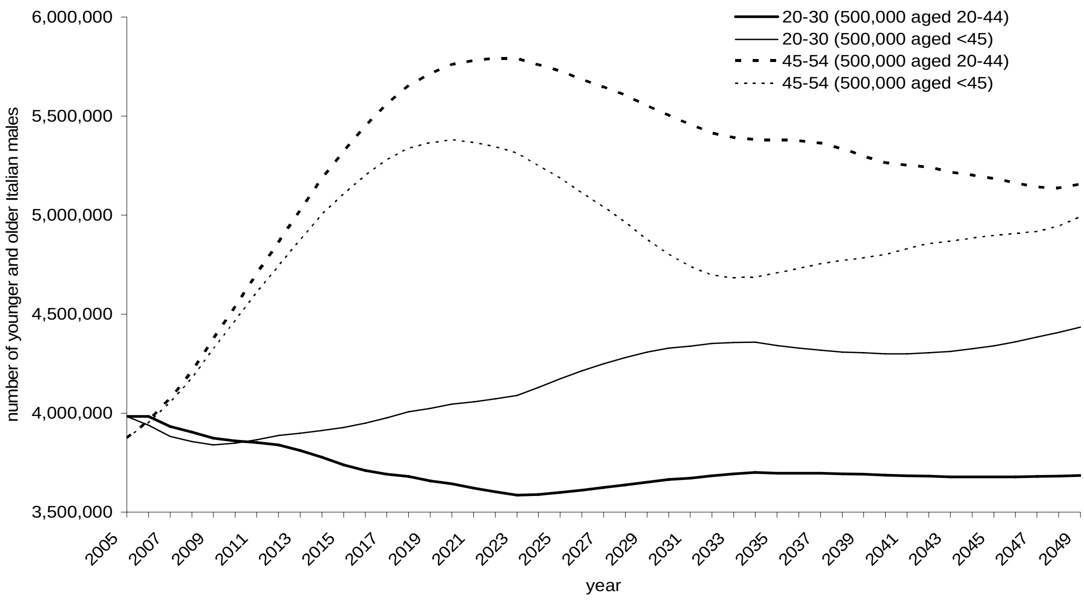


Figure 5.5: Projected numbers of younger and older Italian males according to different migration scenarios, 2005-2049



5.3.2 Fertility sensitivity analysis

The results of different fertility scenarios were investigated in Chapter 3. It was assumed that fertility increases at a higher rate than in the principal scenario. The assumptions relating to mortality and migration were identical to those used in Istat 2005-based principal population projections. The results of the population projections based on different fertility assumptions are used to compute a new set of future wages. A new set of N_i^t s is computed assuming that the TFR reaches 1.67, 1.76, 1.92 or 2.08 by the end of 2049, as compared to 1.60 in the principal (baseline) scenario.

Figure 5.6 below shows the average wage reflecting both future changes in population structure and the impact of cohort size changes on both wages and employment rates in different fertility scenarios. As Figure 5.7 shows, the number of older workers (here aged 45 to 54) will be the same in all the fertility scenarios. This is reasonable given that changes in fertility will start to affect the number of people aged more than 45 years old only from 2050 onwards. Changes in fertility will start to affect the number of younger workers (here aged 20 to 30) from 2025 onwards and, as expected, the higher the fertility rate, the higher number of younger workers and the lower the average wage.

Figure 5.6: Projected average monthly gross wage of Italian males aged 20 to 54 according to different fertility scenarios, 2005-2049

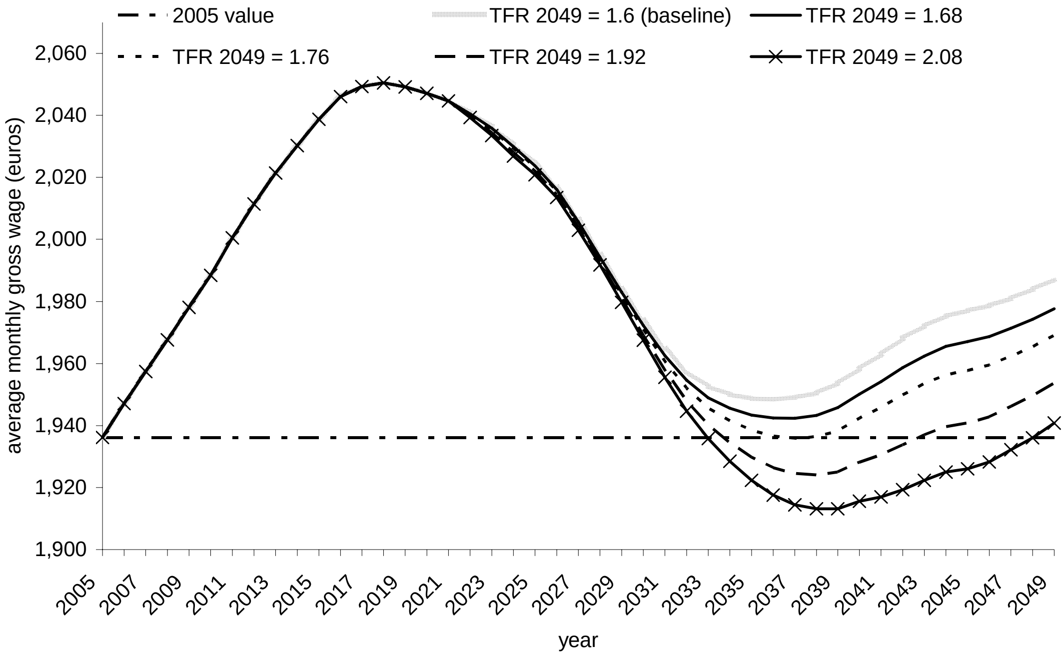
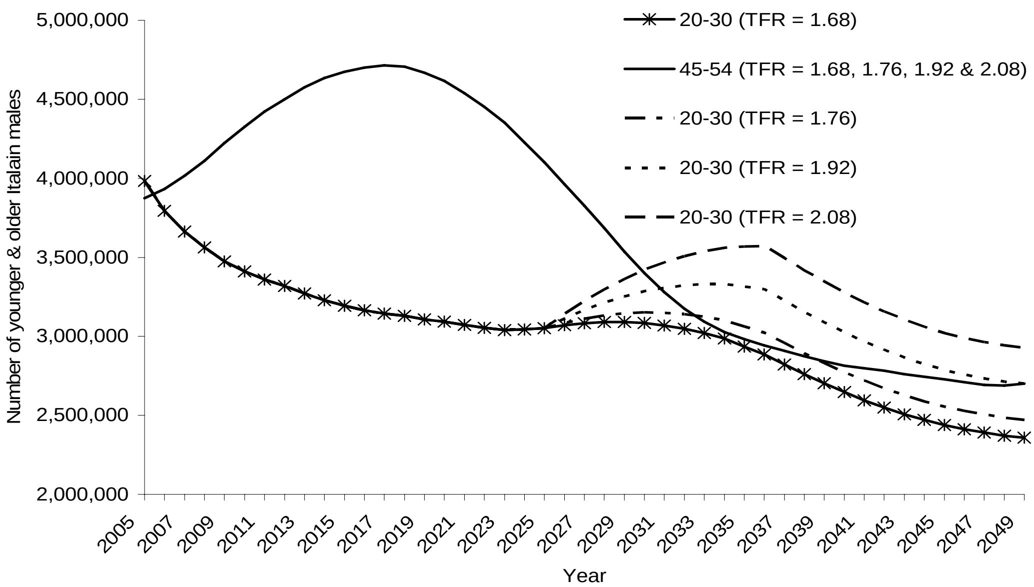


Figure 5.7: Projected numbers of younger and older Italian males according to different fertility scenarios, 2005-2049



5.4 Conclusions

Individual wage and employment data taken from the second wave of Income and Living Conditions, the results of Istat 2005-based population projections, the results of alternative population projections based on higher migration and fertility assumptions and the employment and earnings elasticities computed in Chapter 4 are used to compute and project average future wages of Italian men aged between 20 and 54 until 2049. The results of the *baseline* population projections (based on Istat 2005-based fertility and mortality assumptions and zero net migration assumptions) were used to compute the first set of wage figures and four different effects (i.e. compositional (population) effect; wage cohort size effect; employment cohort size effect; and wage and employment cohort size effect) were taken into account. Also alternative sets of wage figures were computed, based on alternative fertility and migration assumptions. Results were shown when wage and employment cohort size effect was taken into account.

According to the simulation results, the average wage of Italian male workers will increase until 2018, decrease between 2019 and 2033 and then increase again (although to a lesser extent) in the last part of the projection period. The average wage of Italian male workers would decrease to a lesser extent in the second part of the projection period if a substantial number of net migrants (e.g. 300,000; 400,000; or 500,000) aged between 20 and 44 were to immigrate to Italy in each year of the projection period. The average wage of Italian male workers would decrease to a greater extent in the second part of the projection period if the total fertility rate was higher than in the baseline scenario.

Chapter 6 Cohort effects on labour market attainment of younger and older Italian males

6.1 Introduction

Chapter 4 concluded that (relative) cohort size has an overall negative impact on earnings and employment opportunities of Italian males aged 20 to 54 over the life cycle. Individuals aged less than 20 and more than 54 were excluded given to the non randomness of education and retirement decisions. But are individuals belonging to larger cohorts more or less likely to invest in education? Equally, are individuals belonging to larger cohorts more or less likely to move into retirement compared to members belonging to smaller cohorts? The literature on these issues is rather scarce: Section 6.2.1 reviews some of the few studies that investigate whether the position in the demographic cycle has an impact on human capital accumulation. To my knowledge, there are no studies that *specifically* focus on the impact of cohort size on retirement and labour market probabilities of older individuals.

Section 6.2 investigates whether and to what extent demographic variables influence educational and labour market attainment of younger males. Section 6.3 investigates whether and to what extent demographic variables influence labour market attainment of older males. Section 6.4 concludes.

6.2 Cohort effects on educational and labour market attainment of younger Italian males

6.2.1 Literature review

The relationship between (relative) cohort size and educational attainment has already received some attention in the literature, especially in the US (see Stapleton and Young (1988), Connelly and Gottschalk (1995) and Card and Lemieux (2000)). These papers draw on the basic proposition of the human capital investment model according to which individuals choose the level of education that maximises the net present value of their lifetime earnings. Drawing on the assumption that members of larger cohorts suffer from depressed life-time earnings, these studies argue that boomers invest less in human capital due to the decline in the private returns to education in response to larger cohort size. However, one could also argue that individuals belonging to larger cohorts invest more in education if relative shifts in labour supply (higher shares of younger workers) increase youth unemployment.

Stapleton and Young (1988) argue that if the substitutability between younger and older workers decreases with education and the earnings of individuals born into large cohorts are depressed over the life-cycle, then the present value of lifetime earnings of boomers is depressed more for the highly educated workers. Accordingly, young individuals born into large cohorts have fewer incentives to invest in education. Similarly, if jobs carried out by individuals with more education also require more on-the-job training, individuals belonging to unusually large cohorts might try to increase the likelihood of getting a job when entering the labour market by investing less in education. Stapleton and Young's (1988) empirical results confirm their theory. Their results show that when a baby boom occurs, individuals adjust their educational attainment in order to maximise their lifetime earnings. Educational attainment increases for pre and post-boomers and decreases for boomers.

Connelly and Gottschalk (1995) investigate the links between cohort composition and human capital accumulation across generations, focusing also on parents' educational attainment. This is motivated by the evidence that the propensity to pursue higher education varies significantly by parental education. For example, Connelly and Gottschalk (1995) find that, amongst males born in 1960, the likelihood of attending college is 67.9% for males whose father attended college, compared to 34.3% for those whose father did not complete high school.

Connelly and Gottschalk (1995) distinguish between two main effects of parental education on children's educational attainment: a direct compositional effect and an indirect behavioural feedback. The former implies that higher educated parents are more likely to invest more in their children's education. Accordingly, being born in a cohort with a high share of college-educated parents should increase college enrolment rates. The latter implies that if the returns to education decline with a higher supply of college-educated children, then parents may opt for investing less in their children's education. Accordingly, being born in a large cohort with a high share of college-educated parents should decrease college enrolment rates. This second effect could explain why enrolment rates in the US failed to increase despite the growing shares of children born to highly educated parents.

Connelly and Gottschalk (1995) use General Social Survey data from 1972 to 1988 and estimate a probit model where the individual's probability of attending college is regressed on parental education, cohort size, cohort's share with college-educated fathers and race. Connelly and Gottschalk (1995) find that both relative cohort size and the proportion of children with college-educated parents have a *negative* impact on the probability of attending college. They conclude that "the endogenous decline in the rate of return caused by both cohort size and cohort composition seems to have partially offset the exogenous increase in the proportion of children born to college-educated parents, holding all else constant" (Connelly and Gottschalk, 1995, p. 174).

Card and Lemieux (2000) analyze the impact of relative cohort size on schooling attainment for the U.S. from the end of the 1960s to the mid 1990s. Schooling attainment is measured as the average enrolment rates by state and year for four different age groups (i.e. 16 years old, 17 years old, 18 years old and 19-21 years old) for the period 1968-1996. Card and Lemieux (2000) incorporate a number of demand-side factors affecting the choice of when to leave school - including changes in the expected economic return to an additional year of education, the level of real interest rates, tuition costs and cyclical labour market variables – and relative cohort size as the only supply-side factor. They find a significant negative impact of cohort size on enrolment for 18 and 19-21 years old: for example, a 10% larger birth cohort is associated with about 1% point lower enrolment rate for the 18 years old sample.

The evidence from Europe is much scarcer. Two exceptions are Middendorf (2007) and Fertig *et al* (2009).

Middendorf (2007) argues that historical demographic and educational patterns in Europe seem to highlight a negative relationship between the number of births and educational attainment. The number of births in Europe declined by approximately 35% between 1964 and 2002 whereas the proportion of population with post-secondary education increased nearly tenfold. However, Middendorf (2007) points out that this increase in post-secondary education might also be due to other factors, including impact of parents' characteristics (the education of parents has also increased significantly in the same time period) and of the current labour market situation. If unemployment is high, young individuals might try to postpone their entry into the labour market by investing more in education.

Middendorf (2007) analyzes the impact of family background, cohort size and unemployment on educational attainment in Europe. He uses data from the European Community Household Panel (ECHP) and develops an ordered probit model where the dependent variable is the outcome of schooling decision. Contrary to the US studies mentioned above (i.e. Stapleton and Young (1988), Connelly and Gottschalk (1995) and Card and Lemieux (2000)) - which find a negative relationship between cohort size and educational attainment - Middendorf (2007) finds that relative cohort size does not impact on individuals' schooling decisions in Europe.

Fertig *et al* (2009) use individual-level data from the German Socio-Economic Panel to investigate the impact of cohort size and the labour market situation of young (West) German workers on educational attainment. They use an ordered probit model where the highest schooling (and professional) degree is regressed on individual characteristics, parental background information, a proxy variable for the labour market situation and the position in the demographic cycle, captured through: i) a measure of relative cohort size; ii) an indicator for cohorts born in 1978 or later; iii) an interaction term between i) and ii); and iv) a measure of cohort structure (i.e. share of highly educated fathers). The indicator for cohorts born in 1978 or after is introduced to take into account the sharp drop in birth rates occurred in Germany in the late 70s (since 1978, death rates have exceeded birth rates in Germany).

The estimation results for the highest schooling degree show that while the overall cohort effect for males is insignificant, the coefficient of ii) is positive and significant whereas the coefficient of iii) is negative and significant. This indicates differences in the overall level of the highest educational attainment between males born before and after 1978, with younger men belonging to smaller cohorts being more likely to invest more in education than men born in previous years and thus belonging to larger cohorts. More precisely, Fertig *et al* (2009) find that a 1% point increase in relative cohort size reduces the probability of receiving a high schooling degree by almost 7% for individuals born in 1978 or later.

With the only exception of Middendorf (2007), the papers outlined above seem to confirm the existence of a negative relationship between cohort size and human capital accumulation. These studies demonstrate that larger cohort size decreases the private returns to education and that large cohorts tend to invest less in their human capital.

But what about the Italian case? Population ageing might act, ceteris paribus, as an incentive for younger cohorts to invest more in human capital as long as young workers' wages increase as a result of the relative shift in labour supply. However, one could also argue that a shrinking labour force reduces labour market competition and youth unemployment, thus acting as an incentive to invest less in education and enter the labour market at an earlier stage for young cohorts. It follows that, from a theoretical point of view, the net impact of population ageing on the human capital accumulation of younger cohorts is not clear cut. An empirical investigation is then needed.

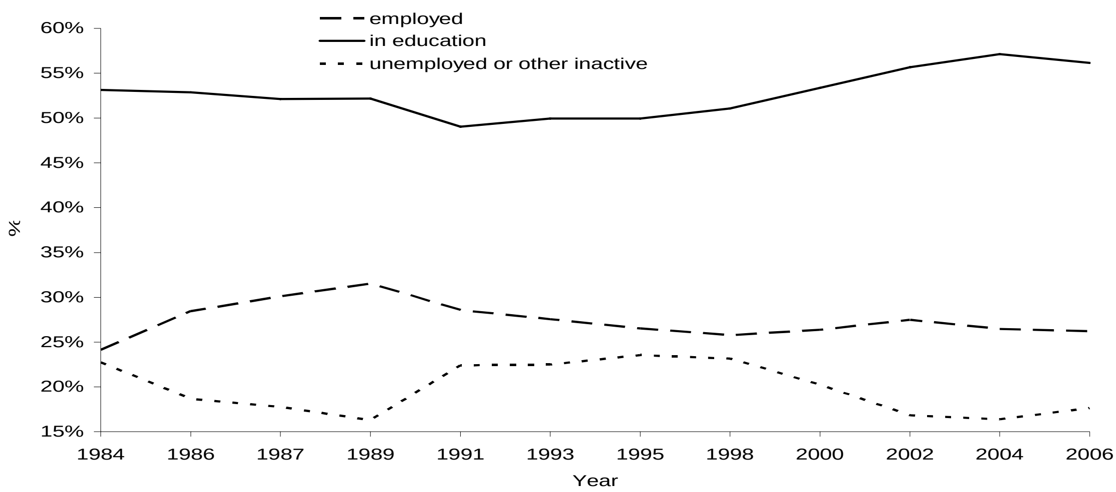
Section 6.2.3 investigates whether the relationship between cohort size and human capital accumulation is significant and negative or positive for younger Italian males. Before turning to this issue, a descriptive overview of labour market and educational attainment trends of younger Italian males in the past fifteen years is provided (Section 6.2.2).

6.2.2 A descriptive overview

This section provides a descriptive overview of basic trends in labour market status and educational attainment of younger males in Italy. For this purpose, the Bank of Italy Survey on Household Income and Wealth is used. A description of this dataset was provided in Chapter 4.

Figure 6.1 below shows employment, education and unemployment or inactivity other than education rates of Italian young males aged 15 to 24 from 1984 to 2006. Figure 6.1 shows that the share of young males in education has risen from 1998 onwards whereas the share of those in unemployment or inactivity other than education has decreased in the same time period. Given this trend, it is worthwhile to investigate historical and current educational attainment of Italian males more closely.

Figure 6.1: Employment, education and unemployment or other inactivity rate of young males in Italy, 1984-2006



Source: Bank of Italy Survey on Household Income and Wealth, weighted data

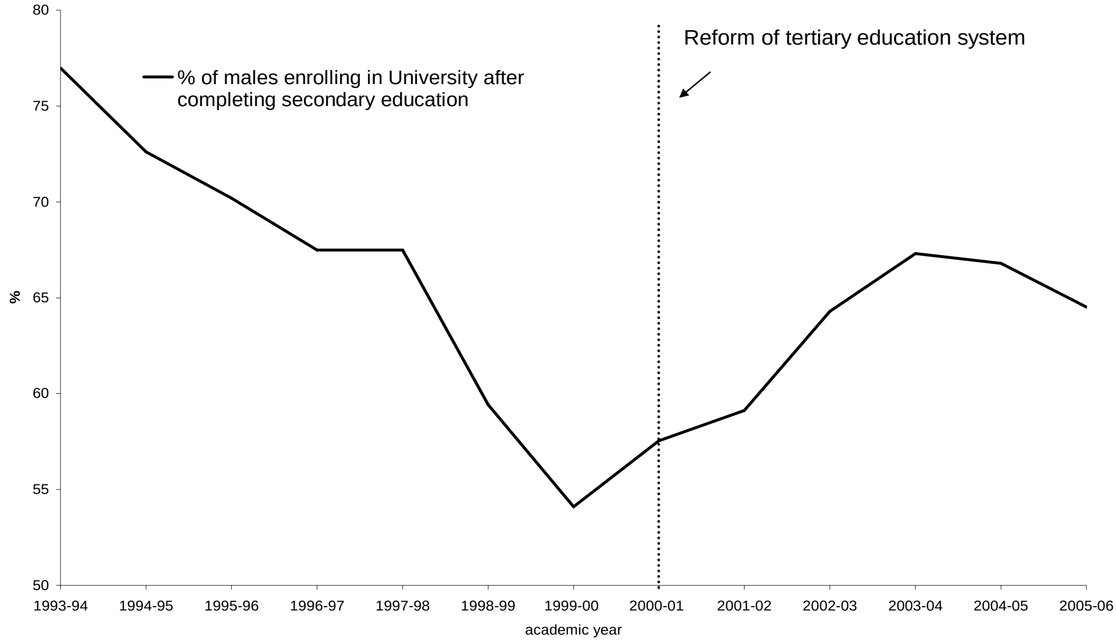
The Italian education system is based on five education tiers: pre-primary education (voluntary, for children aged 3 to 5); primary education (compulsory, for children aged 6 to 10); first level secondary education (compulsory, for children aged 11 to 13); second level secondary education (for pupils aged 14 to 18) and tertiary education. School leaving age was set at 14 years of age in 1962 and was raised by one year in 1999-2000.

Since 2000-2001, the Italian university system has been undergoing major changes, following the so-called "Bologna process"[40]. The reform was originally put into place to make higher education systems across European countries more similar and coherent and to promote labour mobility of young graduates within the European Union borders. Whilst the Italian pre-reform university system was based on a single tier - lasting for four to five years - the current post-reform system is based on two tiers: university students may either obtain a three-year degree (*Laurea breve*) or continue their university studies to pursue a second two-year degree (*Laurea magistralis*). The reform has brought other significant changes, including a considerable increase in the number of subjects students can choose and a reduction in both the number of exams and the complexity of content.

In Italy, the reform was introduced for different reasons, including low higher education enrolment rates, low number of graduates, high drop-out rates and average actual graduation length being well above four or five years. For example, Figure 6.2 shows that the proportion of males with a *diploma* (corresponding to A-levels in the British education system) enrolling in University decreased significantly in the pre-reform years, dropping from 77% in 1993-1994 to 54.1% in 1999-2000. This decreasing pattern reversed its tendency in the post-reform years.

[40] The "Bologna process" is the result of a number of Conferences, held in Paris (1998), Bologna (1999), Prague (2001), Berlin (2003) and Bergen (2005).

Figure 6.2: Tertiary education attainment of Italian males, 1993-94 to 2005-06



Source: Istat

The descriptive overview of this last section seems to show that the labour market status and educational attainment of young males in Italy changed quite significantly in the last eight to ten years, also following the higher education reform brought about by the Bologna process. An empirical analysis aimed at investigating whether changes in the cohort size of Italian younger males impact on their labour market and educational attainment is presented in Section 6.2.3.

6.2.3 Empirical analysis in Italy

The Italian data used for the analysis are 12 waves (1984, 1986, 1987, 1989, 1991, 1993, 1995, 1998, 2000, 2002, 2004 and 2006) of The Bank of Italy Survey on Household Income and Wealth (SHIW). As discussed in Chapter 4, the survey was conducted for the first time in 1965 and first made available as microdata in 1977. However, data prior to 1984 are not used in this analysis because information on individuals' single-year-of-age is not provided in the first waves of the survey. The SHIW collects data on the economic activities of Italian households, with particular attention to income and real estate holdings. The questionnaire also includes information on demographics, housing, health, education and training. The sample used in the most recent surveys includes about 8,000 households (24,000 individuals) distributed over about 300 Italian municipalities.

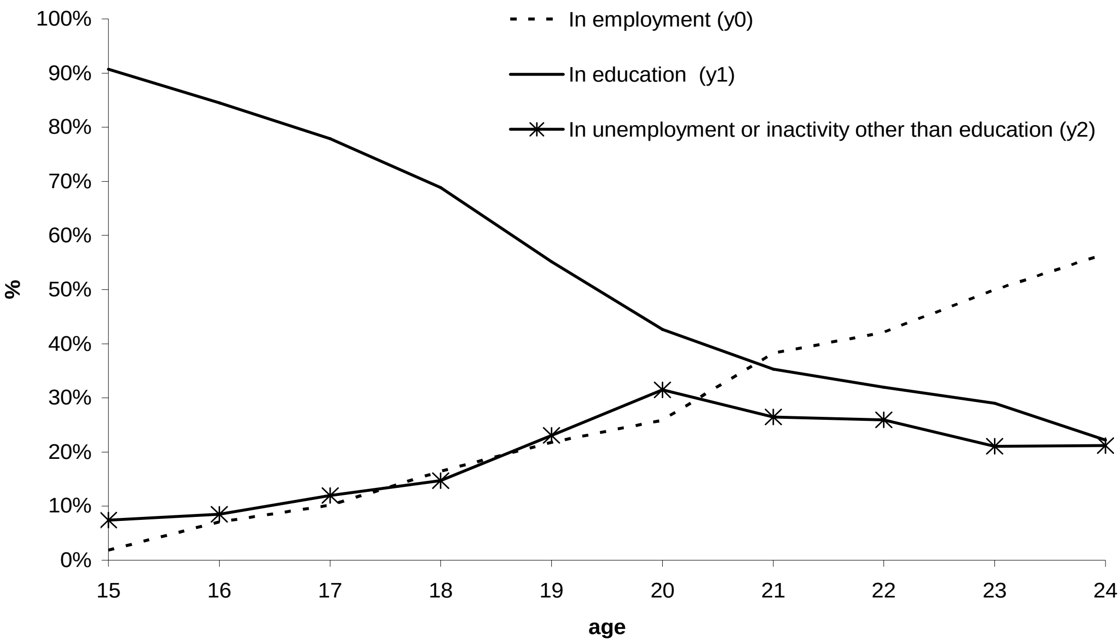
Given that the focus of the analysis is the labour market opportunities and educational attainment of younger males, only individuals aged 15-24 are included in the model. Individuals are aggregated on the base of age and year of observation and labour market and educational opportunities are estimated through a multinomial logit model with grouped data taking the following form:

$$prob(y = j) = \frac{\exp(\beta_j' x)}{\sum_{j=0}^{J} \exp(\beta_j' x)}, \; j = 0,1,2 \qquad [6.1]$$

where:
y_0 = proportion of males in employment;
y_1 = proportion of males in education;
y_2 = proportion of males in unemployment or inactivity other than education;
x= vector of independent variables.

A good description of multinomial logit models with grouped data is provided in Green (1995 and 2000). In general, multinomial variables are characterised by a set of mutually exclusive and exhaustive non-ordered categories – employment, education and unemployment or inactivity other than education in the model under consideration. The sum of the proportions of males in employment, education and unemployment or inactivity other than education is equal to one for each age cell (i.e. $y_0 + y_1 + y_2 = 1$ for each observation). Figure 6.3 shows the average values of y_0, y_1 and y_2 by single year of age between 1984 and 2006. As expected, the share of young males in education decreases significantly with age, whereas the share of young males in employment increases with age. An inverted U-shape patter emerges for those in unemployment or inactivity other than education.

Figure 6.3: Labour market status of Italian young males by single year of age, 1984-2006



Source: Bank of Italy SHIW, weighted data

The independent variables are characteristics of the observed aggregated individuals and include, according to the model specification chosen: i) age where age 0=age 15, 1=age 16, …, 9= age 24; ii) age squared; iii) the natural logarithm of cohort size; iv) the interaction between age and the natural logarithm of cohort size; v) the aggregated unemployment rate of Italian males in year t (per cent); and vi) a time trend where 0=1984, 2=1986, … 22=2006. Cohort size is still expressed as a moving average with inverted V weights of the age group *i*'s share in the total labour force, given here by males aged 15 to 64[41]. As Figure 6.4 below shows, the relative cohort size of young Italian males decreased for all ages between 15 and 24 in the period under consideration. This is mainly the result of the significant decrease in fertility registered in Italy in the 1970s, 1980s and 1990s.

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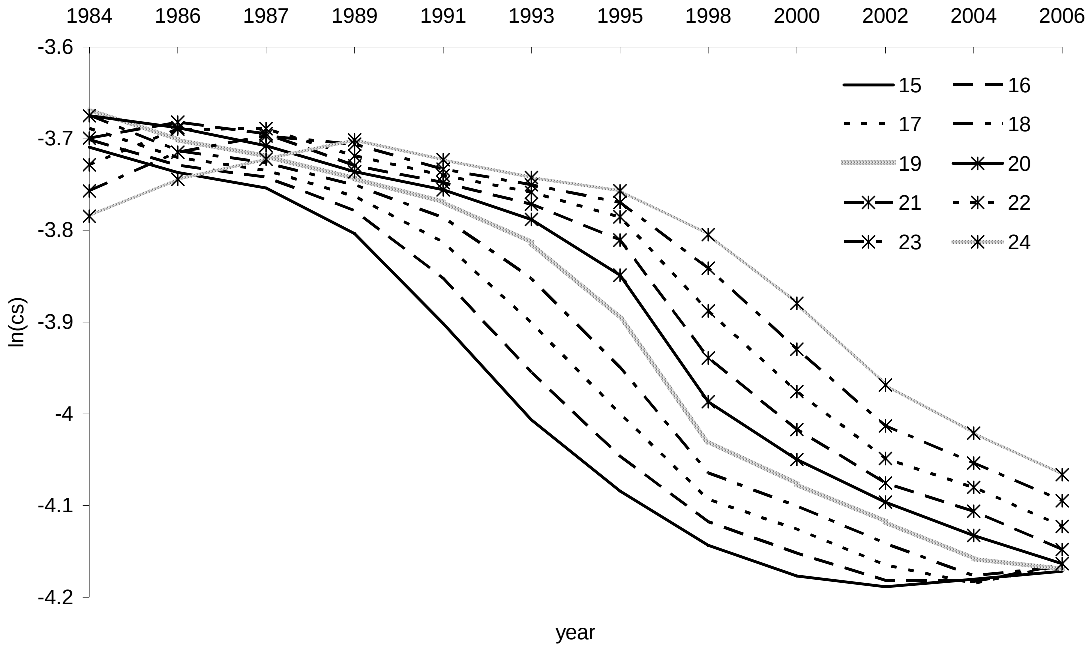
[41] $$\ln(cs_{it}) = \ln\left(\frac{\sum_{k=-2}^{2}(w_k)(N_{i-k,t})}{\sum_{i=15}^{64} N_{it}}\right)$$

Figure 6.4: Relative cohort size of Italian young males, 1984-2006



In order to identify the parameters of the model, the normalization $\beta_0 = 0$ is imposed, thus making "in employment" the reference category[42]. Care is therefore needed in the interpretation of coefficients from the maximum likelihood estimation. The magnitude of each β_j is not by itself especially useful: the parameters do not measure the effect of an explanatory variable on the outcome probabilities directly due to the nonlinear form. The coefficients for the jth alternative "in education" or "in unemployment or inactivity other than education" must be interpreted as the relative risk of choosing alternative j rather than alternative zero.

The exponential of the coefficient of alternative j versus the base category for any regressor gives the odds ratio. A positive coefficient implies that the odds ratio is larger than one and that a unit increase in the regressor raises the probability of category j relative to the probability of the base category. Thus, information on the sign of the coefficient alone is uninformative; one also needs to know the base

[42] This implies that Equation [1] can be equally written as:

$$prob(y = 0) = \frac{1}{1+\exp(\beta_1' x)+\exp(\beta_2' x)}$$

category. One can also estimate the partial effect of the (continuous) variables on the response probability by computing the following partial derivative:

$$\hat{\delta}_{i,j} = \frac{\delta F_j(x, \hat{\beta})}{\delta x_i} \qquad [6.2]$$

Where $F_j(x, \hat{\beta})$ is the multinomial logit function to be estimated and $\hat{\beta}$ is the consistent estimator of β computed by Maximum Likelihood.

$\hat{\delta}_{i,j}$ is the marginal effect of variable i on the response probability j. It represents the effect on the j[th] probability of changing the regressor i by one unit and varies with the values of *all* the explanatory variables. Econometrics software such as Limdep – the software used for the purpose of this analysis - compute marginal effects (and their standard errors) at the mean value of all explanatory variables. However, marginal effects can also be evaluated at other interesting values of the regressors, such as minima, maxima, medians and lower and upper quartiles. The variance (and standard error) can be estimated using the delta method:

$$\hat{\sigma}^2_{i,j} = \frac{\delta}{\delta \beta'} \left[\frac{\delta F_j(x, \hat{\beta})}{\delta x_i} \right] \hat{V}_\beta \frac{\delta}{\delta \beta} \left[\frac{\delta F_j(x, \hat{\beta})}{\delta x_i} \right] \qquad [6.3]$$

where $\hat{V}_\beta$ represents the estimates of the variance covariance matrix of $\hat{\beta}$. The corresponding t-statistic is given by $\hat{\delta}_{i,j} / \hat{\sigma}_{i,j}$ (for more details, see Ai and Norton (2003), Green (2000), Mallick (2008), and Norton *et al* (2004)).

In the model, ten age groups (i.e. 0 = age 15, 1 = age 16, … 9 = age 24) and twelve years of data (1984, 1986, 1987, 1989, 1991, 1993, 1995, 1998, 2000, 2002, 2004 and 2006) are estimated. This gives 120 observations (i.e. 10 age groups times 12 time periods). The labour market data extracted from the SHIW are weighted using

PESOFL (see Banca d'Italia (2008)). To correct for heteroskedasticity, which often accompanies grouped data, robust standard errors are estimated.

The empirical model used to estimate the impact of cohort size on educational and labour market attainment of younger males in Italy is therefore similar to the empirical model used to investigate the impact of cohort size on age-earnings and age-employment profiles of Italian men aged 20 to 54. Individuals are aggregated on the base of age and year of observation and the same explanatory variables are used. However, non-linear estimation (multinomial logit) is substituted for linear estimation (OLS) due to the different nature of the dependent variable.

I could have alternatively followed Connelly and Gottschalk (1995) or Fertig *et al* (2009) and included additional covariates such as parental background information. However, for consistency purposes, I include the same explanatory variables used in Chapter 4. Also, the variables included in the model are clearly exogenous, whereas parental education might be considered as endogenous. Finally, the only way to include information about parents' education in the SHIW dataset is to match parents to their children using variables such as NCOMP (number of members in the household); PAR (1: household head; 2: household head spouse or partner; 3: son / daughter; 4: other). This matching procedure could lead to sample selection-bias: information on parent's education could be gathered only for young individuals still living with their parents.

6.2.4 Results

Tables 6.1 and 6.2 report the estimates of Equation [1] for probability of being in education (prob(y=1)) and probability of being in unemployment or inactivity other than education (prob(y=2)). Seven specifications are included: specification 1 includes only age; age squared is added in specification 2; specification 3 includes only age and ln(cs); age, age squared and ln(cs) are included in specification 4; the interaction between age and ln(cs) is added in specification 5; the aggregate male unemployment rate is included in specification 6 together with age and ln(cs); and specification 7 drops the aggregated unemployment rate and includes the time trend instead. The likelihood ratio test $\left(\chi^2_{DF}\right)$ and pseudo-R^2 for each specification are added at the bottom of the table. A table summarising the mean, standard deviation, minimum and maximum of all variables is also presented (Table 6.3).

Unfortunately, most of the coefficients are statistically insignificantly different from zero. Age seems to be the only significant variable. As age increases, individuals are less likely to be in education rather than in employment. Also, as age increases, individuals are less likely to be unemployed or other inactive.

Table 6.1: Parameter estimates of probability of being in education (prob(y=1)) of Italian males aged 15-24, 1984-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	-0.46	-0.72	-0.45	-0.71	-0.53	-0.45	-0.46
	[4.6]	[1.7]	[4.4]	[1.7]	[0.2]	[4.4]	[3.5]
Age^2		0.028		0.027	0.027		
		[0.7]		[0.7]	[0.7]		
ln(cs)			-0.58	-0.56	-0.79	-0.58	0.00
			[0.4]	[0.4]	[0.2]	[0.4]	[0.0]
ln(cs)·age					0.05		
					[0.1]		
$\bar{u}_m$						-0.01	
						[0.1]	
t							0.0
							[0.1]
α_0	2.94	3.38	0.65	1.15	0.23	0.76	2.80
	[5.0]	[3.3]	[0.1]	[0.2]	[0.0]	[0.1]	[0.2]
N	120	120	120	120	120	120	120
DF	2	4	4	6	8	6	6
Log likelihood	-104.95	-104.39	-104.86	-104.31	-104.30	-104.83	-104.80
Restricted log likelihood	-120.44	-120.44	-120.44	-120.44	-120.44	-120.44	-120.44
LR(χ^2_{DF})	30.98	32.10	31.17	32.28	32.28	31.23	31.29
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.129	0.133	0.129	0.134	0.134	0.130	0.130

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is "in employement". Robust standard errors are used.

Table 6.2: Parameter estimates of probability of being in unemployment or inactivity other than education (prob(y=2)) of Italian males aged 15-24, 1984-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	-0.17	-0.08	-0.17	-0.07	0.09	-0.16	-0.20
	[1.5]	[0.2]	[1.5]	[0.1]	[0.0]	[1.4]	[1.4]
Age^2		-0.010		-0.010	-0.011		
		[0.2]		[0.2]	[0.2]		
ln(cs)			-0.12	-0.13	-0.35	-0.35	1.60
			[0.1]	[0.1]	[0.1]	[0.2]	[0.3]
ln(cs)·age					0.04		
					[0.1]		
$\bar{u}_m$						0.10	
						[0.3]	
t							0.0
							[0.4]
α_0	0.64	0.53	0.16	0.01	-0.85	-1.48	6.58
	[0.9]	[0.4]	[0.0]	[0.0]	[0.1]	[0.2]	[0.3]
N	120	120	120	120	120	120	120
DF	2	4	4	6	8	6	6
Log likelihood	-104.95	-104.39	-104.86	-104.31	-104.30	-104.83	-104.80
Restricted log likelihood	-120.44	-120.44	-120.44	-120.44	-120.44	-120.44	-120.44
LR(χ^2_{DF})	30.98	32.10	31.17	32.28	32.28	31.23	31.29
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.129	0.133	0.129	0.134	0.134	0.130	0.130

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is “in employment”. Robust standard errors are used.

Table 6.3: Descriptive statistics of aggregated variables, 1984-2006

Variable	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
Employment rate y_0	0.270	0.189	0.000	0.663
Education rate y_1	0.538	0.248	0.139	0.960
Unemployment or inactivity other than education rate y_2	0.192	0.091	0.011	0.372
Age	4.5	2.884	0	9
Age^2	28.5	26.965	0	81
Natural logarithm of cs *ln(cs)*	-3.900	0.180	-4.189	-3.668
Interaction between ln(cs) and age *ln(cs)·age*	-17.400	11.053	-36.597	0
Aggregated male unemployment rate $\overline{u}$ (per cent)	7.575	1.042	5.4	9.2
Time trend *t*	10.583	7.130	0	22

Note: the labour market data extracted from the SHIW are weighted using PESOFL.

Age dummies were also introduced and interacted with cohort size, but also this attempt indicated that demographic variables do not impact on labour market opportunities and educational attainment of younger males in Italy. Marginal effects were not computed given that results are highly insignificant.

6.3 Cohort effects on labour market attainment of older Italian males

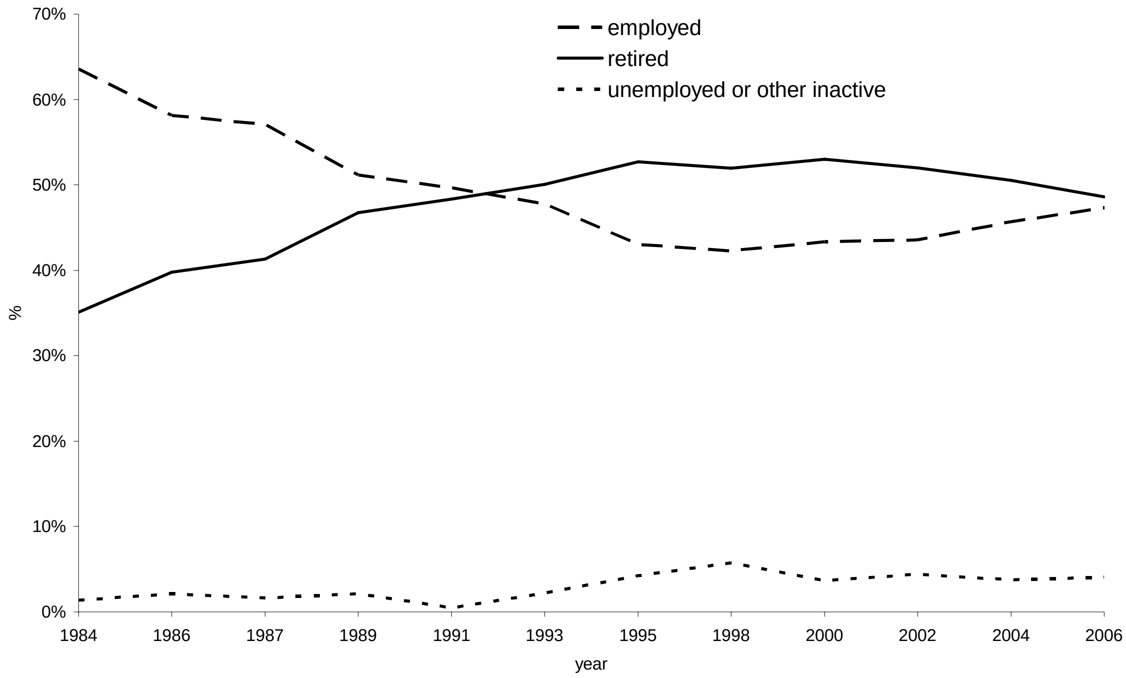
To my knowledge, there exists no literature that *specifically* focuses on the impact of demographic variables on the labour market attainment of older people. Although a number of studies of the cohort crowding literature focus on earnings and employment opportunities of males aged up to 64 or 65 (for example, see Welch (1979), Dooley (1986) and Ben-Porath (1988)), none specifically focuses on the impact of cohort size on retirement, employment or unemployment probabilities of older individuals. However, this is an interesting research question that deserves further investigation. For example, are individuals belonging to larger cohorts more or less likely to be retired, employed or unemployed than individuals belonging to smaller cohorts? Population is ageing rapidly in Italy so there will larger be cohorts of older people in the future. It is therefore important to investigate if cohort size has an impact on retirement, employment or unemployed probability of older cohorts. For example, if it is found that cohort size had a positive impact on retirement probabilities one can expect – ceteris paribus – higher retirement rates for larger cohorts of older people. However, who is going to pay for their pensions?

6.3.1 A descriptive overview

This section provides a descriptive overview of labour market opportunities of older males in Italy between 1984 and 2006, using the Bank of Italy SHIW.

Figure 6.5 below shows employment, retirement and unemployment or inactivity other than retirement rates of Italian older males aged 50 to 70 from 1984 to 2006. The Figure shows that the share of older males in employment decreased whereas the share of older males in retirement increased in the first ten years of the period under consideration, i.e. between 1984 and 1995. However, these patterns seem to have reversed from 1995 onwards. Given this reversal in trend in the last ten years, it is worthwhile investigating historical and current labour market attainment of Italian older males more closely, with specific reference to the Italian pension system's reforms.

Figure 6.5: Employment, retirement and unemployment or other inactivity rate of Italian older males aged 50 to 70, 1984-2006



Source: Bank of Italy SHIW, weighted data

Italian pensions are currently based on a three-pillar system: the first pillar is a pay-as-you-go (PAYG) system, the second pillar comprises supplementary funded pensions and the third pillar is private insurance annuities or individual accounts. The first pillar is mandatory whereas the other two are voluntary. Most of the schemes of the first pillar are administered by the Social Security Institution for the private sector (INPS) which accounts for two thirds of public spending and covers the majority of private employees and the self-employed. Public sector employees' benefits are managed by a separate institution (INPDAP).

The Italian pension system distinguishes between old-age and seniority pensions (*pensione di vecchiaia* and *pensione di anzianita'*, respectively). Seniority pensions are targeted to workers with a long working career started early. In this case, benefits are mainly based on years of contribution rather than on age at retirement. Hence, it is a pension employees can be entitled to before reaching the state retirement age.

Although the 1995 Dini reform (discussed below) implied the withdrawal of this instrument, it is still in place because of its long transitional period.

Since the early 1990s, the Italian pension system has undergone a number of major reforms - most notably in 1992, 1995 and 2004 – due to serious budgetary problems. For example, at the beginning of the 1990s the ratio of fiscal deficit to GDP was 11.7% and the public debt to GDP ratio was 97.1% (Cackley *et al*, 2006). According to the Maastricht Treaty, these two ratios should have not exceeded 3% and 60%, respectively. Also, in the context of an ageing population, the reforms were put into place to reduce the generosity of the first pillar and lower the growth of public sector spending.

Before the 1992 reform, the state retirement age for old-age pensions was 60 years for men and 55 for women, provided that workers had contributed to the program for at least 15 years. Private sector workers could opt for early retirement at any age after 35 years of contributions, compared to 20 years for male and 15 years for female public sector workers. Pensionable earnings were computed on the base of years of service and final salary (more specifically, on the average of the last five-year real wages for private sector workers and on the final salary for public sector workers). Pensionable earnings were converted into social security benefits by applying a 2% factor for each year of social security contribution up to a maximum of 40 years. Hence, a worker could get at most 80% of his pensionable earnings. Benefits were indexed to nominal wage growth. No actuarial penalty was assessed on early retirees.

The first significant reform was put into place in 1992 (known as the Amato reform). The state retirement age was increased from 55 to 60 years for women and from 60 to 65 years for men, provided that workers had contributed for at least 20 years. The minimum number of years of contributions necessary to get into early retirement was raised to 35 years also for public sector employees. The 1992 Amato reform also extended the number of years over which pensionable earnings were computed (from the last 5 years to the entire working life) and changed the basis for indexation of pension benefits from nominal wages to prices (which presumably is typically less than wage growth).

The second important reform was put into place three years later, in 1995 (referred to as the Dini reform). This reform introduced a major change in the award formula, following the Swedish example. The 1995 reform changed the method of benefit calculation from a PAYG and 'defined-benefit' system, to a still PAYG but 'defined-contribution' method (Natali, 2004). Under the new system, benefits were based on contributions: each employee had a notional public pension account credited with 1/3 of the amount of gross wages each year. This amount increased at a rate equal to a 5-year moving average of growth in the country's GDP. Benefits were thus calculated on the basis of contributions paid through the entire working career and virtually saved in notional accounts (Forni, 2004). This measure was put into place to reduce pensionable earnings and thus to alleviate public spending on pensions.

Both male and females employees could retire at 57 years of age if they had at least 5 years of contributions or at any age if they had paid 40 years of contributions. Workers could therefore decide to retire between 57 and 65 years old but would get a "full pension" only at age 65. Moreover, workers who stayed in employment until the age of 67 were entitled to an extra bonus. State retirement age for seniority pension was fixed to 57 years for both men and women with at least 35 years of contribution.

The third significant reform was put into place in 2004 (known as the Berlusconi Reform) and reinforced in 2007 with Law 247/2007. Whilst with the Dini reform each worker could decide to retire between 57 and 65 years, since the Berlusconi reform the retirement age is fixed. Since January 2008, the minimum retirement age for old-age pension is 65 years for men and 60 for women - provided that workers have paid contributions for at least 5 years since 1 January 1996. However, workers with 40 years of contributions may retire at any age.

The new rules for seniority pensions are more complicated and imply that male workers are (will be) entitled to seniority pensions:

- at the age of 58, provided that they have contributed to the program for at least 35 years, between 01/01/2008 and 30/06/2009;
- at the age of 59 (60), provided that they have contributed to the program for at least 36 (35) years, between 01/07/009 and 31/12/2010[43];
- at the age of 60 (61) provided that they have contributed to the program for at least 36 (35) years in 2011 and 2012;.
- 61 (62) years provided that they have contributed to the program for at least 36 (35) years in 2013 and 2014; and
- by contrast female employees can retire at age 57 with 35 years of contribution.

The 2004 reform has also affected the second pillar, which is based on supplementary and voluntary funded pensions. The second pillar is based on two schemes: closed (negotiated) funds regulated by collective agreements; and open funds workers can join individually or in groups managed by financial intermediaries. Since 2004, the end-of-service-allowance (*trattamento di fine rapporto* (or TFR)) - a proportion of employees' wages set aside by employers and paid as a lump sum at retirement - is part of the second pillar, unless employees explicitly claim they want it to be part of the first pillar. This is the so called *'silent-assent'* mechanism and is aimed to favour the development of supplementary benefits.

To sum up, the 1992, 1995 and 2004 reforms aimed to reduce public expenditure on pensions in the context of serious budgetary problems and an ageing population. The main objectives of the reforms were to:

- Increase the state retirement age;
- Shift from a PAYG defined-benefit system to a PAYG defined-contribution system;
- Decrease early retirement incentives, especially for public sector workers;
- Index pensionable earnings to prices rather than to wages; and
- Develop supplementary benefits.

[43] Values in brackets are for self-employers

Table 6.4 below summarises the major changes of the Italian pension system in the last two decades.

Table 6.4: Recent reforms in the Italian pension system

	Form of System	Pensionable Earnings	State retirement age for old-age pensions	State retirement age for seniority pensions
Before 1992	PAYG defined-benefit system: social security benefits computed on the base of years of service and final salary (salaries)	Based on the average of last 5-year real earnings	60 years for men and 55 years for women with at least 15 years of contribution	Allowed at any age after 35 years of contributions for private sector workers; at any age after 20 (15) years of contributions for public sector male (female) workers No actuarial penalty for early retirees when computing benefits
1992 Amato Reform	Basis of indexation of pension benefits shifts from earnings to inflation	Based on career average earnings	Increases to 65 years for men and 60 years for women with at least 20 years of contribution	Allowed at any age after 35 years of contributions for *both* private & public sector workers
1995 Dini Reform	Shift from a PAYG defined-benefit system to a PAYG defined-contribution system: benefits calculated on the basis of contributions paid through the working career and virtually saved in notional accounts	Based on career contributions (capitalized at an annual rate using a 5 year moving average of past GDP growth rates)	Made flexible between 57 (with at least 5 years of contribution) and 65	Fixed to 57 years for both men and women with at least 35 years of contribution.
2004 Berlusconi Reform & Law 247 / 2007	TFR becomes part of the 2nd pillar		Fixed to 65 years for men and 60 for women, with at least 5 years of contribution, or with 40 years of contribution regardless the age of retirement from 1 January 2008	Fixed to: - 58 years provided that workers have contributed to the program for at least 35 years between 01/01/08 and 30/06/09. - 59 (60) years provided that workers have contributed to the program for at least 36 (35) years between 01/07/09 and 31/12/10. - 60 (61) years provided that workers have contributed to the program for at least 36 (35) years in 2011 and 2012. - 61 (62) years provided that workers have contributed to the program for at least 36 (35) years in 2013 and 2014. - However, workers with 40 years of contributions may retire at any age. - age 57 with 35 years on contribution for female employees

Have the measures introduced by the reforms worked? Table 6.5 below compares expenditure on pensions in different European countries: Italy records the highest proportion of GDP spent on pensions, followed by Austria and the Netherlands. However, it is worthwhile to note that whilst other countries facing population ageing such as Germany and Greece have increased the proportion of GDP spent on pensions, in Italy this figure has remained roughly constant.

Table 6.5: Expenditure on pensions (as % of GDP, current prices)

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Italy	*14.6*	*14.2*	*14.5*	*15*	*14.5*	*14.9*	*14.4*	*14.3*	*14.6*	*14.7*	*14.6*	*14.8*
Netherlands	14.2	13.9	13.8	13.4	12.8	12.8	12.5	12.4	12.7	12.8	12.8	12.6
Austria	14	14.2	14.3	14.3	14.2	14.3	14.1	14.3	14.5	14.6	14.3	14.2
Finland	13.4	12.7	12.7	12	11.2	11	10.5	10.6	10.9	11.2	11.2	11.2
Sweden	13.3	12.7	12.7	12.4	12.2	12	11.6	11.6	11.9	12.7	12.6	12.5
France	13.2	13.4	13.5	13.5	13.4	13.4	12.9	12.9	13	13.1	13.1	13.3
Belgium	12.8	11.8	11.9	11.6	11.5	11.3	11	11.1	11.2	11.3	11.2	11.2
Germany	12.4	12.5	12.7	12.7	12.8	12.8	12.9	13	13.2	13.4	13.2	13.1
Luxembourg	12.3	11.1	11	11.3	10.9	10.1	9.4	9.8	10	10.1	9.9	9.7
UK	12	11.8	11.8	11.9	11.4	11.5	12.1	11.7	11	10.8	10.7	11
Denmark	11.4	11.3	11.4	11.1	11	10.8	10.5	10.6	10.7	11.1	11.1	10.9
Greece	11.1	10	10.4	10.5	11.1	11.3	11.1	11.8	11.7	11.6	11.7	11.9
Switzerland	10.6	11.1	11.4	11.7	11.9	12.2	12	12.5	12.7	13.1	13	13.1
Spain	10.4	10.1	10.3	10.1	9.9	9.6	9.6	9.3	9.2	9.1	9	8.9
Norway	8.6	8.4	8.1	8	8.6	8.7	7.6	7.7	8.4	8.7	8.4	8
Iceland	5.5	5.7	5.6	5.7	5.7	5.9	6.2	6.1	6.6	7.3	7.1	7
Ireland	4.3	4	3.7	3.4	3.2	3.7	3.6	3.7	4.7	4.7	4.9	4.9

Source: Eurostat

Notes: The 'Pensions' aggregate comprises part of periodic cash benefits under the disability, old-age, survivors and unemployment functions. It is defined as the sum of the following social benefits: disability pension, early-retirement due to reduced capacity to work, old-age pension, anticipated old-age pension, partial pension, survivors' pension, early-retirement benefit for labour market reasons.

Given the expected shortfalls in the Italian pension system finances over the next few decades, additional reforms might still be needed. Options under consideration include an increase across the board of women’s retirement age, minimum retirement age for men and women, contribution rates and penalties for early retirement. Recent proposals focus on new incentives for private voluntary savings programs, such as the TFR legislation mentioned above.

6.3.2 Empirical analysis

The Italian data used for the analysis are again 12 waves (1984, 1986, 1987, 1989, 1991, 1993, 1995, 1998, 2000, 2002, 2004 and 2006) of the Bank of Italy SHIW. The analysis is restricted to males aged 50 to 70. Individuals are aggregated on the base of age and year of observation. Labour market opportunities are estimated through a multinomial logit model with grouped data. 21 age groups (i.e. 0 = age 50, 1 = age 51, … 20 = age 70) and 12 years of data (1984, 1986, 1987, 1989, 1991, 1993, 1995, 1998, 2000, 2002, 2004 and 2006) are estimated. This gives 252 observations (i.e. 21 age groups times 12 time periods). The labour market data extracted from the SHIW are weighted using PESOFL. To correct for heteroskedasticity, which often accompanies grouped data, robust standard errors are estimated.

The multinomial model (with grouped data) used in the analysis takes the following form:

$$prob(y = j) = \frac{\exp(\beta_j' x)}{\sum_{j=0}^{J} \exp(\beta_j' x)}, \; j = 0,1,2 \qquad [6.4]$$

where:

y_0 = proportion of males in employment (reference category);

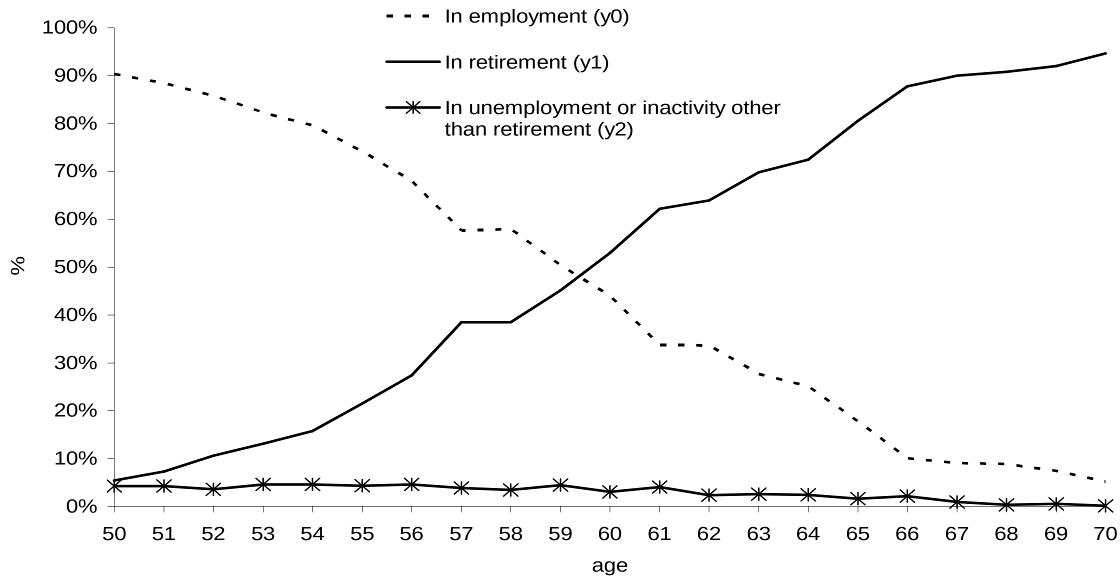
y_1 = proportion of males in retirement;

y_2 = proportion of males in unemployment or inactivity other than retirement;

x= vector of independent variables (including age, age squared, natural logarithm of cohort size, the interaction between the natural logarithm of cohort size and age, aggregated male unemployment rate and a time trend).

The sum of the proportions of males in employment, retirement and unemployment or inactivity other than retirement is equal to one for each age cell. Figure 6.6 shows the average values of y_0, y_1 and y_2 by single year of age between 1984 and 2006. As expected, the share of older males in retirement increases significantly with age, whereas the share of older males in employment decreases with age.

Figure 6.6: Labour market status of Italian males aged 50 to 70 by single year of age, 1984-2006



Source: Bank of Italy SHIW, weighted data

6.3.3 Results

Tables 6.6 and 6.7 report the estimates of Equation [4] for probability of being in retirement (prob(y=1)) and probability of being in unemployment or inactivity other than retirement (prob(y=2)), called hereafter unemployment or other inactivity. Again, seven specifications are included: specification 1 includes only age; age squared is added in specification 2; specification 3 includes only age and ln(cs); age, age squared and ln(cs) are included in specification 4; the interaction between age and ln(cs) is added in specification 5; the aggregate male unemployment rate is included in specification 6 together with age and ln(cs); and specification 7 drops the aggregated unemployment rate and includes the time trend instead.

The likelihood ratio test $\left(\chi^2_{DF}\right)$ and pseudo-R^2 for each specification are added at the bottom of the table. A table summarising the mean, standard deviation, minimum and maximum of all variables is also presented (Table 6.8).

The Tables show that age increases the probability of being retired rather than in employment. Cohort size does not seem to impact on the probability of being retired or unemployed or other inactive versus the probability of being in employment. However, a more detailed analysis involving the computation of marginal effects is needed.

Table 6.6: Parameter estimates of probability of being in retirement (prob(y=1)) of Italian males aged 50-70, 1984-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.28	0.30	0.31	0.30	0.36	0.31	0.28
	[8.2]	[2.4]	[6.0]	[2.3]	[0.3]	[6.1]	[5.1]
Age^2		-0.001		0.001	0.001		
		[0.2]		[0.1]	[0.1]		
ln(cs)			1.18	1.25	0.98	1.28	0.04
			[0.7]	[0.7]	[0.2]	[0.8]	[0.0]
ln(cs)·age					0.02		
					[0.0]		
$\bar{u}_m$						0.11	
						[0.7]	
t							0.03
							[1.2]
α_0	-2.64	-2.72	1.95	2.30	1.21	1.55	-2.82
	[7.2]	[4.6]	[0.3]	[0.3]	[0.0]	[0.2]	[0.4]
N	252	252	252	252	252	252	252
DF	2	4	4	6	8	6	6
Log likelihood	-147.71	-147.68	-147.29	-147.28	-147.27	-147.01	-146.28
Restricted log likelihood	-202.73	-202.73	-202.73	-202.73	-202.73	-202.73	-202.73
LR(χ^2_{DF})	110.03	110.10	110.87	110.88	110.90	111.44	112.88
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0
Pseudo R^2	0.271	0.272	0.273	0.273	0.274	0.275	0.278

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is “in employment”. Robust standard errors are used.

Table 6.7: Parameter estimates of probability of being in unemployment or inactivity other than retirement (prob (y=2)) of Italian males aged 50-70, 1984-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.05	0.10	0.12	0.10	-0.36	0.13	0.07
	[0.7]	[0.4]	[0.9]	[0.4]	[0.1]	[1.0]	[0.5]
Age^2		-0.003		0.002	0.000		
		[0.2]		[0.1]	[0.0]		
ln(cs)			4.09	4.32	5.60	4.74	0.88
			[0.6]	[0.6]	[0.5]	[0.7]	[0.1]
ln(cs)·age					-0.12		
					[0.1]		
$\overline{u}_m$						0.16	
						[0.4]	
t							0.06
							[0.9]
α_0	-3.06	-3.19	13.03	14.03	19.08	14.37	-0.32
	[4.6]	[3.4]	[0.5]	[0.5]	[0.4]	[0.5]	[0.0]
N	252	252	252	252	252	252	252
DF	2	4	4	6	8	6	6
Log likelihood	-147.71	-147.68	-147.29	-147.28	-147.27	-147.01	-146.28
Restricted log likelihood	-202.73	-202.73	-202.73	-202.73	-202.73	-202.73	-202.73
LR(χ^2_{DF})	110.03	110.10	110.87	110.88	110.90	111.44	112.88
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0
Pseudo R^2	0.271	0.272	0.273	0.273	0.274	0.275	0.278

Note to the table: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is “in employment”. Robust standard errors are used.

Table 6.8: Descriptive statistics of aggregated variables, 1984-2006

Variable	Mean	Standard deviation	Minimum	Maximum
Employment rate (y_0)	0.456	0.307	0.016	0.972
Retirement rate (y_1)	0.514	0.318	0.010	0.981
Unemployment or inactivity other than education rate (y_2)	0.030	0.028	0	0.136
Age	10	6.067	0	20
Age^2	136.667	125.688	0	400
Natural logarithm of cs *ln(cs)*	-4.133	0.178	-4.871	-3.892
Interaction between ln(cs) and age *ln(cs)·age*	-42.154	26.768	-97.430	0
Aggregated male unemployment rate $\bar{u}$ (per cent)	7.575	1.040	5.4	9.2
Time trend *t*	10.583	7.114	0	22

Notes: The labour market data extrapolated from the SHIW are weighted using PESOFL.

As discussed above, marginal effects can be computed as $\hat{\delta}_{i,j} = \frac{\delta F_j(x,\hat{\beta})}{\delta x_i}$ and evaluated at interesting values of the regressors, such as means, minima, maxima, medians and lower and upper quartiles. Also, the variance (and standard error) of marginal effects can be estimated using the delta method, so that $\hat{\sigma}^2_{i,j} = \frac{\delta}{\delta\beta'}\left[\frac{\delta F_j(x,\hat{\beta})}{\delta x_i}\right]\hat{V}_\beta \frac{\delta}{\delta\beta}\left[\frac{\delta F_j(x,\hat{\beta})}{\delta x_i}\right]$.

Marginal effects of cohort size on the probability of being employed, retired or unemployed and other inactive are evaluated at each value of age (i.e. age0 = 50, age1 = 51 ,… age20 = 70), at the average, maximum and minimum value of ln(cs) and at the average unemployment rate (specification 6 is used). The marginal effect of x_2=ln(cs) on the probability of being employed (j=0) is given by:

$$\hat{\delta}_{2,0} = \frac{\delta F_0(x,\hat{\beta})}{\delta x_2} = \frac{\delta \frac{1}{1+\exp(\hat{\beta}_1 x)+\exp(\hat{\beta}_2 x)}}{\delta x_2} \qquad [6.5]$$

$\frac{\delta}{\delta\beta}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right]$ is a 8x1 vector that takes the following form:

$$\frac{\delta}{\delta\beta}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] = \begin{bmatrix} \frac{\delta}{\delta\hat{\beta}_{0,1}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{1,1}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{2,1}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{3,1}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{0,2}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{1,2}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{2,2}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \\ \frac{\delta}{\delta\hat{\beta}_{3,2}}\left[\frac{\delta F_0(x,\hat{\beta})}{\delta x_2}\right] \end{bmatrix} \quad [6.6]$$

where x_1=age, x_2=ln(cs) and x_3=u. $\hat{\beta}_{1,1}$ is the estimated coefficient of x_1=age when j=1 and $\hat{\beta}_{1,2}$ is the estimated coefficient of x_1=age when j=2. $\hat{V}_{\beta}$ is 8x8 matrix. To verify that my computations are correct, I compare the estimated marginal effects and standard errors computed at the *mean* value of the explanatory variables with Limdep output. My results and Limdep output are identical.

Results are presented in Tables 6.9 and 6.10 below. Table 6.9 summarises the marginal effect of ln(cs) - and the t statistics - on probability of being employed. Table 6.10 summarises the marginal effects of ln(cs) - and the t statistics - on probability of being retired. Marginal effects which are significant at 10% level or less are presented in bold / italics. Tables 6.9 and 6.10 show that an increase in cohort size decreases the probability of being employed and increases the probability of being retired for males aged 50 to 59 and belonging to a small cohort. For example, if cohort size increases by 1%, the probability of being employed decreases by 4.8% points for males aged 52.

Table 6.9: Marginal effect of ln(cs) on probability of being employed for Italian males aged 50-70, 1984-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	***-0.135***	***-1.7***	-0.286	-0.7	***-0.028***	***-1.6***
51	***-0.160***	***-1.6***	-0.322	-0.7	***-0.037***	***-1.9***
52	-0.190	-1.5	-0.360	-0.7	***-0.048***	***-2.3***
53	-0.223	-1.4	-0.397	-0.7	***-0.064***	***-2.8***
54	-0.259	-1.3	-0.431	-0.7	***-0.083***	***-3.5***
55	-0.295	-1.2	-0.457	-0.8	***-0.107***	***-3.9***
56	-0.329	-1.1	-0.473	-0.8	***-0.136***	***-3.6***
57	-0.357	-1.0	-0.475	-0.8	***-0.169***	***-2.8***
58	-0.374	-1.0	-0.461	-0.8	***-0.206***	***-2.1***
59	-0.377	-0.9	-0.431	-0.9	***-0.244***	***-1.6***
60	-0.365	-0.9	-0.389	-1.0	-0.279	-1.3
61	-0.339	-0.9	-0.339	-1.0	-0.306	-1.0
62	-0.303	-0.9	-0.286	-1.1	-0.321	-0.9
63	-0.261	-0.9	-0.235	-1.2	-0.322	-0.8
64	-0.217	-0.9	-0.188	-1.2	-0.308	-0.7
65	-0.176	-0.9	-0.147	-1.3	-0.281	-0.6
66	-0.139	-1.0	-0.113	-1.4	-0.247	-0.6
67	-0.108	-1.0	-0.086	-1.5	-0.209	-0.6
68	-0.083	-1.0	-0.065	-1.5	-0.532	-0.5
69	-0.063	-1.0	-0.049	-1.6	-0.137	-0.5
70	-0.047	-1.1	***-0.147***	***-1.6***	-0.107	-0.5

Table 6.10: Marginal effect of ln(cs) on probability of being retired for Italian males aged 50-70, 1984-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	0.056	1.0	0.061	0.6	***0.025***	***2.3***
51	0.073	0.9	0.077	0.6	***0.034***	***2.6***
52	0.094	0.9	0.094	0.5	***0.045***	***3.1***
53	0.118	0.8	0.112	0.5	***0.060***	***3.8***
54	0.146	0.8	0.130	0.5	***0.079***	***4.5***
55	0.175	0.8	0.145	0.4	***0.102***	***4.5***
56	0.204	0.7	0.155	0.4	***0.131***	***3.7***
57	0.228	0.7	0.157	0.4	***0.164***	***2.7***
58	0.245	0.7	0.150	0.3	***0.164***	***2.0***
59	0.251	0.6	0.134	0.2	***0.238***	***1.6***
60	0.245	0.6	0.110	0.2	0.273	1.2
61	0.227	0.6	0.082	0.1	0.300	1.0
62	0.553	0.2	0.053	0.1	0.315	0.9
63	0.519	0.2	0.027	0.0	0.316	0.7
64	0.135	0.5	0.004	0.0	0.303	0.7
65	0.104	0.4	-0.013	0.0	0.277	0.9
66	0.077	0.4	-0.026	-0.1	0.242	0.6
67	0.055	0.3	-0.034	-0.1	0.205	0.5
68	0.037	0.3	-0.038	-0.1	0.168	0.5
69	0.024	0.2	-0.039	-0.1	0.134	0.5
70	0.014	0.1	-0.038	-0.1	0.105	0.5

The marginal effects of ln(cs) on probability of being unemployed or other inactive are statistically insignificant for all values of age and ln(cs) and are not presented for brevity.

6.3.4 Educational breakdown

In Chapter 4, males aged 20 to 54 were split into two education categories (i.e. low educated and medium-high educated workers) based on the assumption that the gap between experienced and inexperienced workers is more marked in occupations that require higher skills. The analysis performed in this Chapter has not investigated if estimators differ for older males with different educational background. A modified version of the Hausman test is used to compare the estimators for low and medium-high educated males aged 50 to 70. It can be written as follows:

$$H = (\hat{\alpha}_{MH} - \hat{\alpha}_L)' \left[\hat{V}_{MH} + \hat{V}_L\right]^{-1} (\hat{\alpha}_{MH} - \hat{\alpha}_L) \sim \chi^2(g) \qquad [6.7]$$

Specification 6 is used so $\hat{\alpha}_{MH}$ and $\hat{\alpha}_L$ are 8x1 vectors of the estimated coefficients of medium-high and low educated older males, respectively. For example, $\hat{\alpha}_{MH}$ is a 8x1 vector of the estimated constant ($\hat{\alpha}_0$) and the estimated coefficients of age ($\hat{\alpha}_1$), ln(cs) ($\hat{\alpha}_2$) and $\bar{u}$ ($\hat{\alpha}_3$) for j=1 and j=2.

$$\hat{\alpha}_{MH} = \hat{\alpha}_{i,jMH} = \begin{bmatrix} \hat{\alpha}_{0,1MH} \\ \hat{\alpha}_{1,1MH} \\ \hat{\alpha}_{2,1MH} \\ \hat{\alpha}_{3,1MH} \\ \hat{\alpha}_{0,2MH} \\ \hat{\alpha}_{1,2MH} \\ \hat{\alpha}_{2,2MH} \\ \hat{\alpha}_{3,2MH} \end{bmatrix} \quad \hat{\alpha}_L = \hat{\alpha}_{i,jL} = \begin{bmatrix} \hat{\alpha}_{0,1L} \\ \hat{\alpha}_{1,1L} \\ \hat{\alpha}_{2,1L} \\ \hat{\alpha}_{3,1L} \\ \hat{\alpha}_{0,2L} \\ \hat{\alpha}_{1,2L} \\ \hat{\alpha}_{2,2L} \\ \hat{\alpha}_{3,2L} \end{bmatrix} \quad \hat{\alpha}_{MH} - \hat{\alpha}_L = \begin{bmatrix} \hat{\alpha}_{0,1MH} - \hat{\alpha}_{0,1L} \\ \hat{\alpha}_{1,1MH} - \hat{\alpha}_{1,1L} \\ \hat{\alpha}_{2,1MH} - \hat{\alpha}_{2,1L} \\ \hat{\alpha}_{3,1MH} - \hat{\alpha}_{3,1L} \\ \hat{\alpha}_{0,2MH} - \hat{\alpha}_{0,2L} \\ \hat{\alpha}_{1,2MH} - \hat{\alpha}_{1,2L} \\ \hat{\alpha}_{2,2MH} - \hat{\alpha}_{2,2L} \\ \hat{\alpha}_{3,2MH} - \hat{\alpha}_{3,2L} \end{bmatrix} \qquad [6.8]$$

$\hat{V}_{MH}$ and $\hat{V}_L$ are the estimates of the variance covariance matrixes and have the variances of each element down their diagonal and the covariance terms in the off diagonals. Finally, g is the length of the parameter vector being tested (8).

The hypotheses to test are $H_0 : \hat{\alpha}_{MH} = \hat{\alpha}_L$ and $H_1 : \hat{\alpha}_{MH} \neq \hat{\alpha}_L$. H_0 is rejected if $H = \chi^2(g)$ is greater than the χ^2 critical value for g degrees of freedom at α level of significance (i.e. $H > \chi^2_\alpha\ (g)$). In my specification H=11.25 so $H_0 : \hat{\beta}_{MH} = \hat{\beta}_{LOW}$ can be rejected at 18.8% level of significance.

The Hausman test can also be used to compare the estimators for low and medium-high educated older males separately for j=1 and j=2 (g=4). H =10.2 when j=1 and H = 2.26 when j=2. $H_0 : \hat{\beta}_{MH} = \hat{\beta}_{LOW}$ can be rejected at 3.7% level of significance for j=1; $H_0 : \hat{\beta}_{MH} = \hat{\beta}_{LOW}$ can be rejected a 68.8% level of significance for j=2.

The results of the Hausman test indicate some evidence (although weak) of statistically significant differences in the estimators for low and medium-high educated males aged 50 to 70. Accordingly, results are presented for medium-high and low educated workers separately. The sample size is reduced to 189 observations: data prior to 1989 are not used because the highest level of education attained is recorded *only* for *income recipients* in the 1984, 1986 and 1987 waves of the SHIW.

The descriptive statistics of Table 6.11 show that the average employment rate of males aged 50 to 70 is higher for medium-high educated males (53.1%) as compared to low educated males (39.1%). Conversely, low educated workers are more likely to be retired (56.9%) or other inactive (4%) as compared to medium-high educated workers.

Table 6.11: Descriptive statistics of aggregated variables, 1989-2006

Variable	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
Employment rate (y_0) – medium-high educated males	0.531	0.302	0	1
Employment rate (y_0) –low educated males	0.391	0.292	0	0.957
Retirement rate (y_1) – medium-high educated males	0.447	0.310	0	0.988
Retirement rate (y_1) – low educated males	0.569	0.310	0.019	1
Unemployment or inactivity other than education rate (y_2) – medium-high educated males	0.022	0.032	0	0.139
Unemployment or inactivity other than education rate (y_2) – low educated males	0.040	0.038	0	0.158
Age	10	6.071	0	20
Age^2	136.667	125.772	0	400
Natural logarithm of cs *ln(cs)*	-4.102	0.124	-4.707	-3.892
Interaction between ln(cs) and age ln(cs)·age	-41.662	26.137	-94.140	0
Aggregated male unemployment rate $\overline{u}$ (per cent)	7.622	1.158	5.4	9.2
Time trend *t*	8.556	5.615	0	17

Notes: The labour market data extracted from the SHIW are weighted using PESOFL.

Tables 6.12 to 6.15 show that age increases the probability of being retired rather than in employment for both medium-high and low educated workers. The other variables do not seem to be statistically significant. However, a more detailed analysis involving the computation of marginal effects is needed.

Table 6.12: Parameter estimates of probability of being in retirement (prob(y=1)) of Italian males aged 50-70 with medium-high education, 1989-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.26	0.41	0.31	0.41	1.06	0.31	0.29
	[7.0]	[2.6]	[4.5]	[2.6]	[0.6]	[4.4]	[3.8]
Age^2		-0.007		-0.006	-0.003		
		[1.0]		[0.8]	[0.3]		
ln(cs)			2.62	1.65	-0.89	2.69	1.62
			[0.9]	[0.5]	[0.1]	[0.9]	[0.4]
ln(cs)·age					0.17		
					[0.4]		
$\overline{u}_m$						0.01	
						[0.1]	
t							0.02
							[0.5]
α_0	-2.88	-3.53	7.36	3.03	-6.96	7.55	3.28
	[6.5]	[4.3]	[0.6]	[0.2]	[0.2]	[0.6]	[0.2]
N	189	189	189	189	189	189	189
DF	2	4	4	6	8	6	6
Log likelihood	-110.31	-109.76	-109.87	-109.55	-109.49	-109.81	-109.72
Restricted log likelihood	-147.38	-147.38	-147.38	-147.38	-147.38	-147.38	-147.38
LR(χ^2_{DF})	74.15	75.25	75.03	75.66	75.79	75.15	75.337
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.252	0.255	0.255	0.257	0.257	0.255	0.256

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is "in employment". Robust standard errors are used.

Table 6.13: Parameter estimates of probability of being in unemployment or inactivity other than retirement (prob(y=2)) of Italian males aged 50-70 with medium-high education, 1989-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.04	0.08	0.11	0.10	-0.07	0.13	0.08
	[0.4]	[0.2]	[0.6]	[0.3]	[0.0]	[0.7]	[0.4]
Age^2		-0.002		0.000	0.000		
		[0.1]		[0.0]	[0.0]		
ln(cs)			4.44	4.48	4.77	5.72	2.72
			[0.5]	[0.4]	[0.3]	[0.5]	[0.2]
ln(cs)·age					-0.05		
					[0.0]		
$\bar{u}_m$						0.16	
						[0.3]	
t							0.03
							[0.3]
α_0	-3.46	-3.57	14.00	14.21	15.33	17.85	6.95
	[3.9]	[2.9]	[0.4]	[0.4]	[0.2]	[0.4]	[0.2]
N	189	189	189	189	189	189	189
DF	2	4	4	6	8	6	6
Log likelihood	-110.31	-109.76	-109.87	-109.55	-109.49	-109.81	-109.72
Restricted log likelihood	-147.38	-147.38	-147.38	-147.38	-147.38	-147.38	-147.38
LR(χ^2_{DF})	74.15	75.25	75.03	75.66	75.79	75.15	75.337
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.252	0.255	0.255	0.257	0.257	0.255	0.256

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is “in employment”. Robust standard errors are used.

Table 6.14: Parameter estimates of probability of being in retirement (prob(y=1)) of Italian males aged 50-70 with low education, 1989-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.28	0.27	0.29	0.28	0.75	0.30	0.28
	[7.0]	[2.0]	[4.2]	[2.0]	[0.4]	[4.1]	[3.5]
Age^2		0.000		0.001	0.003		
		[0.0]		[0.1]	[0.3]		
ln(cs)			0.79	0.95	-0.10	1.35	0.11
			[0.2]	[0.3]	[0.0]	[0.4]	[0.0]
ln(cs)·age					0.12		
					[0.2]		
$\overline{u}_m$						0.08	
						[0.4]	
t							0.01
							[0.3]
α_0	-2.25	-2.21	0.87	1.55	-2.58	2.48	-1.93
	[5.6]	[3.7]	[0.1]	[0.1]	[0.1]	[0.2]	[0.1]
N	189	189	189	189	189	189	189
DF	2	4	4	6	8	6	6
Log likelihood	-114.28	-114.24	-113.99	-113.98	-113.83	-113.86	-113.87
Restricted log likelihood	-154.43	-154.43	-154.43	-154.43	-154.43	-154.43	-154.43
LR(χ^2_{DF})	80.31	80.38	80.88	80.90	81.21	81.15	81.134
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.260	0.260	0.262	0.262	0.263	0.263	0.263

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is “in employment”. Robust standard errors are used.

Table 6.15: Parameter estimates of probability of being in unemployment or inactivity other than retirement (prob(y=2)) of Italian males aged 50-70 with low education, 1989-2006

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Age	0.06	0.11	0.14	0.15	3.36	0.16	0.11
	[0.8]	[0.4]	[1.0]	[0.6]	[0.6]	[1.1]	[0.7]
Age^2		-0.003		0.000	0.013		
		[0.2]		[0.0]	[0.5]		
ln(cs)			5.56	5.54	-0.08	6.69	3.21
			[0.7]	[0.7]	[0.0]	[0.8]	[0.4]
ln(cs)·age					0.84		
					[0.5]		
$\overline{u}_m$						0.13	
						[0.4]	
t							0.04
							[0.5]
α_0	-2.65	-2.80	19.24	19.14	-2.99	22.68	9.63
	[4.1]	[3.0]	[0.7]	[0.6]	[0.1]	[0.7]	[0.3]
N	189	189	189	189	189	189	189
DF	2	4	4	6	8	6	6
Log likelihood	-114.28	-114.24	-113.99	-113.98	-113.83	-113.86	-113.87
Restricted log likelihood	-154.43	-154.43	-154.43	-154.43	-154.43	-154.43	-154.43
LR(χ^2_{DF})	80.31	80.38	80.88	80.90	81.21	81.15	81.134
Prob χ^2_{DF} >critical value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2	0.260	0.260	0.262	0.262	0.263	0.263	0.263

Notes: absolute value of t-statistics is given in parentheses. The estimation method is multinomial logit with grouped data. The reference category is "in employment". Robust standard errors are used.

Marginal effects of cohort size on the probability of being employed, retired or unemployed or other inactive are evaluated at each value of age (i.e. age0 = 50, age1 = 51 ,… age20 = 70), at the average, maximum and minimum value of ln(cs) and at the average unemployment rate (specification 6 is used) for both medium-high and low educated workers.

Table 6.16 shows that an increase in cohort size decreases the probability of being employed for males aged 58 to 64 belonging to small cohorts and males aged 64 to 70 belonging to large cohorts with a medium-high level of education. For example, the probability of being employed decreases by 9% points for males aged 70 and belonging to a large cohort. Also, Table 6.17 shows that an increase in cohort size reduces the probability of being employed for males aged 50 to 53 belonging to small cohorts and with a low level of education.

Tables 6.18 and 6.19 show that cohort size increases the probability of being retired for males aged 58 to 64 belonging to a small cohort and with medium-high level of education and for males aged 50 to 53 belonging to a small cohort and with low level of education. The negative impact of cohort size on employment and the positive impact on retirement seem to be significant only at an early stage (i.e. age 50 to 53) for low educated males and at a later stage (i.e. age 57 to 70) for medium-high educated males.

Table 6.16: Marginal effect of ln(cs) on probability of being employed, medium-high educated males aged 50-70,1989-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	***-0.146***	***-1.7***	-0.322	-0.7	-0.020	-0.7
51	***-0.180***	***-1.7***	-0.376	-0.7	-0.026	-0.7
52	***-0.221***	***-1.6***	-0.438	-0.7	-0.035	-0.8
53	-0.271	-1.5	-0.506	-0.7	-0.046	-0.9
54	-0.330	-1.4	-0.576	-0.7	-0.062	-1.0
55	-0.398	-1.3	-0.644	-0.8	-0.082	-1.1
56	-0.471	-1.2	-0.704	-0.5	-0.108	-1.2
57	-0.546	-1.1	-0.748	-0.7	-0.142	-1.4
58	-0.616	-1.0	-0.768	-0.9	***-0.185***	***-1.7***
59	-0.671	-1.0	-0.761	-1.0	***-0.238***	***-2.2***
60	-0.704	-0.9	-0.725	-1.0	***-0.302***	***-3.3***
61	-0.708	-0.9	-0.664	-1.2	***-0.374***	***-6.4***
62	-0.682	-0.9	-0.089	-1.3	***-0.453***	***-6.0***
63	-0.630	-1.0	-0.500	-1.5	***-0.531***	***-2.8***
64	-0.558	-1.0	***-0.414***	***-1.8***	***-0.600***	***-1.7***
65	-0.477	-1.0	***-0.334***	***-2.1***	-0.675	-1.2
66	-0.395	-1.1	***-0.264***	***-2.5***	-0.675	-0.9
67	-0.319	-1.2	***-0.205***	***-2.8***	-0.667	-0.8
68	-0.251	-1.2	***-0.157***	***-3.0***	-0.630	-0.7
69	-0.195	-1.3	***-0.119***	***-2.3***	-0.569	-0.6
70	-0.149	-1.4	***-0.09***	***-2.7***	-0.494	-0.5

Table 6.17: Marginal effect of ln(cs) on probability of being employed, low educated males aged 50-70, 1989-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	-0.222	-0.9	-0.544	-0.7	***-0.049***	***-2.3***
51	-0.260	-0.9	-0.599	-0.7	***-0.065***	***-2.5***
52	-0.302	-0.8	-0.648	-0.6	***-0.084***	***-2.2***
53	-0.345	-0.7	-0.686	-0.6	***-0.108***	***-1.8***
54	-0.386	-0.6	-0.708	-0.6	-0.138	-1.4
55	-0.420	-0.6	-0.710	-0.6	-0.172	-1.1
56	-0.444	-0.5	-0.690	-0.6	-0.209	-0.9
57	-0.453	-0.5	-0.646	-0.6	-0.248	-0.7
58	-0.445	-0.5	-0.588	-0.7	-0.285	-0.6
59	-0.421	-0.5	-0.515	-0.7	-0.316	-0.5
60	-0.382	-0.5	-0.438	-0.7	-0.335	-0.4
61	-0.335	-0.5	-0.361	-0.7	-0.340	-0.4
62	-0.284	-0.4	-0.290	-0.7	-0.330	-0.3
63	-0.233	-0.4	-0.228	-0.8	-0.306	-0.3
64	-0.187	-0.4	-0.176	-0.8	-0.273	-0.3
65	-0.148	-0.5	-0.135	-0.8	-0.234	-0.3
66	-0.114	-0.5	-0.825	-0.1	-0.195	-0.2
67	-0.087	-0.5	-0.076	-0.8	-0.158	-0.2
68	-0.066	-0.5	-0.056	-0.9	-0.126	-0.2
69	-0.050	-0.5	-0.042	-0.9	-0.098	-0.2
70	-0.037	-0.5	-0.031	-0.9	-0.076	-0.2

Table 6.18: Marginal effect of ln(cs) on probability of being retired, medium-high educated males aged 50-70, 1989-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	0.082	1.4	0.127	0.8	0.018	0.7
51	0.109	1.3	0.163	0.7	0.024	0.8
52	0.142	1.2	0.207	0.7	0.032	0.8
53	0.185	1.2	0.258	0.7	0.043	0.9
54	0.236	1.1	0.315	0.6	0.058	1.0
55	0.297	1.0	0.374	0.6	1.058	1.1
56	0.365	1.0	0.429	0.6	0.104	1.2
57	0.436	0.9	0.475	0.6	0.137	1.4
58	0.503	0.9	0.504	0.6	***0.180***	***1.7***
59	0.560	0.8	0.510	0.6	***0.232***	***2.2***
60	0.596	0.8	0.493	0.5	***0.295***	***3.3***
61	0.596	0.8	0.454	0.5	***0.368***	***6.7***
62	0.589	0.8	0.400	0.5	***0.446***	***6.1***
63	0.546	0.8	0.337	0.4	***0.524***	***2.8***
64	0.484	0.8	0.272	0.4	***0.593***	***1.7***
65	0.413	0.8	0.213	0.3	0.644	1.2
66	0.340	0.8	0.160	0.3	0.668	0.9
67	0.272	0.8	0.117	0.2	0.661	0.8
68	0.212	0.8	0.083	0.2	0.625	0.7
69	0.162	0.7	0.057	0.1	0.564	0.6
70	0.121	0.7	0.037	0.1	0.490	0.5

Table 6.19: Marginal effect of ln(cs) on probability of being retired, low educated males aged 50-70, 1989-2006

	Average ln(cs)		**Maximum ln(cs)**		**Minimum ln(cs)**	
Age:	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**	**Marginal effect**	**t statistics**
50	0.084	0.4	0.064	0.2	***0.047***	***2.6***
51	0.106	0.4	0.071	0.2	***0.062***	***2.6***
52	0.129	0.3	0.074	0.1	***0.081***	***2.2***
53	0.155	0.3	0.071	0.1	***0.104***	***1.7***
54	0.179	0.3	0.059	0.1	0.133	1.3
55	0.199	0.3	0.037	0.0	0.167	1.0
56	0.213	0.3	0.004	0.0	0.204	0.8
57	0.216	0.2	-0.039	0.0	0.242	0.7
58	0.227	0.2	-0.088	-0.1	0.279	0.6
59	0.186	0.2	-0.139	-0.1	0.309	0.5
60	0.157	0.2	-0.187	-0.1	0.328	0.4
61	0.121	0.2	-0.227	-0.2	0.333	0.4
62	0.085	0.1	-0.183	-0.2	0.323	0.3
63	0.051	0.1	-0.274	-0.2	0.300	0.3
64	0.022	0.0	-0.282	-0.2	0.267	0.3
65	-0.001	0.0	-0.280	-0.2	0.229	0.3
66	-0.018	0.0	-0.271	-0.2	0.190	0.2
67	-0.030	-0.1	-0.257	-0.2	0.154	0.2
68	-0.037	-0.1	-0.239	-0.2	0.122	0.2
69	-0.041	-0.1	-0.220	-0.2	0.095	0.2
70	-0.042	-0.2	-0.200	-0.2	0.072	0.2

The marginal effects of ln(cs) on probability of being unemployed or other inactive are statistically insignificant for all values of age and ln(cs) and are not presented for brevity.

The modified version of the Hausman test is also used to compare the estimators for older males living in Northern and Southern Italy.

The hypotheses to test are $H_0 : \beta_{NORTH} = \beta_{SOUTH}$ and $H_1 : \beta_{NORTH} \neq \beta_{SOUTH}$. In my specification, H = 3.8 so $H_0 : \beta_{NORTH} = \beta_{SOUTH}$ can be rejected at 87% level of significance. The Hausman test is finally used to compare the estimators for Northern and Southern older males for j=1 and j=2. H = 2.08 for j=1 and H = 3.53 for j=2. $H_0 : \beta_{NORTH} = \beta_{SOUTH}$ can be rejected at 72.1% level of significance for j=1; $H_0 : \beta_{NORTH} = \beta_{SOUTH}$ can be rejected at 47.3% level of significance for j=2. Hence, there do not seem to exist statistically significant differences in the estimators for Northern and Southern older males.

6.4 Conclusions

Evidence that cohort size has an overall negative impact on age-earnings and age-employment opportunities of Italian males aged 20 to 54 is found in this chapter. The empirical analysis of this chapter extend the analysis to younger and older Italian men, investigating if and to what extent cohort size also impacts on the educational and labour market attainment of younger males (aged 15 to 24) and on the labour market attainment of older males (aged 50 to 70). This chapter is therefore an expansion of the cohort crowding literature: similar arguments are used but the focus of attention is shifted to the younger and older edges of the population. Put differently, this chapter investigates if the position in the demographic cycle affects also the labour market (and educational) attainment of people who are not in the working age.

A multinomial logit model with grouped data is estimated. Younger males are split into “employed”, “in education” and “unemployed or other inactive”; older males are split into “employed”, “retired” and “unemployed or other inactive”. The same covariates used to investigate the impact of cohort size on age-earnnigs and age-employment profiles on males aged 20 to 54 are employed. Marginal effects (and standard errors) are computed and reported for different values of age and cohort size.

Evidence that cohort size impacts on labour market and educational attainment of younger Italian males is not found. Younger individuals born into smaller cohorts do not seem to have more incentives to invest in education in Italy.

Some evidence, although weak, that cohort size has a negative impact on employment probabilities and a positive impact on retirement probabilities of Italian older males is found. Cohort size seems to decrease the probability of being employed and increase the probability of being retired of Italian men with intermediate or high qualifications, aged from 58 to 70. Cohort size also seems to decrease the probability of being employed and increase the probability of being retired of Italian men with low qualifications, aged 50 to 53.

The negative impact of cohort size on employment and the positive impact on retirement seem to be significant only at an early stage (i.e. age 50 to 53) for low educated older males and at a later stage (i.e. age 58 to 70) for medium-high educated older males. This can partially explained by the fact that men with a medium-high level of education tend to stay in the labour market longer if compared to men with a low level of education.

Viewed from this perspective, the secular trend to an older population seems to entail some disadvantages – expressed here in terms of lower employment rates and higher retirement rates - for subsequent larger generations of older males.

Chapter 7 Conclusion and discussion

7.1 Summary and main findings

The dissertation investigated whether and to what extent the process of population ageing - the transformation of the age structure to relatively greater proportions in the older age groups - will impact on the personal welfare of the Italian population. Italian historical and current demographic trends were analysed in detail in Chapter 2. Future potential demographic trends were also addressed in Chapter 2, with particular attention to Istat 2005-based population projections. The role of positive and increasing levels of (young) net migration and higher fertility could play to counteract or decelerate the phenomenon of population and labour force ageing in Italy was investigated in Chapter 3. The impact of labour force decline and ageing on age-earnings and age-employment profiles of Italian workers aged 20 to 54 belonging to different birth cohorts was addressed in Chapters 4 and 5. The impact of population ageing on human capital accumulation and labour market attainment of Italian younger and older males was investigated in Chapter 6.

If current mortality and fertility trends continue, the Italian labour force will decline in size and age to a significant extent in the next decades. Positive and increasing levels of (young) net migration might decelerate the phenomenon of labour force ageing and decline in the short to medium term, but this is not a long-term solution. On the other hand, higher fertility might counteract the phenomenon of labour force ageing and decline in the long term, but this is not a short term solution.

The main findings of the empirical models tested in the dissertation show that changes in the population and labour force age structure have the potential to affect the economic prosperity of individuals. The relative scarcity of younger generations (and especially of younger generations of medium and highly educated workers) seems to have an overall positive effect on their labour market outcomes. At the same time, larger generations of older workers are put at disadvantage.

Younger individuals born into smaller cohorts do not seem to have more incentives to invest in education in Italy. On the contrary, cohort size seems to have a negative (although weak) impact on employment probabilities and a positive (although weak) impact on retirement probabilities of Italian older males. In other terms, generational crowding is primarily expected to impact on relative employment and earnings probabilities of working age Italian males and on employment and retirement probabilities of older Italian men.

The empirical analysis of Chapter 4 and the simulations of Chapter 5 were summarised in a paper which was published in Mosca (2009)[44].

7.2 Discussion and policy implications

The simulations carried out in Chapter 3 showed that large inflows of young individuals could decelerate population ageing and labour force ageing and decline in Italy. The working age population would remain roughly stable in the long-run if 375,000 – 400,000 young net migrants migrated to Italy every year. These figures seem to be in line with the migration figures registered by Istat in the last few years. However, they are significantly higher than the immigration quota determined annually by the Italian President of the Council of Ministers and the Parliament.

Also, this does not mean that higher levels of migration is “the” solution to population and labour force ageing. Large levels of net migration are likely to be associated with a number of problems, primarily social tensions with the native population. Unfortunately, social tensions between immigrants and the local population are relatively common in Italy. Also, positive and large levels of net migration are not a long-term solution. Even if substantial numbers of net migrants were to relocate to Italy, these will also grow old eventually: young net migrants quickly grow themselves from being a rejuvenating factor to being mature members

[44] Mosca, I. (June 2009) “Impact of Population Ageing on Earnings and Employment in Italy”, *Labour*, Vol. 22, Issue 2, pp. 371-395.

of the population. This leaves their main demographic impetus to be their enhancing effects on future fertility (Fertig and Schmidt, 2003, p.23).

Alternative fertility scenarios were also investigated, given that low and declining fertility is the principal cause of Italy's population ageing. Italy experienced a sharp increase in fertility 1950s and 1960s (baby boom), like many other industrialised countries. The total fertility rate peaked at 2.7 births per woman in 1964. However, since then, the trend has been downwards and the total fertility rate has been below the replacement level of 2.1 births per woman from 1977 onwards. The causes of such a sharp decline in fertility in Italy are widely debated in the literature. More women are enrolling in higher education and have greater career opportunities. This increases the opportunity cost of having children. Other factors including increasing likelihood to get temporary rather than permanent contracts in the Italian labour market and difficulties in finding housing and getting mortgages for young couples may be among the factors causing couples to further postpone childbearing and have fewer children.

Cultural factors are also believed to play a role. The role of the family and the role of the mother within the family have traditionally been very important in Italy. Heran (2007) argues that there has been a shift from a matriarch model where the mother expresses her love to her children by having many of them (multiplicative love) to a model in which she expresses her love by having a few of them and not allowing them to leave home at an early age (exclusive love). In economics terms, this represents Becker's trade-off between children quality and quantity.

The results of the fertility simulations show that even if fertility boomed today, one would need to wait for two decades to see the impacts of larger cohorts of new-borns on the size of the working age population (delayed effect of number of births on number of labour market entrants). Even if TFR reached 2.32 by 2050 (a value well above the replacement rate), the working age population would still decrease in size. Hence, an increase of fertility on its own would not be sufficient to counteract the declining labour force, at least in the short-term. However, it could have more significant impacts in the long-term.

Should the Italian government intervene and put into place programs targeted to foster fertility? Examples could be child allowances, birth grants and loans, income tax relief and incentives, childcare facilities, access to subsidised housing, monthly salaries at the birth of a second or subsequent child, free education and a taxation on childlessness (for a more detailed review see Jackson (2001, pp. 40-41)).

The implementation of programs targeted to foster fertility is vividly debated in the literature. In countries like Sweden, family friendly policies such as parental leave enable men to share the responsibilities of raising the children, even at an early stage of the children's lives. In Italy, family friendly policies are scarce. The incentives serious enough to alter this key decision in the lives of most Italian women would probably need to be quite generous. It is difficult to assess to what extent family-friendly policies could actually trigger a rise in fertility in Italy.

The empirical model developed in Chapter 4 found some evidence that over the life cycle cohort size depresses employment opportunities of individuals with low education and earnings and employment rates of males with intermediate and high qualifications born into large cohorts. These results show that changes in the population and labour force age structure have the potential to affect the economic prosperity of individuals. The relative scarcity of younger generations seems to have an overall positive effect on their labour market outcomes. New unusually small cohorts are going to experience higher relative earnings and employment opportunities and put older workers at relative disadvantage.

Viewed from this perspective, the secular trend to an older and shrinking population seems to entail serious advantages for subsequent smaller generations. However, it might be argued that these effects will be mitigated by the effects of the technological progress. "Throughout the modern era, subsequent generations have experienced higher economic prosperity than their predecessors. While this tendency has slowed down in recent decades, over the life cycle the effects of the technological progress benefit the baby boom generation of the 1960s in comparison to the subsequent baby-boost. The technological and organizational advances throughout the next decades might enhance the productivity of the large baby boom generation, which is by then a generation of older workers. Also, it might be argued that due to their relative large size, larger cohorts will be able to influence the working of the market to their advantage and hence to experience relatively favourable outcomes" (Fertig and Schmidt, 2003, p.22) .

The dissertation also investigated whether and to what extent cohort size impacts on the educational and labour market attainment of younger males (aged 15 to 24) and on the labour market attainment of older males (aged 50 to 70). Evidence that cohort size impacts on labour market and educational attainment of younger Italian males was not found. Younger individuals born into smaller cohorts do not seem to have more incentives to invest in education in Italy. Some evidence, although weak, that cohort size has a negative impact on employment probabilities and a positive impact on retirement probabilities of Italian older males was found.

The negative impact of cohort size on employment and the positive impact on retirement seem to be significant only at an early stage (i.e. age 50 to 53) for low educated older males and at a later stage (i.e. age 58 to 70) for medium-high educated older males. This can be partially explained by the fact that men with intermediate and high qualifications tend to stay in the labour market longer if compared to men with a low level of education. Viewed from this perspective, the secular trend to an older population seems to entail some disadvantages - expressed here in terms of lower employment rates and higher retirement rates - for subsequent larger generations of older males.

The dissertation focused on the impact of population ageing on the labour market. However, the phenomenon of population ageing will impact on the Italian economy in many other different ways, which were not investigated because of space constraints in the dissertation. For example, as the 65+ age group grows the demand for state-supplied health and personal care, residential services, housing, pensions and other services consumed by the elderly increases. Unfortunately at the same time, the base expected to pay for this increase – essentially people of working age – will become progressively smaller both in absolute numbers and in relative population share. It is not difficult to conclude that such a situation of increasing imbalance is not sustainable indefinitely into the future.

It is however important to remember that not all effects of population ageing and population decline are negative. A smaller population puts less pressure on the environment. Also the number of people in the younger age groups declines. This suggests a fall in the number of children of school age and associated reductions in expenditure on primary and secondary schooling (at least in relative terms). Older workers are an important source of volunteer labour and rate of volunteering is on the rise. As the population ages, and if past trends in participation continue, the amount of volunteer labour contributed to the economy will increase sharply. Finally population ageing and a declining labour force provide incentives for governments and employers to more seriously invest in the education and training of the work force which should increase labour productivity.

7.3 Further research

The dissertation leaves considerable scope for further research.

Changes in the size and composition of Italian population will have both direct demand- and supply-side effects. These impacts will generate endogenous economic responses on variables such as the level of investment, labour market participation and price competitiveness. The interaction of these variables will produce changes in aggregate indicators, such as total employment, GDP and consumption. The results of the population projections carried out in the dissertation may be used to investigate the magnitude of these changes in a Computable General Equilibrium (CGE) framework. The Computable General Equilibrium model provides a comprehensive description of an economy using a system of simultaneous equations. All the markets, sectors and industries are modelled together with corresponding inter-linkages. The computable nature of the problem enables to use the model for simulations. Numerical results for endogenous variables are obtained based on assumptions about exogenous variables, functional forms and parameters. In this framework, population projections could be used to generate exogenous shocks to the model.

There already exists a number of studies which investigate the impacts of projected future demographic changes on the economy in a CGE framework. For example, Lisenkova *et al* (2009) link a multi-period economic Computable General Equilibrium modelling framework with a demographic model to analyse the economic impact of projected Scottish population ageing and declining on the Scottish economy. Future projected population changes are used to generate exogenous disturbances in the AMOS (A Macro-Micro Model Of Scotland) model, which is best regarded as a Computable General Equilibrium modelling framework. Lisenkova *et al* (2009) conclude that the resulting tightening of the labour market will have adverse consequences for the Scottish employment level, growth and competitiveness. They also investigate if these negative effects might be mitigated in presence of higher levels of net migration.

Pappas (2008) carries out a similar analysis for Greece. Greek population is projected to decline and age in the next decades. Also Greece has experienced a declining fertility rate (1.4 in 2008) and a continuously increasing life expectancy. Pappas (2008) calibrates AMOS modelling framework to data on the Greek economy given in the form of a Social Accounting Matrix (SAM) for the year 2004. Pappas (2008) concludes that if current Greek demographic trends continue, there will be a negative impact upon economic activity. He estimates negative effects on GDP and employment growth. The same exercise could be done for Italy, using the SAM constructed by Caramaschi (2004).

The empirical analysis of Chapter 4 was performed using eight waves of the European Community Household Panel, from 1994 to 2001. The same dataset could be used to perform the same empirical analysis for other countries that are undergoing the phenomenon of population ageing, such as the UK, Spain, Greece and Germany. Results could then be compared with the results obtained for Italy. The precise extent to which wages and employment opportunities of workers of different ages change following an increase/decrease in relative cohort size depends on the institutional framework of the labour market. The degree of flexibility (rigidity) of the labour market varies quite significantly across European countries. A demographic change is expected to impact on both earnings and employment opportunities in a rigid labour market (Italy); only on earnings profiles in a labour market working without significant frictions (UK). Hence, a cross-country comparison could lead to interesting results.

Also, the ECHP finished in 2001 and has been progressively replaced with data collection under the EU-SILC regulations. In Italy, it has been replaced by the survey "Reddito e Condizioni di Vita" ("Income and Living Conditions"). Up to date, the survey has been carried out four times (2004-2007). It would be interesting to repeat the analysis in a few year time, when more waves of Income and Living Conditions will be available. This will also coincide with the labour market entry of the very small cohorts born in the 1980s.

In the ECHP, individuals' wage data are collected net of taxes. Net wages are then converted into gross wages through specific micro-simulation models. In Income and Living Conditions, data on gross wages are collected directly. This reduces measurement errors since micro-simulations models to convert net into gross wages are not then needed. Also, Income and Living Conditions is based on a larger sample. For example, around 4,000 men aged 20 to 54 were interviewed in the last wave of the ECHP (2001), compared to around 13,000 in the second wave of Income and Living Conditions. The availability of more observations would also enable a more detailed breakdown of educational categories. Medium and highly educated workers were merged in the empirical analysis of Chapter 4 due to a lack of data for the highly educated workers (i.e. insufficient number of observations).

For consistency purposes, the empirical model used to estimate the impact of cohort size on age-earnings and age-employment profiles of Italian men aged 20 to 54 and the empirical model used to estimate the impact of cohort size on educational and labour market attainment of younger males in Italy employed the same explanatory variables. However, non-linear estimation (multinomial logit) was substituted for linear estimation (OLS) due to the different nature of the dependent variable. Recent studies (Connelly and Gottschalk (1995) or Fertig *et al* (2009)) suggest that also parental background information should be included as covariate when assessing the impact of cohort size on human capital accumulation. This is motivated by the evidence that the propensity to pursue higher education varies significantly by parental education. However, parents' education can be considered as an endogenous variable whereas the controls employed in my empirical model, i.e. age, cohort size, a time trend and aggregated unemployment rate, are clearly exogenous. Finally, the only way to include information about parents' education in the SHIW dataset is to match parents to their children using variables such as NCOMP (number of members in the household); PAR (1: household head; 2: household head spouse or partner; 3: son / daughter; 4: other). This matching procedure could lead to sample selection-bias: information on parents' education could be gathered only for young individuals still living with their parents. However, this potential selection bias might be relatively small in magnitude given that children in Southern Europe (including Italy) tend to stay at home longer (usually until they get married). This clearly leaves scope for further research.

Also, the migration sensitivity analysis of Chapter 3 did not take into consideration that migrants could return to their home countries after spending a number of years in Italy. This assumption was somehow restrictive. A more detailed analysis could allow decomposition of migration flows into permanent and temporary. The simulations carried out in Chapter 3 enabled me to compute the number of annual net migrants Italy would need to keep the working age population constant at its 2005 level. One could change the focus of the analysis and investigate the extent to which the state retirement age should be increased to keep the working age population constant.

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Appendix A: Replication of Istat population projections using differentials in Popgroup

Figure A.1: Projected number of births, Istat and Popgroup (2005 – 2050)

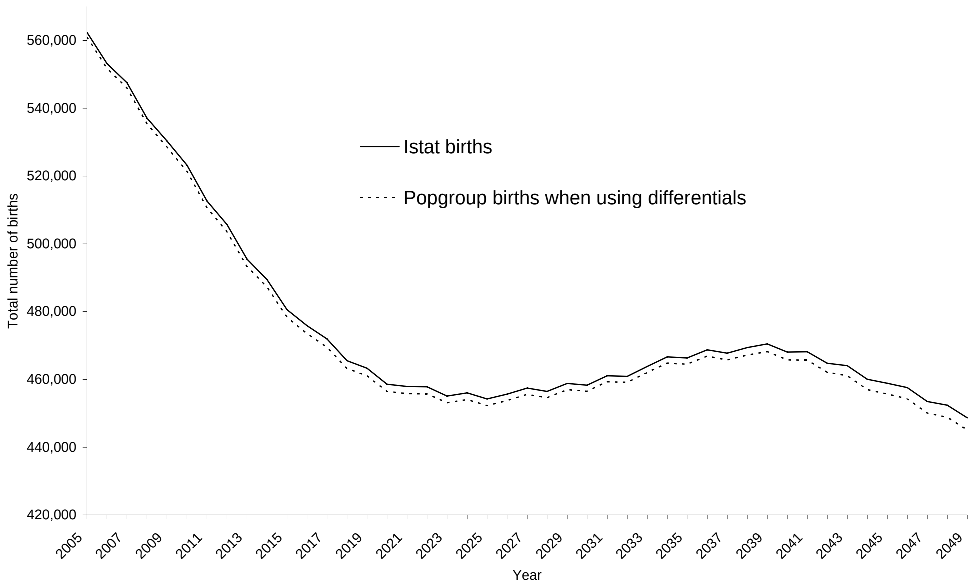


Figure A.2: Projected number of total males, using counts and differentials (2005 – 2050)

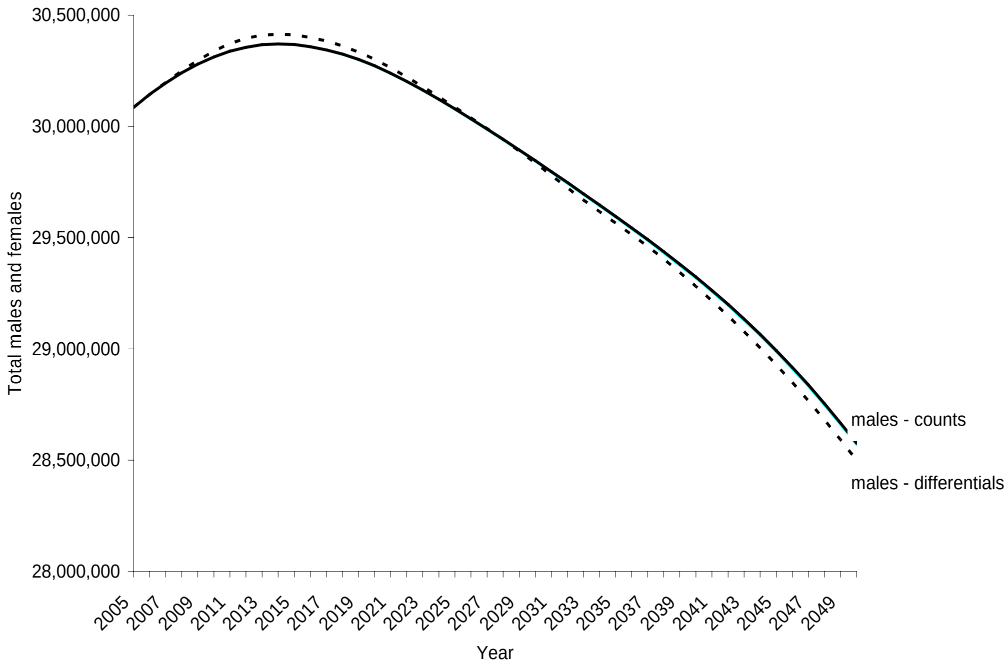


Figure A.3: Projected number of total females, counts and differentials (2005 – 2050)

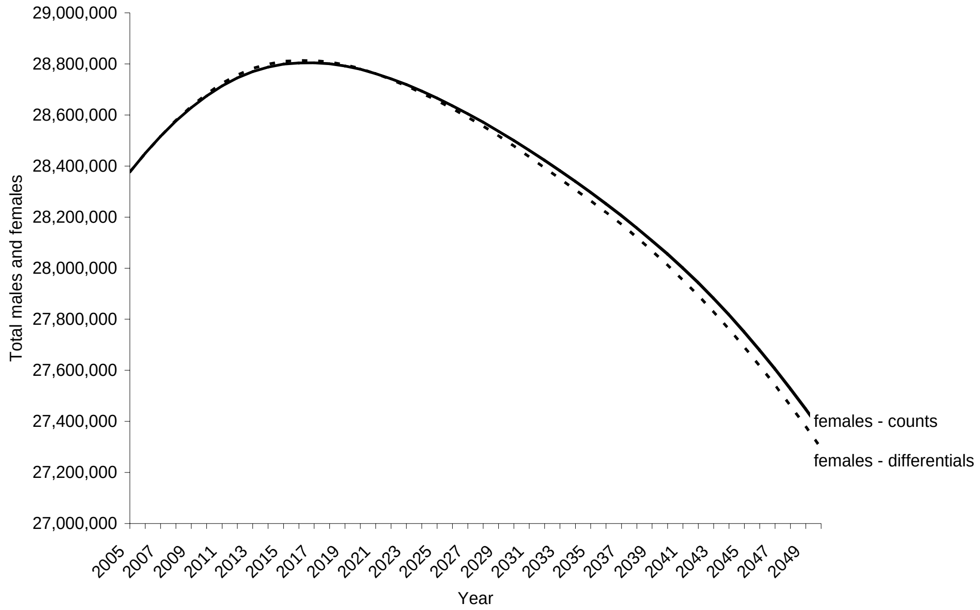


Figure A.4: Projected number of males and females aged 0-4, using counts and differentials (2005 – 2050)

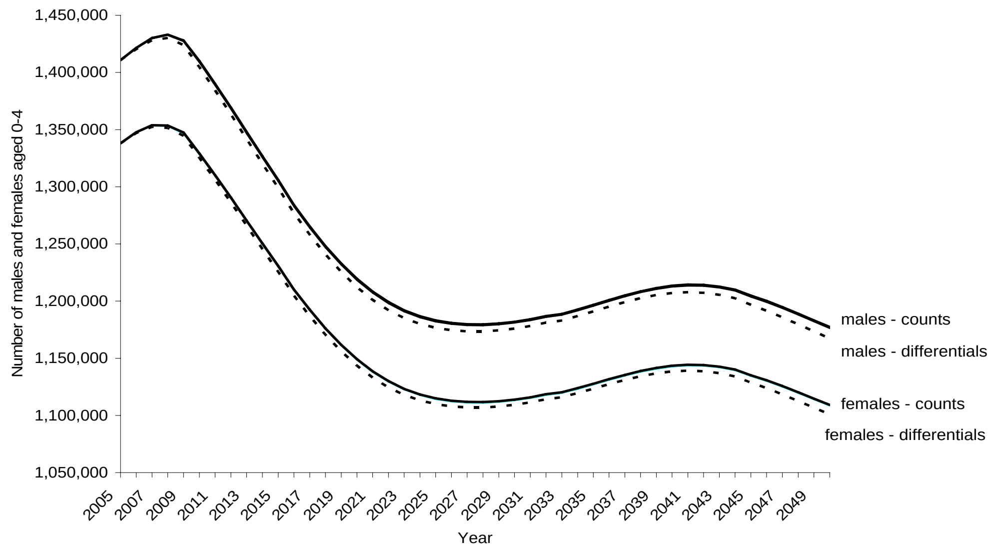


Figure A.5: Projected number of males and females aged 5-9, using counts and differentials (2005 – 2050)

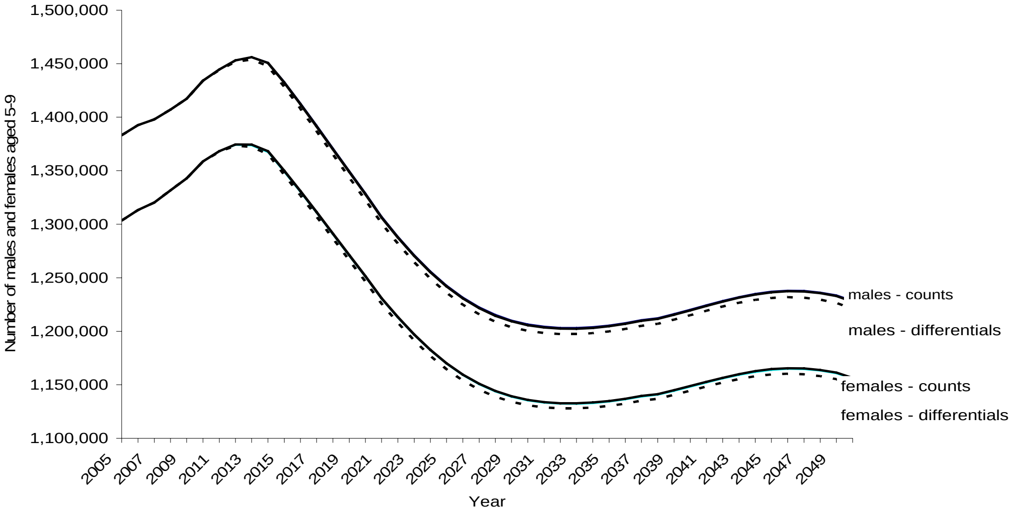


Figure A.6: Projected number of males and females aged 10-14, using counts and differentials (2005 – 2050)

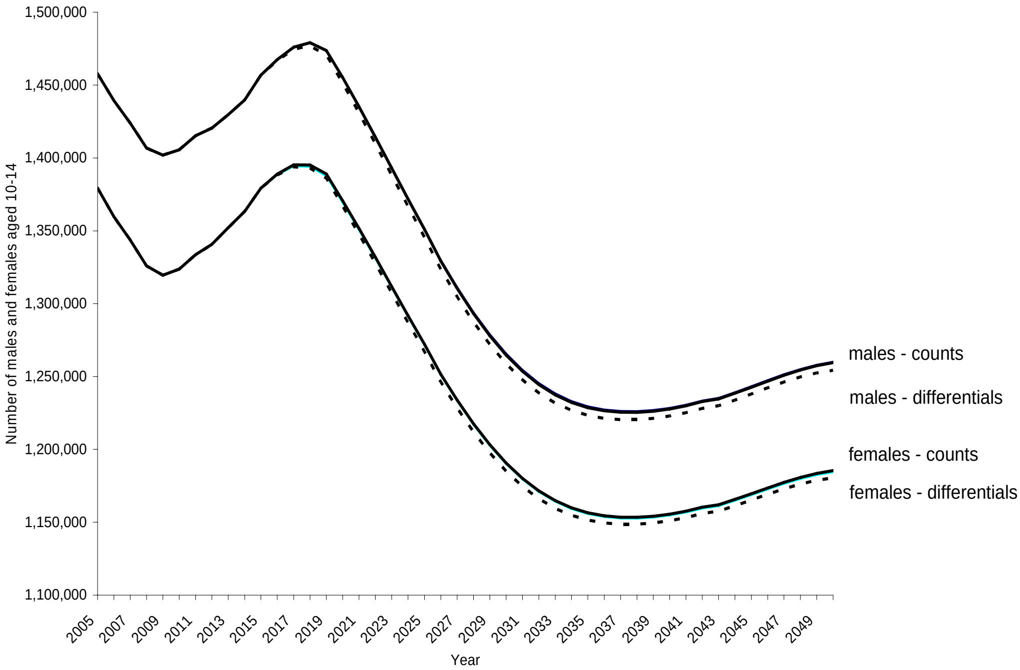


Figure A.7: Projected number of males and females aged 15-19, using counts and differentials (2005 – 2050)

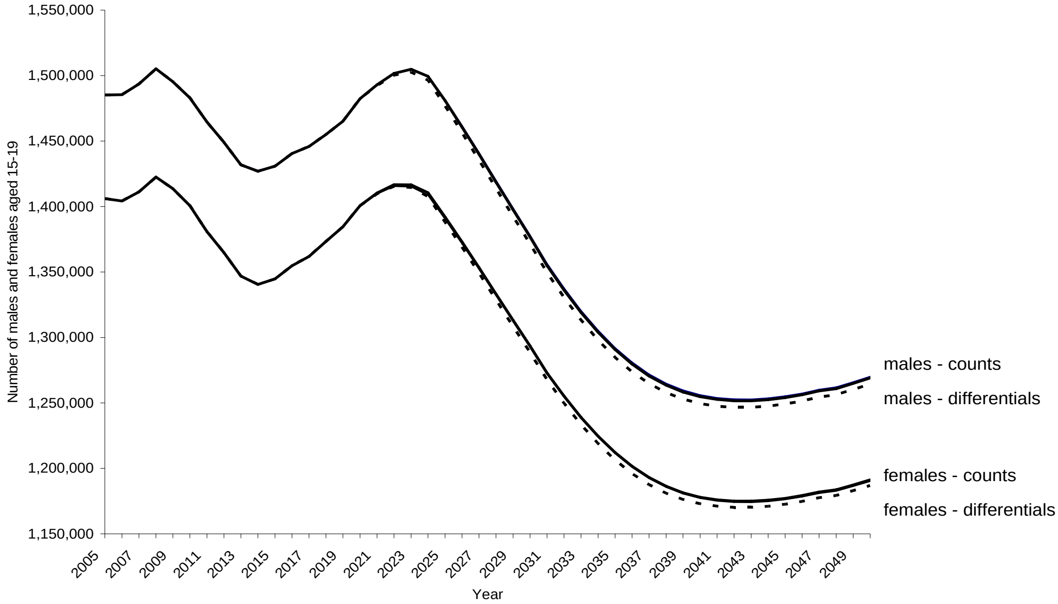


Figure A.8: Projected number of males and females aged 20-24, using counts and differentials (2005 – 2050)

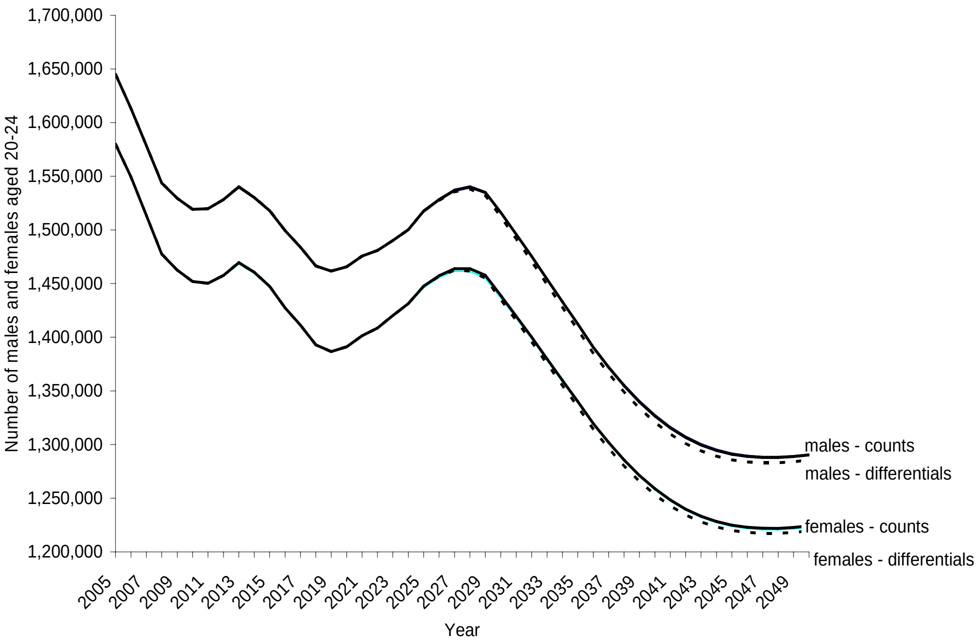


Figure A.9: Projected number of males and females aged 25-29, using counts and differentials (2005 – 2050)

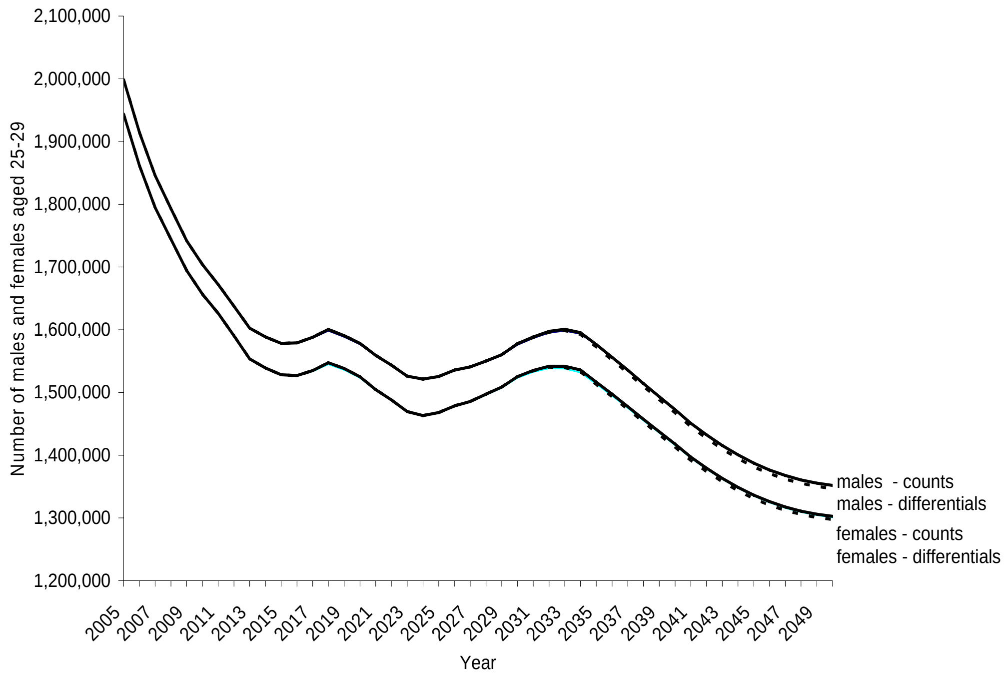


Figure A.10: Projected number of males and females aged 30-34, using counts and differentials (2005 – 2050)

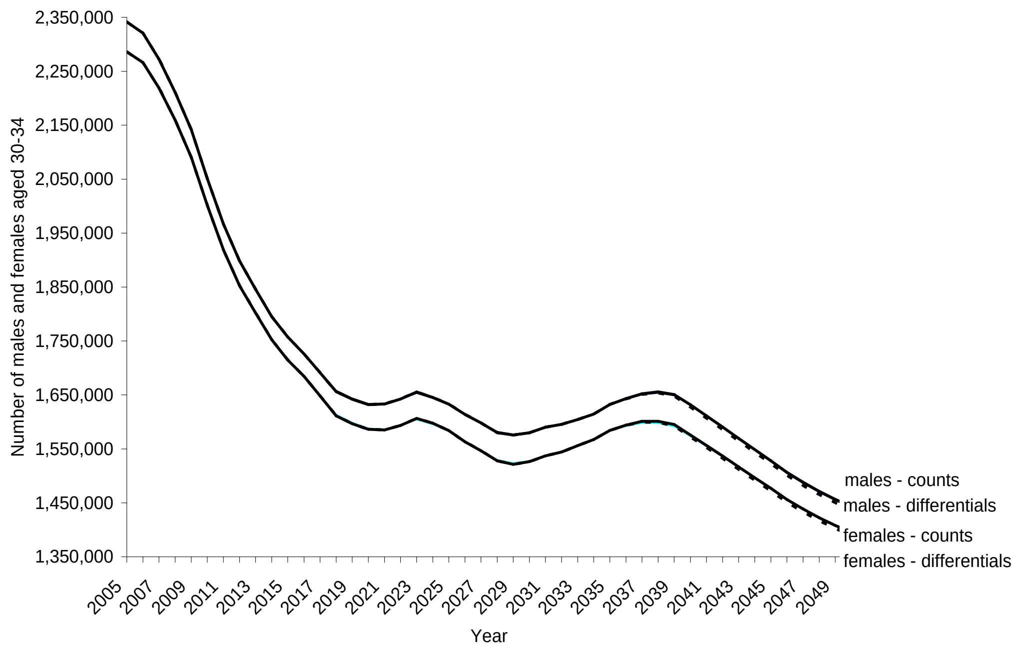


Figure A.11: Projected number of males and females aged 35-39, using counts and differentials (2005 – 2050)

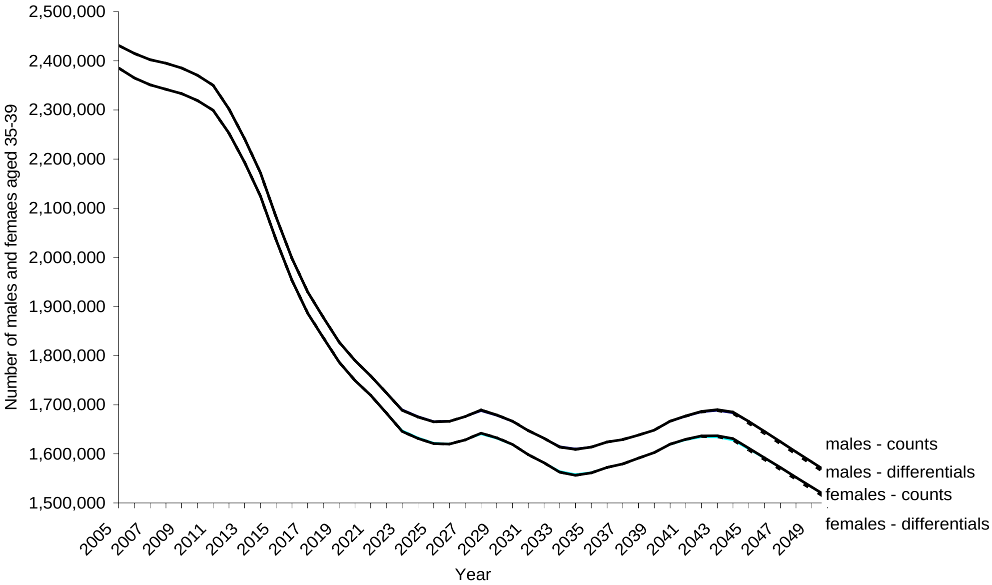


Figure A.12: Projected number of males and females aged 40-44, using counts and differentials (2005 – 2050)

Figure A.13: Projected number of males and females aged 45-49 using counts and differentials (2005 – 2050)

Figure A.14: Projected number of males and females aged 50-54, using counts and differentials (2005 – 2050)

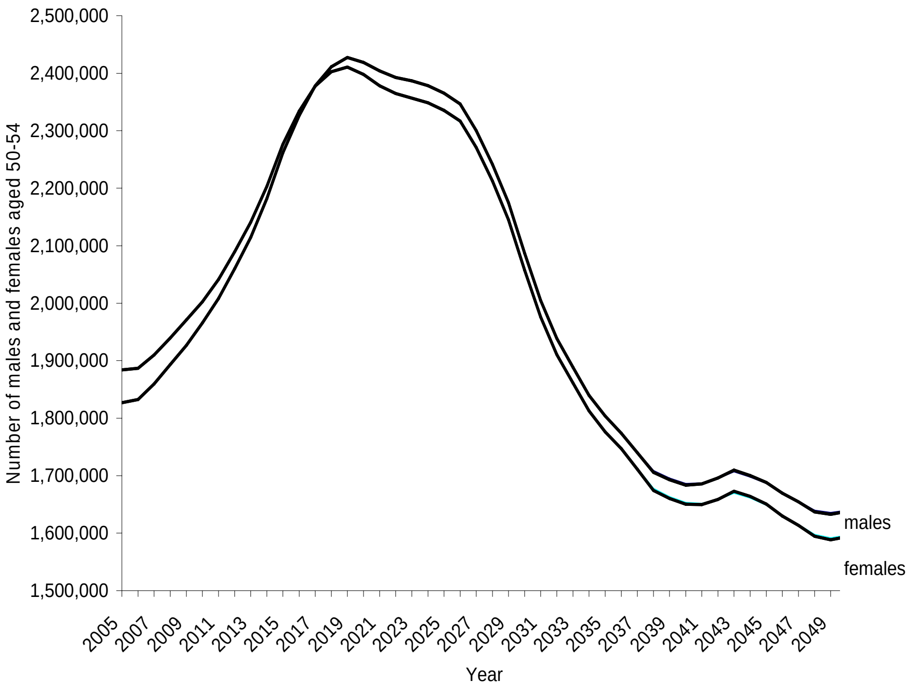


Figure A.15: Projected number of males and females aged 55-59 using counts and differentials (2005 – 2050)

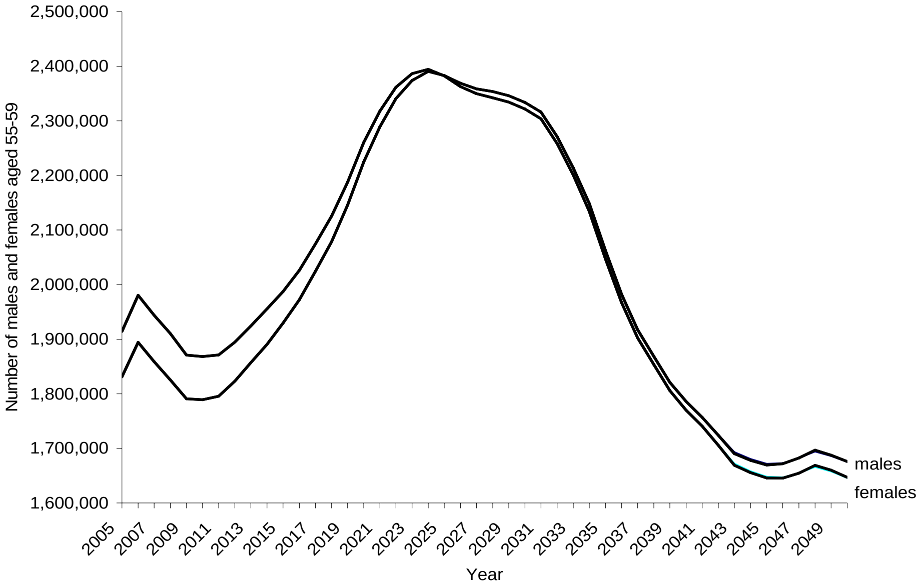


Figure A.16: Projected number of males and females aged 60-64, using counts and differentials (2005 – 2050)

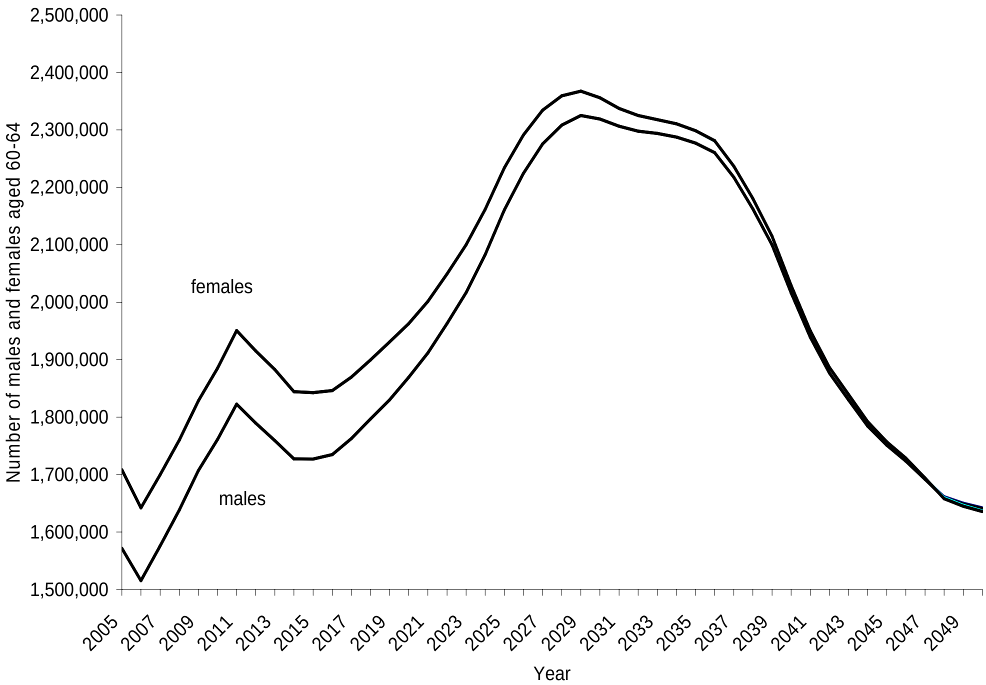


Figure A.17: Projected number of males and females aged 65-69, using counts and differentials (2005 – 2050)

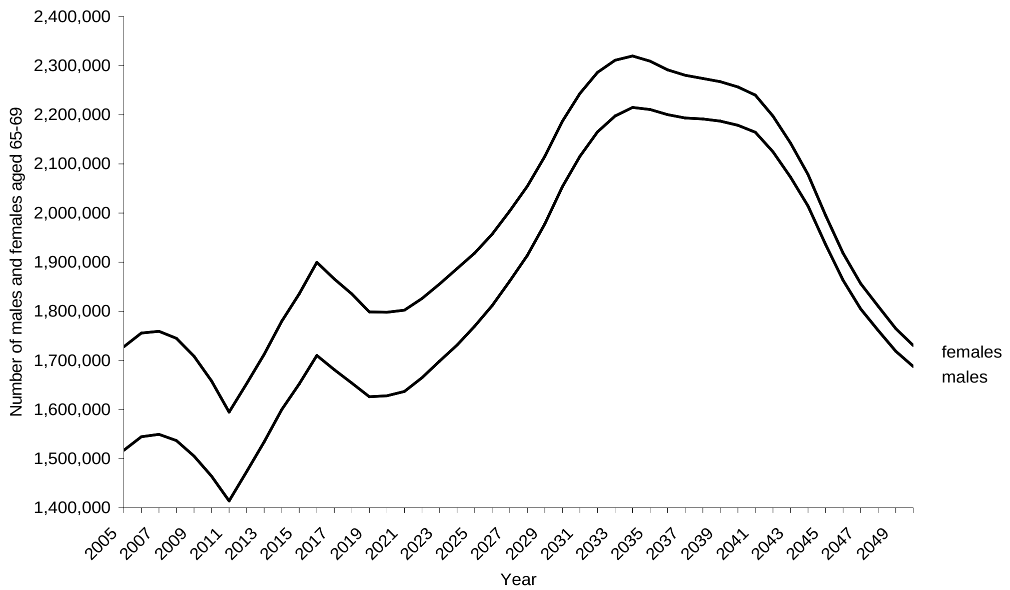


Figure A.18: Projected number of males and females aged 70-74, using counts and differentials (2005 – 2050)

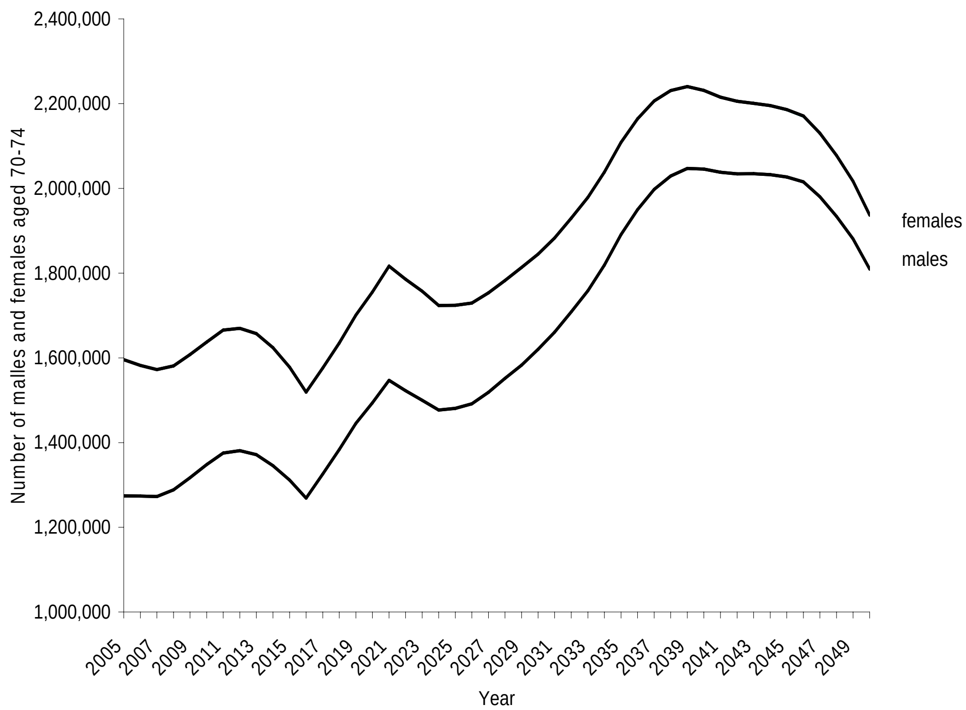


Figure A.19: Projected number of males and females aged 75-79, using counts and differentials (2005 – 2050)

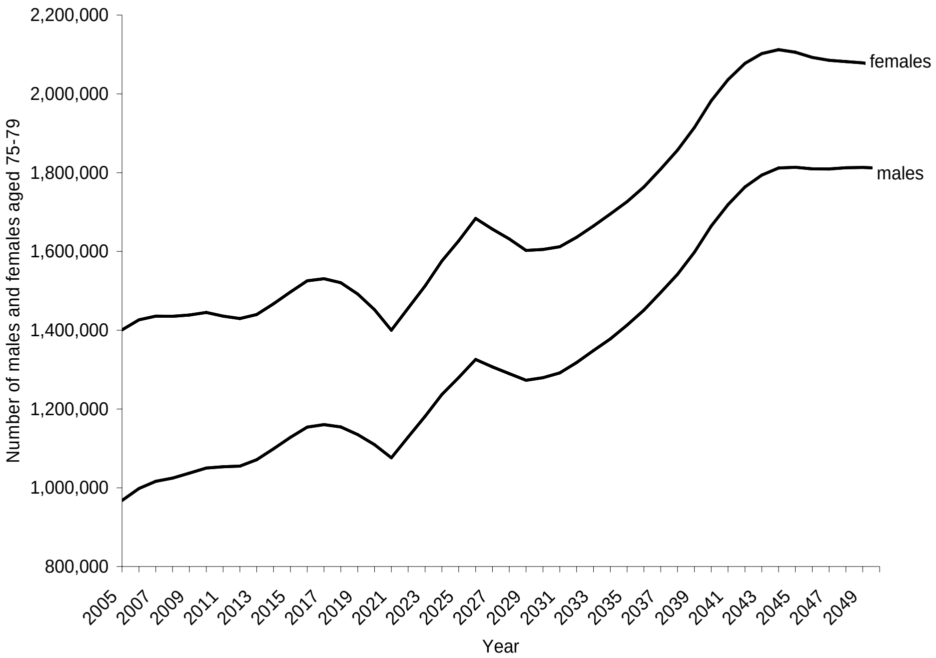


Figure A.20: Projected number of males and females aged 80-84, using counts and differentials (2005 – 2050)

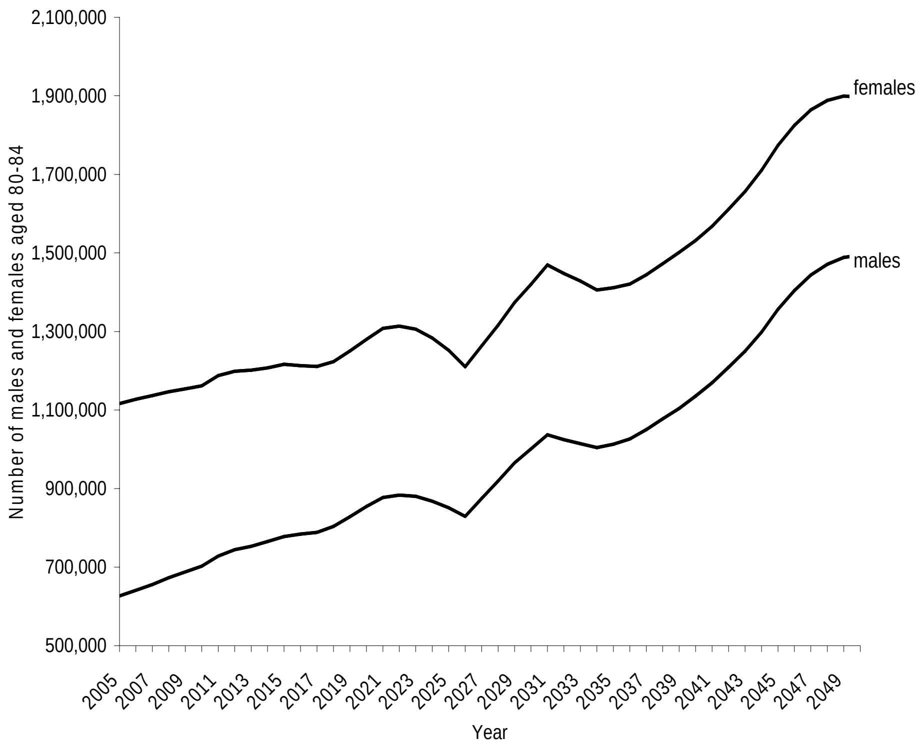


Figure A.21: Projected number of males aged 85+, using counts and differentials (2005 – 2050)

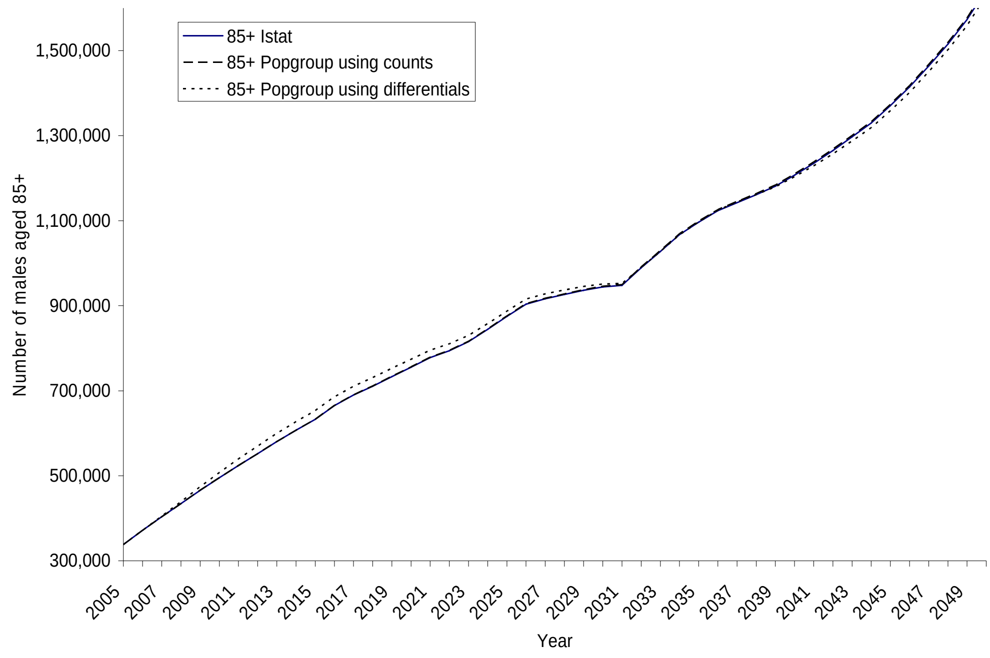
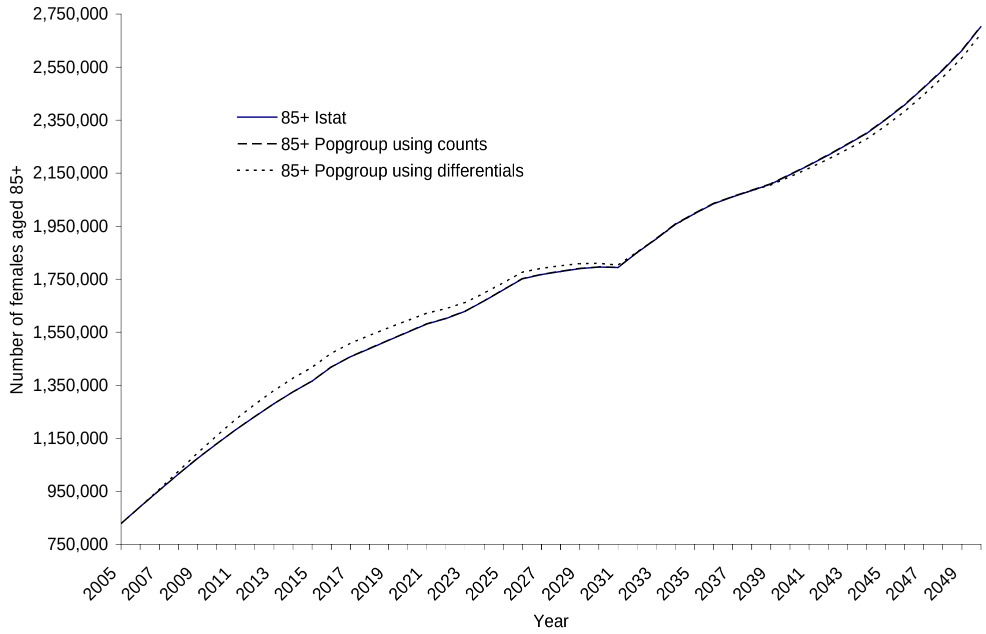


Figure A.22: Projected number of females aged 85+, using counts and differentials (2005 – 2050)



Appendix B: Hausman Test (modified version)

A modified version of the Hausman test is used to compare the estimators for low and medium-high educated males aged 20 to 54. It can be written as follows:

$$H = \left(\hat{\alpha}_{MH} - \hat{\alpha}_{L}\right)' \left[\hat{V}_{MH} + \hat{V}_{L}\right]^{-1} \left(\hat{\alpha}_{MH} - \hat{\alpha}_{L}\right) \sim \chi^2(g) \qquad \text{[A.1]}$$

Specification 6 (which includes age, age squared, the logarithm of cohort size, the interaction between age and the logarithm of cohort size, the aggregated unemployment rate and a time trend as regressors) is used so $\hat{\alpha}_{MH}$ and $\hat{\alpha}_{L}$ are 7x1 vectors of the estimated coefficients of medium-high and low educated males, respectively. For example, $\hat{\alpha}_{MH}$ is a 7x1 vector of the estimated constant ($\hat{\alpha}_0$) and the estimated coefficients of age ($\hat{\alpha}_1$), age squared ($\hat{\alpha}_2$), the logarithm of cohort size ($\hat{\alpha}_3$), the interaction between the logarithm of cohort size and age ($\hat{\alpha}_4$), the aggregated unemployment rate ($\hat{\alpha}_5$) and the time trend ($\hat{\alpha}_6$).

$$\hat{\alpha}_{MH} = \begin{bmatrix} \hat{\alpha}_{1,MH} \\ \hat{\alpha}_{2,MH} \\ \hat{\alpha}_{3,MH} \\ \hat{\alpha}_{4,MH} \\ \hat{\alpha}_{5,MH} \\ \hat{\alpha}_{6,MH} \\ \hat{\alpha}_{0,MH} \end{bmatrix} \quad \hat{\alpha}_{L} = \begin{bmatrix} \hat{\alpha}_{1,L} \\ \hat{\alpha}_{2,L} \\ \hat{\alpha}_{3,L} \\ \hat{\alpha}_{4,L} \\ \hat{\alpha}_{5,L} \\ \hat{\alpha}_{6,L} \\ \hat{\alpha}_{0,L} \end{bmatrix} \quad \hat{\alpha}_{MH} - \hat{\alpha}_{L} = \begin{bmatrix} \hat{\alpha}_{1,MH} - \hat{\alpha}_{1,L} \\ \hat{\alpha}_{2,MH} - \hat{\alpha}_{2,L} \\ \hat{\alpha}_{3,MH} - \hat{\alpha}_{3,L} \\ \hat{\alpha}_{4,MH} - \hat{\alpha}_{4,L} \\ \hat{\alpha}_{5,MH} - \hat{\alpha}_{5,L} \\ \hat{\alpha}_{6,MH} - \hat{\alpha}_{6,L} \\ \hat{\alpha}_{0,MH} - \hat{\alpha}_{0,L} \end{bmatrix} \qquad \text{[A.2]}$$

$\hat{V}_{MH}$ and $\hat{V}_{L}$ are the estimates of the variance covariance matrixes and have the variances of each element down their diagonal and the covariance terms in the off diagonals. Finally, g is the length of the parameter vector being tested (7).

The hypotheses to test are $H_0 : \alpha_{MH} = \alpha_L$ and $H_1 : \alpha_{MH} \neq \alpha_L$. H_0 is rejected if $H = \chi^2(g)$ is greater than the χ^2 critical value for g degrees of freedom at α level of significance (i.e. $H > \chi^2_\alpha\ (g)$). H=14.4 in the earnings model and 278.2 in the employment model. H_0 can therefore be rejected at 5% level of significance in the earnings model and at 1% level of significance in the employment model. The results of the Hausman test indicate strong evidence of statistically significant differences in the estimators for low and medium-high educated males aged 24 to 50.

Appendix C: Effect of cohort size on age-employment profiles using SHIW

For completeness, employment equations are also estimated using the Survey on Household Income and Wealth (SHIW). Results are compared to the ECHP results. Data prior to 1989 are not used because the highest level of education attained is recorded only for income recipients in the 1977 to 1987 waves of the SHIW. The SHIW employment regressions are estimated on 315 observations (i.e. 35 age groups times 9 time periods (1989, 1991, 1993, 1995, 1998, 2000, 2002, 2004 and 2006)).

The results of specification 6 are presented in Table C.1 below. SHIW regression results are in line with ECHP results. The coefficients of age and age squared are positive and negative, respectively. Cohort size has a negative impact at labour market entry and the coefficient of the interaction between age and natural logarithm of cohort size is positive. However, the coefficients differ in magnitude and statistical significance. The take-over points are slightly different, but still in the age range 35 to 45.

Table C.1: Parameter estimates of employment equations, ECHP (1994-2001) and SHIW (1989 – 2006); specification 6

	Low-educated workers		Medium-high educated workers	
	ECHP	SHIW	ECHP	SHIW
Age	0.527	0.431	1.586	1.268
	[4.9]	[2.6]	[8.4]	[5.8]
Age^2	-0.008	-0.006	-0.010	-0.011
	[19.0]	[13.6]	[15.2]	[15.4]
ln(cs)	-1.447	-0.823	-6.399	-3.774
	[3.2]	[1.7]	[8.6]	[6.4]
ln(cs)· age	0.058	0.045	0.291	0.200
	[2.0]	[1.0]	[5.6]	[3.4]
$\overline{u}$	-0.235	-0.150	0.119	-0.063
	[5.4]	[5.4]	[2.1]	[1.4]
T	-0.033	-0.074	-0.020	-0.045
	[2.3]	[8.2]	[1.1]	[3.0]
α_0	-3.311	-1.201	-27.610	-15.520
	[1.8]	[0.6]	[9.1]	[6.5]
Take-over point	45	42	38	39
R^2	0.794	0.663	0.878	0.810
N	280	315	280	315

Notes: absolute value of t-statistics given in parentheses. The dependent variable is the natural logarithm of the employment rate divided by one minus the employment rate. The estimation method is OLS with robust standard errors.

Appendix D: Standard error computations

The empirical model used to investigate the impact of cohort size on age-earnings and age-employment profiles (see Equations [1] and [2], Chapter 4) includes an interaction term (i.e. ln(cs)·age). One could argue that it is necessary to go beyond the partial effect / elasticity calculations and compute the corresponding *standard errors* across the full range of the age variable (see Brambor *et al* (2006). Following Brambor *et al* (2006), the variance of the elasticity of earnings with respect to cohort size is given by:

$$\sigma^2_{\varepsilon wage,cs} = \text{var}(\hat{\alpha}_3) + (age)^2 \text{ var}(\hat{\alpha}_4) + 2(age)\text{cov}(\hat{\alpha}_3\hat{\alpha}_4) \qquad [C.1]$$

The square root of the variance is the standard error and the ratio of the elasticity to the standard error is the t statistics.

Equally, the variance of the partial effect of cohort size in the employment equation is given by:

$$\sigma^2_{\frac{\delta \ln\left(\frac{e}{1-e}\right)}{\delta \ln(cs)}} = \text{var}(\hat{\alpha}_3) + (age)^2 \text{ var}(\hat{\alpha}_4) + 2(age)\text{cov}(\hat{\alpha}_3\hat{\alpha}_4) \qquad [C.2]$$

Table D.1 shows the standard error computations of the elasticity of earnings with respect of cohort size and of the partial effect of cohort size on e/(1-e) at different values of age: 20, 25, 30, 35, 40, 45, 50 and 54. The elasticity of earnings with respect to cohort size is insignificant at all the age values for low educated workers. The partial effect of cohort size on e/(1-e) is negative and significant at labour market entry and positive (and significant at 5% level) for older workers at the edge of the sample size.

The elasticity of earnings with respect to cohort size is negative and significant for younger workers and positive and significant for older workers. The partial effect of cohort size on e/(1-e) is negative and significant at labour market entry and positive (and significant at 5% level) for younger and middle-aged workers.

Table D.1: Standard error computations at different age values

Age:	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**54**
Low educated workers:								
ε(wage,cs)	0.051 [0.5]	0.042 [0.5]	0.033 [0.5]	0.025 [0.4]	0.016 [0.2]	0.007 [0.1]	-0.002 [0.0]	0.000 [0.0]
$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial \ln(cs)}$	-1.922 [4.1]	-1.396 [3.6]	-0.870 [2.4]	-0.344 [0.9]	0.183 [0.4]	0.709 [1.2]	1.235 [1.7]	1.656 [2.0]
Medium-high educated workers:								
ε(wage,cs)	-0.358 [4.4]	-0.241 [3.6]	-0.124 [2.0]	-0.007 [0.1]	0.110 [1.3]	0.227 [2.1]	0.344 [2.6]	0.437 [2.9]
$\frac{\partial \ln\left(\frac{e}{1-e}\right)}{\partial \ln(cs)}$	-5.722 [7.7]	-4.636 [7.7]	-3.550 [6.3]	-2.463 [3.8]	-1.377 [1.7]	-0.291 [0.3]	0.795 [0.6]	1.664 [1.2]

Appendix E: Descriptive statistics - "Income and Living Conditions"

Table E.1 shows some basic statistics of the second wave of "Income and Living Conditions", carried out at the end of 2005. The Table shows that around three in five males aged 20 to 54 had a medium or high level of education and around four in five were in employment. As expected, average wages of Italian medium-high educated workers were higher than average wages of low-educated workers. On average, low educated workers earned around 85% of medium-high educated workers.

Table E.1: Unweighted basic descriptive statistics, second wave of "Income and Living Conditions", 2005

N males aged 20 to 54	13,363
% with low education	41.4%
% with medium-high education	58.4%
% in employment - low education	80.4%
% in employment - medium-high education	79.3%
average monthly wage - medium-high education	2,088.1
average monthly wage - low education	1,790.4

Notes: the sum of the shares of low and medium-high educated workers is not 100% due to a number of individuals not reporting their highest level of education attained. The employment rate is computed as the ratio of number of males in employment to the number of males in the population. Wages are expressed in gross nominal terms (Euros) and are collected only for those working for an employer (self-employed are excluded). The gross amount refers to the monthly amount in the main job for employees, before tax and social insurance contributions are deducted. It includes usual paid overtime, tips and commission but excludes income from investments - assets, savings, stocks and shares.