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The Impact of Changes in Educational Attainment on Life Expectancy in Ireland

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1. Introduction

The purpose of this article is to quantify the contribution of the increasing educational attainment of the Irish population to the prospective improvement in life expectancy over the next 50 years. This analysis uses recently published information for Ireland on life expectancy by level of education. This article also considers the implications of the new data on life expectancy for differences in death rates by level of education for different groups in the population today.

Barrett and Bergin (2005) discuss the impact of age-related pressures on the public finances. Increased longevity and a higher old-age dependency ratio can lead to fiscal challenges in terms of providing for healthcare and pension spending. However, much will depend on how policy on pensions and retirement develops over the coming years. In turn, the pattern of labour force participation (and hence economic dependency) will be affected by the changing educational attainment of the population aged 65 and over. Here we consider how the demographic structure may change over the coming half century and the results can be used in future work on the cost of age dependency.

The Central Statistics Office has already forecast the population assuming significant increases in life expectancy (CSO, 2008). For the period 2011 to 2041, they suggest that life expectancy could increase from 76.7 to 86.5 years for males and 81.5 to 88.2 for females. This CSO study did not differentiate life expectancy for males and females by education level.

Because the educational attainment of the older cohorts of the population today is very different from that for the cohort currently in their late twenties, the educational attainment of the population as a whole will, inevitably, change greatly over the coming fifty years. The current generation in their late twenties will gradually replace the older, less well educated, generations as they age. Given observed differences in life expectancy by level of education, this will be an important factor driving the expected increase in life expectancy over the coming half a century. In turn the increase in the longevity of the population will result, not only in higher population levels, but in also in a rising old-age dependency ratio. This will affect demand for public services, not least pensions and healthcare.

For males in the 20 to 35 age group the "excess" deaths among those with limited education compared to the average for the population of the same age is very significant. Thus the lower life expectancy is manifest in different experiences for those aged between 20 and 34, depending on their level of education. However, just because low educational attainment is associated with lower life expectancy does not imply a causal relationship. As argued in this paper, it is probable that they are both affected by a wide range of other demographic and health characteristics. Thus while the new data on life expectancy can be used to forecast

changes in the population (because education and life expectancy are correlated) they cannot, on their own, be used to explain the "excess" deaths in the population today.

Section 2 of this paper considers the new information on life expectancy for Ireland which is used in the article. Section 3 briefly considers evidence from other countries. Section 4 sets out the methodology used in the analysis and Section 5 presents the results. Brief conclusions are drawn in Section 6.

2. Data

For the first time for Ireland CSO (2010) gives life expectancy by sex, cross-classified by highest level of education completed. The life expectancy estimates are given for males and females aged 20, 35, and 65. (Obviously life expectancy at birth is the same for the population as a whole as their final level of education as adults is unknown.) The data have been derived by the CSO from a joint analysis of the data in the 2006 Census on the population and data in the Vital Statistics on deaths in the year subsequent to the Census, 2006/7. Thus the estimates are applicable to the years 2006/2007.

The estimates were derived by linking the records of individual deaths for the year 2006/7 to the relevant records for the same individuals in the 2006 Census. The matching was done by geo-coding (calculating the precise geographic location) of the addresses in the two data sets and then matching the named individuals in the data on deaths to their record in the Census. This matching was accomplished for over 90 per cent of deaths in the relevant year (CSO, 2010).

This matching of the data allowed the CSO to derive a wealth of demographic information about the individuals who died in the year after the Census. In particular they used these data to derive life expectancies by level of education completed and also life expectancy by social class. In this paper we concentrate on the education data as this is the basis on which the ESRI's demographic model is constructed (Bergin *et al.*, 2008).

Table 1 shows the life expectancies for males at different ages in 2006, derived from the matched data sets (CSO, 2010). The data are shown by three levels of education completed. Those who had no qualifications were aggregated with those who had a junior certificate level of education – here referred to as primary and lower secondary. The Table shows a big gap between the life expectancy at age 20 and 35 for those with the lowest level of educational attainment relative to the other categories. The gap is somewhat narrower at age 65.

Table 1: Male Life Expectancy by level of Education Completed, 2006/7

|	**Males, 2006**			
Life expectancy at various ages	0	20	35	65
Highest Level of Education				
• Primary & Lower Secondary	n.a.	53.3	41.3	16.3
• Secondary	n.a.	58.5	44.5	17.5
• Third Level	n.a.	61.3	46.9	19.3
Population	76.8	57.5	43.3	16.6

Source: CSO, 2010.

Table 2 shows similar data for women for 2006/7. In this case there is still a significant difference at age 20 and 35 between those with the most limited education and the rest of the population. However, the gap is much smaller than in the case of males. At age 65 the gap is actually smaller for males than for females.

Table 2: Female Life Expectancy by level of Education Completed, 2006/7

	Females, 2006			
Life expectancy at various ages	0	20	35	65
Highest Level of Education				
• Primary & Lower Secondary	n.a.	59.5	45.6	19.4
• Secondary	n.a.	63.2	48.5	20.8
• Third Level	n.a.	65.2	50.4	22.1
Population	81.6	62.1	47.4	19.8

Source: CSO, 2010.

Figure 1: Males by level of education completed, five year cohorts, % of total cohort,2010
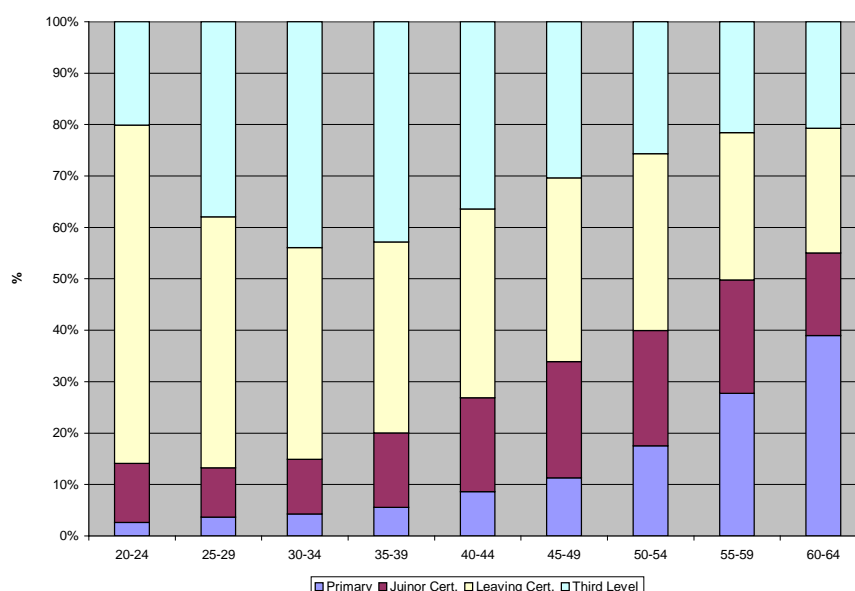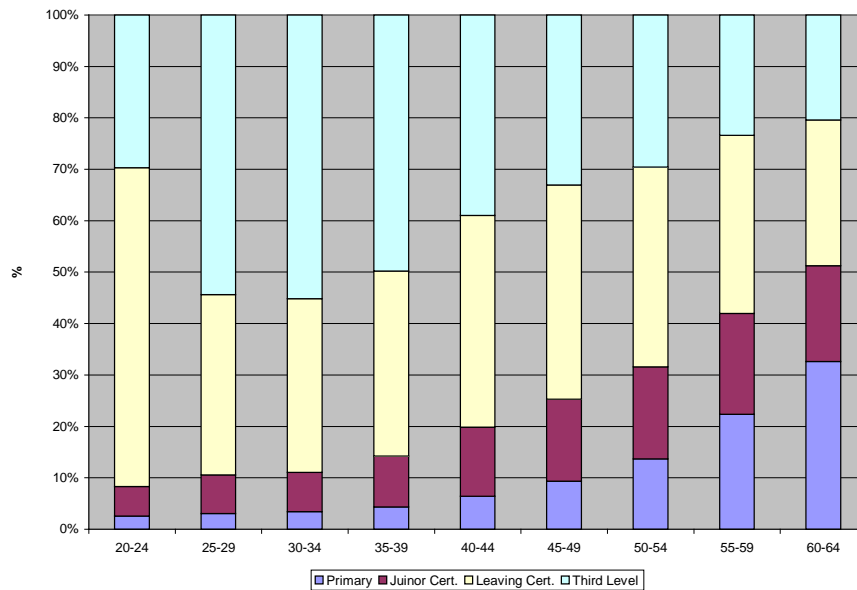

Source: CSO Quarterly National household Survey special tabulation.

In this paper we combine these data on life expectancy with data from the Quarterly National Household Survey for 2010 on educational attainment for different age groups. For 2010 Figure 1 shows the proportion of each cohort of males by level of education completed. Looking at the 25-29 cohort (many of those in their early twenties were still in the educational system) the proportion with third level education was 38 per cent whereas those with a junior certificate or less accounted for only 14 per cent of the cohort. However, for the 60-64 year old cohort the situation is reversed: only 21 per cent had completed third level education while 56 per cent had not progressed beyond junior certificate.

Figure 2 shows similar data for females. Once again there is a very big change between the average educational attainment of the oldest cohorts shown in the Figure relative to the youngest. For 25-29 year old females 54 per cent had completed third level education whereas the numbers with no more than a junior certificate accounted for only 11 per cent

of the cohort. By contrast only 20 per cent of 60-64 year old females had completed third level while 51 per cent had not progressed beyond a junior certificate.

Figure 2: Females by level of education completed, five year cohorts, % of total cohort,2010

Source: CSO Quarterly National household Survey special tabulation.

This large disparity in educational attainment between the 60-64 cohort and the 25-29 cohort for both males and females means that, even without any further change in educational participation, there will be a dramatic change in the average educational attainment of the population in the future as the younger cohorts of well educated males and females gradually replace the older cohorts. Because higher levels of education generally result in higher productivity (measured by earnings), higher labour force participation and lower unemployment than is the experience of those with lower levels of educational attainment, this will affect the economy and society in many different ways. In this paper we concentrate on how the rising educational attainment of the population is likely to affect life expectancy.

3. Literature Review

The correlation between increased educational attainment and increased life expectancy has been observed elsewhere. Here we discuss a series of studies using US data. These studies have used different methods to try and control for the fact that education is itself endogenous in modelling its relationship with life expectancy.[1]

Lleras and Muney (2005) found a large causal effect on mortality rates of changes in compulsory schooling laws that took effect between 1915 and 1939 in at least 30 states in

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[1] Education is endogenous in the sense that it is also "caused" by a range of demographic and social factors which also probably affect life expectancy.

the US. These results were derived from an analysis of the data from the 1960, 1970 and 1980 US censuses and the 1992 National Health and Nutrition Examination Survey Epidemologic Follow up Study (NHEFS). Using a GLS estimator they showed that the incremental effect of an additional year spent in education reduces the chances of death over the following decade by approximately 1.3 percent. Using instrumental variable methods they showed an even larger inverse effect of education on mortality: the effect of education was estimated to be - 3.7%, and - 5.1% as estimated using aggregated data at the gender/state-of-birth and cohort level. In other words, the most conservative estimate showed that an additional year of education in 1960 led to an increase in life expectancy of 1.7 years.

Crimmins and Saito (2001) studied the effect of education on life expectancy in the US in the years 1970, 1980 and 1990. The dataset consisted of the 1970, 1980 and the 1990 censuses, and the 3 year data from the National Health Interview Survey (NHIS) centred on the census years. The study showed that within every sex-race group, those with higher educational status, as measured by years of school completed, are expected to live longer. For example, at 30 years of age, Caucasian females with higher educational status were expected to live 3.8 years longer, while males were expected to live 6.7 years longer. For African Americans aged 30, the differential amounted to 10.5 and 11.8 years for women and men, respectively.

Lynch (2003) studied the age and cohort effects on the relationship between education and self-rated health (SRH), which can be used as an indicator of mortality . Two techniques were applied to two different datasets. First, the data from the National Health Interview Survey (NHIS) was used to estimate standard age – period – cohort logistic regressions that allowed for the varying effect of education across age and cohort, quadratic interaction between age and education, and the interaction between age, cohort and education. Second, data from the National Health and Nutrition Examination Survey (NHANES) and its follow-ups were used to estimate a Bayesian normal hierarchical random-effects model, which was able to differentiate between differences in mortality that were due to differences between people and the differences attributable to the life-course. The logistic model showed that there was an inverse relationship between education and the probability that an individual will report fair or poor health. This relationship was statistically significant at 5 percent. Moreover, for each cohort, the effect of education increased up to a point and then declined. However, the peak occurred at different ages for the three birth cohorts. The random-effects model showed that as people age, education slows down the deterioration in health.

Using data from the 1989 and 1990 US census statistics and vital statistics to conduct a cross-sectional multiple regression analysis of the effects of income and education on mortality, Muller (2002) found that educational attainment, as measured by the lack of completed high school education, explained the variation in mortality better than income inequality. In particular, absence of high school education accounted for more than 50% of the variation in mortality, while the two measures of income inequality – Gini coefficient and per capita income – accounted for 27.7% of the variation.

4. Methodology

The approach taken in this article is first to develop education specific life tables – tables which show by single year of age the probability that a male or female will survive for at least a year. These are derived by modifying the standard life table for the population as a whole so that it reproduces the age specific life expectancies shown in CSO 2010 for the year 2006 for each of the three groups differentiated by level of education. We also derive a modified version of the life table for the aggregate population (undifferentiated by education) which reproduces the increase in life expectancy forecast by the CSO over the next 40 years (CSO,2008).[2]

On the basis of zero migration and taking the population structure as it was in 2010 we then use the ESRI's demographic model to forecast the population for the next 40 years using these three different sets of life tables. We assume an unchanging total fertility rate in the forecast period to estimate the number of births each year.

In the demographic model it is assumed that whatever education level is possessed by an individual at age 25 is the final and highest level attained in their lifetime. For the ages 20 to 24, however, transfers between Secondary and Third Level education are assumed to take place on a gradual basis. These transfers represent those who graduate from University each year with a primary qualification. For example, between the ages of 21 and 22, it is assumed that 10% of those with secondary education will obtain a third level degree. The percentages used for calculating transfers are assumed to be constant over the period and they are included in the appendix.

The standard version of the model applies the life table for the aggregate population to forecast future population on the basis of unchanging life expectancy. It estimates for each of the next 40 years how many of the population in each age cohort survive to the following year. This produces a forecast for population numbers out to 2050.

We then incorporate the education specific life tables (with unchanging education specific life expectancy over time) to calculate how much of the population in 2010 will survive each year to produce an alternative estimate of the population out to 2050. This alternative estimate takes account of the interaction between rising educational attainment and differing education specific life expectancies to produce an estimate of the effect of rising educational attainment on the future population and on future age dependency ratios.

Finally we use the life table, which assumes a rising life expectancy as forecast by the CSO, to estimate the population out to 2050.

The difference between the first and the second forecast gives an estimate of the effect of changing educational attainment on the future population. The difference between the

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[2] In fact it is a separate life table for each of the forty years which changes so as to reproduce the gradual rise in life expectancy assumed by the CSO.

second and the third gives an estimate of the effect of the CSO's forecast of rising aggregate life expectancy net of the effect of the rising educational attainment of the population.

In summary three scenarios are used to calculate the impact of educational attainment on life expectancy.

1. Life expectancy is held constant at 2006 levels and the population is not differentiated by education.
2. Life expectancy is held constant at 2006 levels and differentiated by level of education.
3. Life expectancy rises in line with CSO forecasts and the population is not differentiated by education.

For the purpose of this study, zero net migration is assumed from 2011 to 2061, and the Total Fertility Rate is assumed to be constant at 2.07 over the period. (These assumptions can be readily altered in the model to give different scenarios on migration and fertility.)

In the Irish Life Tables No.15 (CSO 2009), the methodology is provided for calculating life expectancies.

The life expectancy at age x, e_x^0, is the total future life time in years which will on average be passed through by persons aged exactly x.

l_x is the number of persons surviving to exact age x out of the original 100,000 aged 0.

L_x is person years, or the number of years survived by life table cohort between the ages x and x+1: $L_x = \frac{l_x + l_{x+1}}{2}$.

T_x is cumulated person years, i.e. $T_x = \sum_x^{105} L_x$

Hence, $e_x^0 = \frac{T_x}{l_x}$.

CSO (2010) provides life expectancies by sex by highest level of education completed for the ages 20, 35 and 65. Using these life expectancies as a benchmark, scale factors can be generated to derive education-specific life tables from the population life table, such that the education-specific life expectancies match those shown in the CSO estimate of education specific life expectancies at 20, 35 and 65.

These life tables are not unique. The scale factors are used to multiply the probability of an individual aged t surviving one year to t+1. Separate scale factors are calculated for each year between 20 and 105. The scale factors are chosen so that they are constant over a range of years or so that they change in a regular fashion (see Appendix 1 for more an example). Thus for a person aged t the probability of surviving to age t+1 is increased if $s_t>1$ (or reduced if $s_t<1$) and the revised probability p_{t1} is modified to become p_{t2} where $p_{t2} = s_t\ p_{t1}$. It is assumed that there is no deviation from the aggregate population life expectancy before the age of 20.

Using this approach life tables are generated for males and females for three levels of educational levels; Primary and Junior Cert, Leaving Cert, and Third Level education.

Using these life tables the probability of someone aged t surviving to age t+n, $P_{t,t+n}$, can be calculated as the product of each of the individual probabilities of surviving a single year for each year between year t and year t+n.

$$P_{t,t+n} = \prod_{i=t}^{t+n} p_i$$

Then the number of deaths per 100 individuals between the age of t and t+n will be equal to 100(1- $P_{t,t+n}$).

The education-specific survivorship rates (life tables) derived in this paper are not unique - a different set of survival probabilities can give the same life expectancy result where the probabilities do not follow the smooth pattern that we have assumed. The rates in this study were generated such that they reproduce the CSO's published education-specific life expectancies and they were assumed to show a stable pattern over time. We experimented with a different pattern of survivorship for the years between 20 and 34 but this did not greatly alter our results.

5. Results

Impact of changing educational attainment on the population

Here we consider how the rising educational attainment of the population, interacting with differences in life expectancy by level of education, may affect the growth in the population over the next fifty years. We use the existing ESRI Demographic Model, which forecasts the population by four levels of educational attainment. As outlined above, we incorporate into this model the information from the CSO on the differing life expectancies by level of education. We then use this enhanced model to examine three scenarios on the future population. By comparing the results for these three scenarios we derive an estimate of how the changing educational attainment of the population may affect the rise in average life expectancy for the population and, hence, the size of the Irish population in future decades.

As outlined above, we consider three scenarios where:

1. Life expectancy is held constant at 2006 levels and the population is not differentiated by education – the base case.
2. Life expectancy is held constant at 2006 levels and differentiated by level of education.
3. Life expectancy rises in line with CSO forecasts and the population is not differentiated by education.

It should be emphasised that, while scenario 3 uses the CSO assumptions about future life expectancy, it differs from the CSO forecasts in assuming zero migration and a constant Total Fertility Rate (TFR) of 2.07 over the next fifty years. These assumptions do not represent

"forecasts". Rather they are used to simplify the analysis so that the effects of changing educational attainment can be clearly identified in the simulations.[3]

Under scenario 1), the population is estimated to grow by 0.6 million between 2010 and 2060, to 5.1 million. Under scenario 3), the population is estimated to increase by 1.2 million 20 around 5.7 million. The difference between these two estimates is explained purely by differences in assumptions concerning life expectancy.

Under scenario 2, life expectancy is also assumed to remain unchanged but life expectancy is allowed to differ depending on an individual's educational attainment. When this assumption interacts in the model with the change in educational attainment of the population it gives rise to a significantly higher population than in the base case, scenario 1: by 2060 the population would be around 0.8 million higher than in 2010 at 5.3 million.

These results are summarised in Table 3, which shows the difference in the forecast population changes relative to the base where life expectancy is constant. This Table shows that by 2060, even if education specific life expectancy remained constant over time, the change in the average educational attainment of the population would see an additional increase in the population of 184 thousand relative to the base case. The Table also shows that using the CSO's assumptions about rising life expectancy for the population as a whole would result in an increase in the population by 2060 of around 595 thousands relative to the base case. Thus the changing educational attainment of the population would account for 30 per cent of the population increase which would occur under the CSO's assumptions on rising life expectancy. The rest of the increase would be accounted for by the rise in life expectancy itself.

Table 3: Estimated Increase in Population Under different Scenarios, Difference compared to base case of unchanging life expectancy

	Thousands				
	2020	2030	2040	2050	2060
CSO Rising Life Expectancy	75	191	328	466	595
Differentiated by Education	36	66	106	153	184
Percentage Contribution of Education	48.2	34.5	32.2	32.8	31.0

The different assumptions on life expectancy also have major implications for the average educational attainment of the population in future years. Figure 3 shows how the average educational attainment of the male population aged 65 and over would change as a result of rising life expectancy as assumed by the CSO. Whereas in 2010 just under 20 per cent of the population over 65 had third level education and over 60 per cent had only primary or lower secondary, by 2050 the average educational attainment could change dramatically under these assumptions. As shown in Figure 3 around 30 per cent of males over 65 would have

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[3] We also experimented with different assumptions on TFR and migration but these did not significantly alter the results.

third level education while only around a quarter would have lower secondary or primary education.
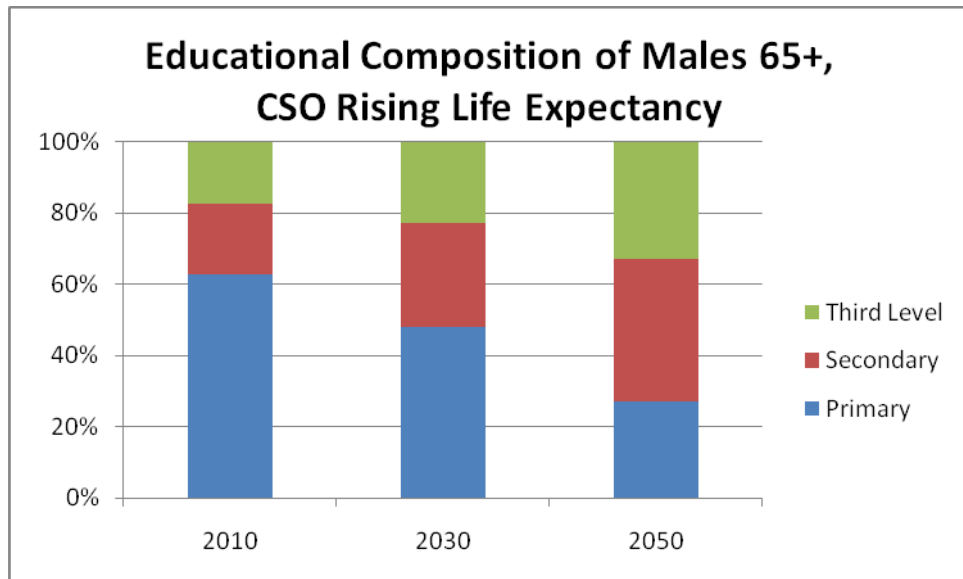
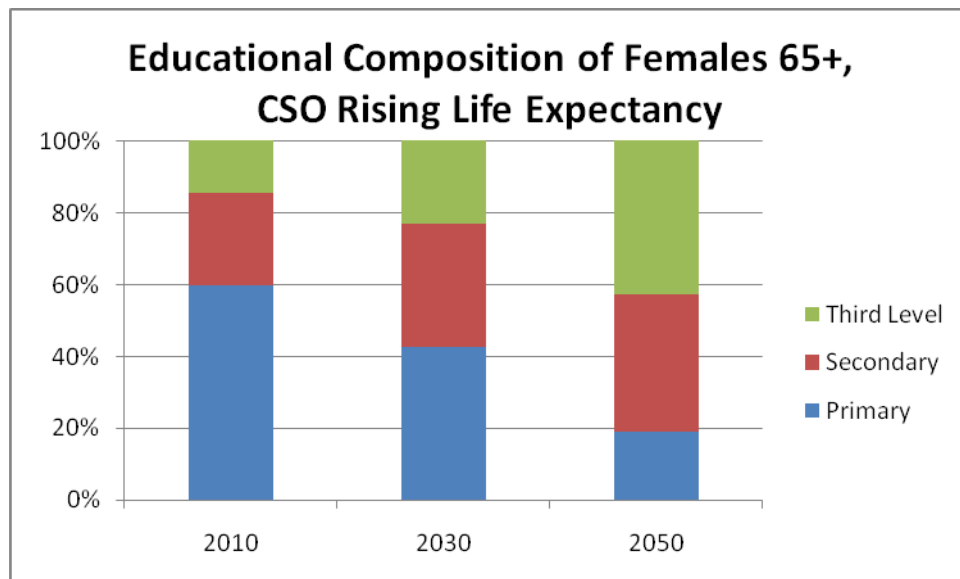Figure 4 shows a similar breakdown of the educational attainment of the female population under the CSO assumptions on rising life expectancy. In the case of females the change in composition is even more dramatic than in the case of males. While in 2010 significantly less than 20 per cent of the females over 65 had third level education, by 2050 the proportion would have risen to over 40 per cent under the CSO assumptions. The proportion with only

primary or lower secondary education would be reduced by more than two thirds to under 20 per cent.

These changes in the educational attainment of the population aged over 65 will have significant implications across a range of areas of the economy (and society). It will affect labour force participation; it may well affect health costs and care needs; it will definitely affect life expectancy and the age distribution of the population aged over 65. In Appendix 2 we show the educational attainment of the population aged over 80 on the same basis as for the population aged over 65.

So far we have looked at the educational structure of the population assuming that the life expectancy of individuals is the same irrespective of their educational attainment. In Figures 5 and 6 we compare the educational attainment of the population aged 65 and over, where life expectancy rises for all individuals, as assumed by the CSO, with the effects of constant education specific life expectancies. This comparison will underestimate the impact of education on the composition of the population in the future because here we assume that there is no change over time in education specific life expectancies. Nonetheless, the comparison in Figures 5 and 6 shows how big an impact the interaction of rising educational attainment and differing education specific life expectancies may have on the composition of the future population aged over 65.
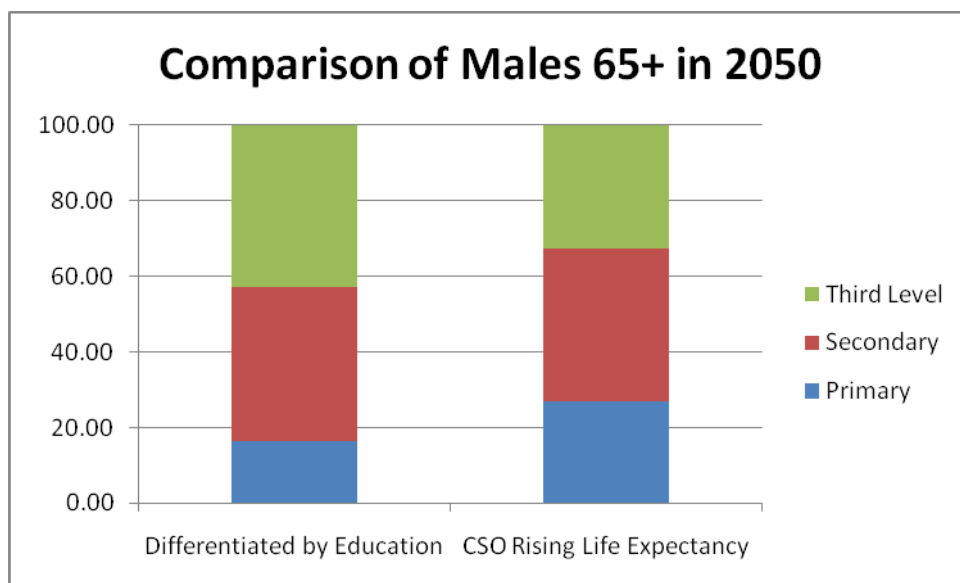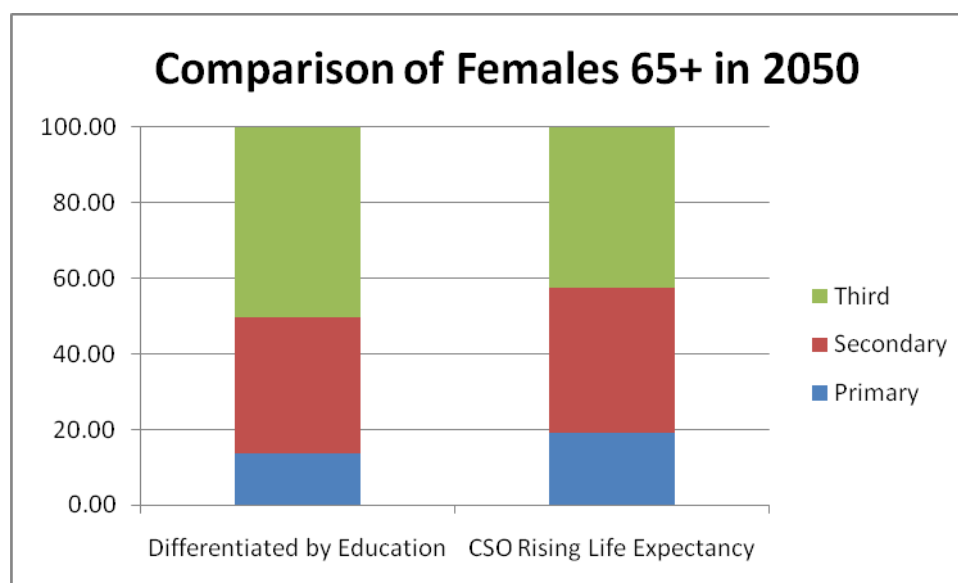
Figure 5: Comparison of Educational Composition of population of males over 65 in 2050 under differing assumptions

In the case of males, when the higher life expectancy of those with third level education is taken into account Figure 5 suggests that by 2050 they could account for over 40 per cent of males over 65 rather than the approximate 30 per cent where life expectancy is expected to rise on an equal basis for the population as a whole (as assumed by the CSO). For women the difference in the educational composition of the over 65s arising from taking account of higher life expectancy for those with a good education is also quite significant, though smaller than in the case of males.

This change in the educational attainment of the population aged 65 and over may affect the economy and society through a range of channels. Those with a good education are more likely to continue to participate in the paid labour force after the age of 65 and the jobs open to them are also suitable for older people. Jobs in sectors like building and construction which tend to be populated by people with lower educational attainment tend to be much less suitable for people aged over 65.

The changing educational attainment of the population aged 65 and over may also affect the demand for health services and care needs. Because they are likely to have had much higher life time earnings (Kelly, McGuinness and O'Connell, 2009), those with higher levels of educational attainment are likely to have accumulated higher wealth, in terms of physical and financial assets, and better pension eligibility than those with more limited education. This could allow them to fund additional care reducing pressures on the state.

Dependency Ratios

Here we briefly set out the implications of the rising population aged 65 and over for dependency ratios. As shown in Table 4 rising life expectancy, as assumed by the CSO, will see a dramatic increase in the old age dependency ratio (the proportion of the population aged 65+ relative to the population of working age between 15 and 64). Even with

unchanging education specific life expectancy there would be a near doubling in this ratio by 2050.

Table 4: Population Old-Age Dependency Ratio at selected years

Population Old-Age Dependency Ratio at selected years				
	2020	2030	2040	2050
CSO Rising Life Expectancy	23.41	30.67	39.79	50.93
Differentiated by Education	22.47	27.70	34.11	42.14

Table 5: Population Dependency Ratio

Population Dependency Ratio at selected years				
	2020	2030	2040	2050
CSO Rising Life Expectancy	56.70	59.10	69.03	83.49
Differentiated by Education	55.76	56.13	63.35	74.70

The figures for the population dependency ratio also show a very substantial rise over the period to 2050, as shown in Table 5. (The population dependency ratio is here defined as the ratio of the population under 15 plus the population aged 65 and over relative to the population aged between 15 and 64).

Excess Deaths

As discussed in Section 4, using the estimated education specific life tables for 2006 we have calculated the number of deaths per 100 persons expected between 20 and 34 and between 35 and 64 for males and females with different levels of education. Table 6 shows the expected number of deaths per 100 males for the different age ranges. For males with primary and junior certificate education aged 20 in 2006 6.15 per cent would be expected to die before they reach the age of 35. However, for those with a secondary education only 1.86 per cent would be expected to die. The "excess" death rate associated with having only completed and junior certificate education relative to those with secondary education thus amounts to 4.3 percentage points – a very big excess. The gap between the death rate for those with secondary education and third level education is much smaller at 0.8 percentage points.

Table 6: Deaths per 100 Males differentiated by education

Deaths per 100, Males			
Between the ages:	Primary	Secondary	Third Level
20 - 34	6.15	1.86	1.10
35 - 64	17.81	11.31	8.45

For those aged 35-64 the gap between the death rate for those with primary and junior certificate education relative to those with a secondary education is also very large – 6.5 percentage points with a not insignificant gap between those with a secondary education and those with a third level education. Thus those with only a primary or a junior certificate

education suffer from a very much reduced life expectancy reflected in very much higher death rates over most of their adult lives.

Table 7: Deaths per 100 Females differentiated by education

Deaths per 100, Females			
Between the ages:	Primary	Secondary	Third Level
20 - 34	2.09	0.55	0.35
35 - 64	12.44	7.72	5.40

Table 7 shows the same data for females. The gap between the death rates for those with secondary education and third level education is quite small over the full age range 20-64. There is a larger gap between the death rates for those with the lowest level of education and those with secondary education. However, it is much smaller than is the case for males. The difference between males and females is particularly striking for those in the age range 20-34.

It is not possible to attribute any causal relationship between the higher death rate and the level of education attained on the basis of this analysis. Both education and life expectancy are jointly affected by a range of demographic factors and health factors. For example, a pre-existing health problem in their childhood or teenage years could have seriously affected an individual's education, while simultaneously affecting their life expectancy in their twenties. In addition, because the numbers in the category with the lowest educational attainment in 2006 were quite small, the presence of a significant number of individuals with pre-existing health problems could have a disproportionate effect on the death rate.

Nonetheless, as shown in Table 8, the bulk of the deaths for males aged between 20 and 34 are due to accidents, suicide etc. rather than to natural causes. By contrast for women over half of the deaths in that age group are due to natural causes. The total number of deaths due to natural causes is rather similar for men and women, which suggests that, where excess deaths occur for males, they are primarily due to an increased incidence of motor and other accidents, suicide and other causes unrelated to disease of physical illness. For males, deaths attributed to suicide accounted for almost 29 per cent of the total deaths while the figure for females was 15 per cent.

Table 8: Deaths by Cause, Males and Females aged 20 to 34, Total for 2007 and 2008

	Females				Males			
	20-24	25-29	30-34	20-34	20-24	25-29	30-34	20-34
Natural	40	71	101	212	53	84	98	235
Other	39	60	45	144	256	265	251	772
Of which suicide	17	25	12	54	98	109	82	289
Total	79	131	146	356	309	349	349	1007
Natural, % of total	50.6	54.2	69.2	59.6	17.2	24.1	28.1	23.3
Other % of total	49.4	45.8	30.8	40.4	82.8	75.9	71.9	76.7
Of which suicide, % of total	21.5	19.1	8.2	15.2	31.7	31.2	23.5	28.7

Table 9: Deaths by Cause, Males and Females aged 35 to 64, Total for 2007 and 2008

	Females	Males
Natural	3547	5307
Other	367	1037
Of which suicide	120	342
Total	3914	6344
Natural, % of total	90.6	83.7
Other % of total	9.4	16.3
Of which suicide, % of Total	3.1	5.4

While poor educational attainment is a good indicator that males, in particular, are subject to a higher probability of dying from accidents, suicides etc., it is not an explanation for this phenomenon. It is highly probably that both poor educational attainment and the higher probability of dying from "unnatural" causes among males is due to a range of factors that jointly affect educational performance in teenage years and subsequent life expectancy for those in their 20s and early 30s. While the gap in life expectancy for females aged 20 to 34 with limited educational attainment relative and the rest of the female population is much smaller than for males, it is, nonetheless, substantial. As with males, the explanation for this phenomenon must be found in a range of factors that go well beyond educational attainment.

For those aged 35-64 the bulk of the deaths, male and female, are due to natural causes as shown in Table 9. For this age group the size of the cohort of the population with only primary or lower secondary education is much larger than for the younger age group. While it is not possible to allocate the deaths by educational attainment it is still clear that the bulk of the deaths for all three educational categories are due to natural causes in this age group. In this case the explanation for "excess" deaths among this age group must lie with the wide range of social and demographic factors which affect an individual's health.

6. Conclusions

This paper has examined the potential effect of differences in life expectancy across educational groups on the future population. It shows that the combination of a rising share of those with a third level education and higher life expectancies for this group will lead to a substantial rise in the share of the population aged over 65. It will also affect the educational composition of the older population, which may have important implications for the economy and society over the coming decades.

The fact that people with better education live longer does not necessarily suggest a causal relationship between education and life expectancy. It is highly probably that they are both affected by a range of other social and demographic factors. Nonetheless, the research cited in Section 3 for the US does suggest that, controlling for these otherfactors, education does have some significant effect on life expectancy.

This paper also shows that there is a very considerable number of "excess" deaths among the population with only primary and lower secondary education, where "excess" is defined as being substantially greater than for those with higher levels of education in the same age

group. This is particularly true for males aged between 20 and 34. As only a minority of deaths in this age group are due to natural causes this would suggest that there are other factors at work over and above education.

A major question for future research must be the reasons underlying the big difference in life expectancies by level of education, especially for the younger age groups. It is possible that different factors may explain the variation at age 20 to 34 and at older ages, given that only a minority of deaths in the younger age group is due to natural causes while the majority of deaths in older age groups are due to natural causes.

The data set on which the CSO life expectancies are based offers potential scope for researchers to analyse the effect of a much wider range of social and demographic variables on life expectancy and cause of death using data for individuals. Also, in years to come, the Growing up in Ireland data set, by providing consistent data in the future on individuals from an early age through to their twenties, may well allow researchers to examine how experience of children prior to adulthood may have a permanent effect on their life expectancy.
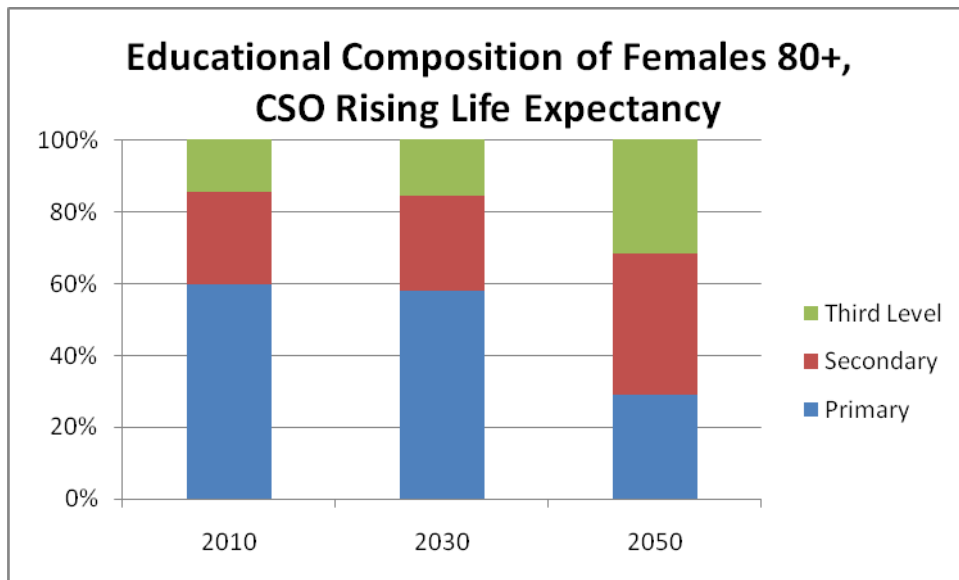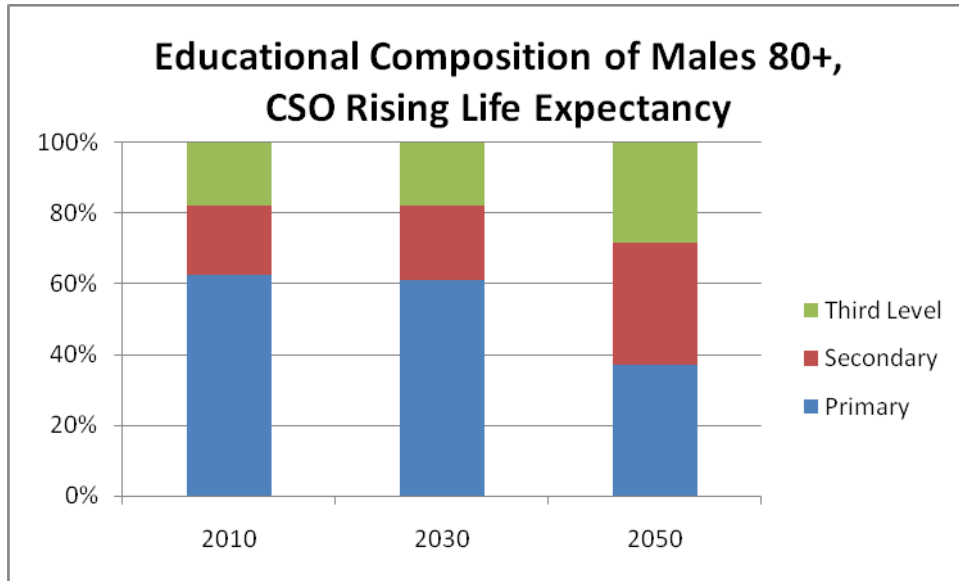
This article has simplified the analysis by only looking at the case of constant education specific life expectancies. If evidence became available for Ireland or other countries on how such life expectancies are changing over time this could be incorporated into subsequent analysis.

The ageing of the population and the increase in the dependency ratio under different assumptions has major potential implications for future pension and care costs. While the dependency ratios may rise inexorably, the changing educational attainment of those aged 65 and over may modify the impact of this rise in dependency on the costs for the state. This is a further area which merits research.

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Appendix

Educational Composition of Males 80+, CSO Rising Life Expectancy

Educational Composition of Females 80+, CSO Rising Life Expectancy

Appendix: Example of Survival Proabilities derived from the Population probabilities in CSO, 2009.

	Population	Primary		Third Level	
Survival Probabilities for Males, 2006					
Age	Probability	Probability	Change	Probability	Change
20	0.99897	0.99617	-0.0028	0.99922	0.00025
21	0.99891	0.99591	-0.003	0.999165	0.000255
22	0.99887	0.99567	-0.0032	0.99913	0.00026
23	0.99888	0.99548	-0.0034	0.999145	0.000265
24	0.99893	0.99533	-0.0036	0.9992	0.00027

Appendix: Transition to Third Level

Proportion with third level

Age	Males	Females
20	3	3
21	11	15
22	21	30
23	31	40
24	35	50

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2011		
	413	Poverty Traps and Climate Change *Richard S.J. Tol*
	412	UK Tourists, The Great Recession and Irish Tourism Policy *Niamh Callaghan* and *Richard S.J. Tol*
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