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Utilising Microsimulation to Estimate New Marginal Returns to Education: Ireland 1987-2005

Darragh Flannery
Cathal O'Donoghue

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Darragh Flannery
University of Limerick,
REDP, Teagasc and NUI Galway

Cathal O'Donoghue
REDP, Teagasc
and IZA

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

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In this paper we utilise microsimulation techniques in the form of an income generation model and a tax/benefit model to estimate both the fiscal and net private return to education at a marginal level. This is carried out empirically using Irish data across the period 1987-2005 and is the first study to utilise these techniques in such a manner. The results indicate that a more generous tax/benefit system, combined with a greater state burden of the cost of education over this period may have helped increase the individual's return to education, while reducing the state return from investing in education. The methodology employed allows us to specifically analyse the impact of various components of the tax/benefit system upon these returns across time and show the role of income tax changes upon the return to education for the individual and the state.

JEL Classification: I22, I28

Keywords: returns to education, microsimulation, income generation model

Corresponding author:

Darragh Flannery
Department of Economics
University of Limerick
Limerick
Ireland
E-mail: darragh.flannery@ul.ie

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1 INTRODUCTION

The relationship between an individual's education and earnings has formed the basis for much empirical work in the economics of education produced in the past fifty years (See Card, 1999 and Harmon et al, 2001). This has focused on comparing the private benefits of extra education in the shape of higher lifecycle earnings against the private cost to the individual of education.

However, several possible issues with the basic specification of this methods have been highlighted; higher gross earnings from education may vary taxes/benefit liabilities (Heckman et al, 2008) and extra education may affect labour supply decisions (Booth and Coles, 2007; Trostel and Walker, 2006), which may alter the estimated return to education from a private viewpoint. Allied to this, estimates of the fiscal returns to education are largely ignored within the literature to date. The fiscal return to education can determine the return to government from expenditure on education as the amount of tax paid and social benefits received are related to gross earnings. Fiscal returns in addition to private returns may help frame policy decision making in relation to the financing of education.

There have been a few studies that have attempted to explicitly model net income (gross income + benefits – taxes) into the measure of returns to education. Noonemans and Cortens (1997) use micro tax for Belgium to estimate fiscal and net private returns using an internal rate of return (IRR) method. However, they only incorporate income tax and social contributions, ignoring benefits and other taxes. They also ignore the possible employment effect of education. O'Donoghue (1999) used the European tax/benefit microsimulation model EUROMOD to estimate the marginal fiscal and net private returns to education for four European countries including Ireland, using 1994 tax/benefit rules. While this study did incorporate the possible employment effect of education in its estimations, it did so at the national average level and not at the micro level. Also, it did not account for education related pension income changes. De la Fuente and Jimeno (2009) estimate the private and fiscal returns to education across 14 European countries. This study does incorporate some benefits as its uses unemployment and pension benefits, however, it uses average national wage data to estimate the education impact of gross earnings in place of micro data and assumes each individual is single with no children when applying income tax rates on individuals. The OCED (2008b) has also provided the fiscal and private rates of return for a range of countries. They incorporate an employment effect and income tax effect of extra education similar to that seen in earlier estimates. However, they again use national average tax rates with the assumption that individuals are single with no children and the study does not take into account possible employment effects. Also, these estimates also do not include the educational impact on varying social welfare levels.

In this paper we utilise a microsimulation model to try to capture the fiscal and employment effect associated with education, incorporating the heterogeneity of the population to estimate both the fiscal and net private return to education at a marginal

level for the period 1987-2005 using Irish data. Incorporating the tax/benefit system and labour market participation effects at a micro level may help us arrive at a more accurate estimation of these returns with these techniques never utilised before with respect to educational outcomes.

The next section identifies some possible adjustments and deficiencies within the traditional estimation of the marginal returns to education. A specification of the calculation of each of our returns, attempting to compensate for any possible adjustments or deficiencies is then presented. In the following section we explore the methodologies utilised, including an income generation model. We then present our results for the estimates of the marginal net private and fiscal returns to education. Finally, we conclude the paper.

2 MINCERIAN RETURNS TO EDUCATION: BACKGROUND AND POSSIBLE ADJUSTMENTS

The basic Mincerian earnings approach to estimating the return to education is specified by equation 1 below and pioneered by the work of Becker and Chiswick (1966) and Mincer (1974).

$$LnY_i = \beta_o + \beta_1 S_i + \beta_2 T_i + \beta_3 T^2 + \beta_4 X_i + \nu_i \quad (1)$$

Where Y is an earnings measure (typically gross earnings) for individual i, S is years of schooling and T is the potential labour market experience after education, X is a vector of the individuals personal characteristics and ν is unobserved characteristics. Using OLS techniques from the above specification, the coefficient β_1 can be interpreted as the average rate of return to schooling (See Card 1999; Trotstal et al 2002; Harmon at al 2001 and Harmon et al 2002)

2.1 Possible Adjustments and Deficiencies

Despite their popular use, a number of potential adjustments and/or deficiencies with the earnings functions methodologies involved in measuring the returns to education may be raised.

Firstly, if gross earnings is utilised for Y_i, the non-linear impact of the tax/benefit system and consequential bias in the estimate of private returns is ignored Heckman et al, 200x) with the progressive nature of most tax-benefit systems likely to reduce the private return to education. Some studies, have incorporated the role of the tax system throught the use of net earnings (See Harmon et al 2001; Trostel et al 2002; and Harmon et al 2002). However, this framework does not allow the measurement of fiscal returns.

Similarly, theses studies typically ignore the role of employment effects in measuring the net return to education. The specification of the returns to education in equation 1 assumes that that changes in earnings capture the full benefit of investing in education. This ignores the possible employment effect of education. Nickel (1979)

and Mincer (1991) both show that for Great Britain and the USA respectively, higher levels of education reduces the probability of being unemployed. Therefore, the transition from unemployment to employment resulting from extra education will increase the return to that education. Conversely, the return may close to zero if an individual does not enter or leave the labour market post education.

In placing the focus on earnings as the sole benefit of education, any pension related or financial asset which may be a function of life-cycle earnings are also ignored. As higher education levels are associated with higher earnings it may be plausible to suggest that a higher education may increase an individual's pension income or the probability of having an occupational pension. With respect to financial assets, Soloman (1975) finds that those with higher levels of education may gain some private benefits from having better portfolio management, with a greater probability of holding and seeing higher returns from riskier investments.

The relationship between income, education, employment probabilities and the tax benefit system can be illustrated with a simple equation as illustrated below.

$$Y_n = TB(Y_g) \tag{2}$$

Where

$$Y_g = (p\_Y_e(S) \times Y_e(S) + p\_Y_m(S) \times Y_m(S)) \tag{3}$$

Y_n is net income, Y_g is gross income and TB represents the tax/benefit rules which are dictated to by gross income. However, gross income is dependent on gross earnings (Y_e), whether or not an individual is in work (p_Y_e), other non-work income inflows and outflows (Y_m) and the probability of having such inflows or outflows of income (p_Y_m), all of which are dependent on schooling level S.

While β_1 from equation 1 above is generally presented as the average private return to education within many estimates that use the Mincerian earnings function specification, accounting for factors such as the employment and tax/benefit effects of education may help investigate the net benefits to the individual of extra education.

From equations 2 and 3 above, the employment effect of education effect partially drives the earnings effect and potential other non-labour income may drive with overall income levels which in turn drives the overall gross income education differential. However, the redistributive nature of the tax-benefit system can alter this differential by reducing benefits and higher tax rates as gross incomes rise.

We can use these equations to measure the fiscal return to education. The possible interaction of education and tax/benefit liabilities entail that analysing the changes in taxes and benefits from a change in education relative to the public cost of this extra education can provide an estimate of the return the government receives from investing in education.

Perhaps the most considered critique in measurements of the returns to education stem from potential bias in the OLS estimates using the Mincerian earnings function specification due to endogenity. This bias may come from the error term in equation 26 being correlated with education due to omitting ability as a control in estimations. Instrumental variable (IV) estimates such as those conducted by Harmon and Walker (1995) for the UK show that OLS estimates may be negatively biased as a result. However, Card (2001b) and Harmon et al (2002) acknowledge that some caution must be shown in relying on IV estimates, mainly due to choice of instrument. Also, Callan and Harmon (1999) suggest that OLS estimates are not significantly biased downwards when compared to IV estimates in a study using Irish data and this potential bias is not within the focus of the research presented in this paper.

2.2 Alternative Measures of the Returns to Education

We use a methodology similar to O'Donoghue (1999) to measure the marginal returns to education. This is defined as the ratio of the benefit of a marginal difference in education to the cost of the marginal change in education[1] from both a private and fiscal viewpoint. We first specify the marginal private rate of return as

$$r_{private} = \frac{[((1 - ss_{ee} - t) \times (p\_emp_w \times (Y_{s+1} - Y_s))] + [p\_Ym \times (Y_{ms+1} - Y_s)(1 - t)] + bY_{s+1} - bY_s}{[(1 - ss_{ee} - t) \times (p\_emp_s \times Y_n)] + E_p + bY_n} \quad (4)$$

The numerator here specifies the net benefits to the individual from a marginal change in education. The tax/benefit element is broken down into various elements and the change in earnings from a one year increase in education is highlighted.

Specifically, $Y_{s+1} - Y_s$ is the change in gross earnings from moving from level s education to level s+1 (Y_s is the actual wage without an increase in education level, Y_{s+1} is the gross salary after one more year of schooling). If we assume that gross wage increases with education, then this benefit should be a positive value. However, this may be conditional on the fact an individual is in work and is captured by the term *p_empw* above. If an individual is not in work, either before or after the change in level of education, then this benefit may be zero. We note $Y_{ms+1} - Y_s$ as the change in miscellaneous other incomes and payments that may vary due to changes in education such as income from capital investments, income from an occupational pension and outflows such as pension contributions that may impact the taxable income of an individual. As with earnings, having such income or contributions may also be dependent on education level, a fact captured by the term p_Ym and also may be reduced by any tax on this income tm. The term ss_{ee} is the employee rate of social insurance contributions while t is the income tax rate, all of these will be conditional gross earnings and the probability of being in work, but may also be dependent on other inflows and outflows such as capital income and pension contributions. The term bY_{s+1} are the benefits received at level s+1 of schooling, while bY_s represents

[1] As with O'Donoghue (1999) it is acknowledged that these costs and benefits may not take place at the same time and so an assumption of the discount rate equating to the growth rate may be used for convenience.

the benefits that one might receive with level s of education. These benefits are generally contingent on gross income and include unemployment benefit, pension benefit and child benefit. Again the benefits with schooling level s+1 may be expected to be lower than bY_s in a progressive tax/benefit system, thus lowering the return to the individual.

The denominator of equation 4 represents the costs to the individual of changing from one level of education to another where Y_n = Y'1 - Y'0 is the net wage foregone during schooling (Y'1 is the foregone wage while in education and Y'0 is the wages while a student) and p_emp_s is the probability of being employed while in schooling. The term ss_{ee} is the employee social insurance contribution, t is the income tax rate, all of which will be dependent on Yn. bY_n is seen as the benefits foregone while in education and may include benefits such as unemployment assistance. Ep is the direct private costs involved in moving from one year of education to another and captures only the individual's contribution to this change. The net private IRR is the value $r_{private}$ takes when the ratio of the marginal benefits and marginal costs is calculated.

Next we specify a measure of the marginal return to education from a fiscal viewpoint

$$r_{fiscal} = \frac{[((ss_{ee} + ss_{er} + t) \times (p\_emp_w \times (Y_{s+1} - Y_s)) + [(p\_Ymx(Y_{s+1} - Y_s)) \times t_m] - bY_{s+1} - bY_s}{[(ss_{ee} + ss_{er} + t) \times (p\_emp_s x Y_n)] - bY_n + E_g} \quad (5)$$

It is now the marginal benefits to the state that are the numerator of our equation, with the notation of the terms seen in equation 5 remaining the same. One new term is seen on the benefits side, ss_{er} , representing employer social insurance contributions. As we are now concerned with the state's return, higher employment probabilities, higher earnings and other incomes from a change in education levels may entail higher taxes, social insurance contributions and lower benefits and represent a benefit to the state.

The denominator marginal cost element of the fiscal return to education is much the same as that seen with equation 4 with similar terms involved. However, the term E_g replaces the direct private cost of education and represents the public cost of varying education levels. The fiscal IRR is the value r_{fiscal} when the ratio of the marginal benefits and marginal costs of education to the state is calculated.

3 DATA AND METHODOLOGICAL CONSIDERATIONS

The data used in this paper comes from the Living in Ireland survey. This survey is a household panel dataset which ran from 1994 to 2001. It contains a variety of income, social, demographic and labour market variables at the individual and household levels. The sampling frame for the survey comes from the electoral register in Ireland with the original sample size of 4,048 interviewed households, with over 14,000 individuals in these households. Like any other panel dataset attrition was a problem and by the final wave the number of interviewed households fell to 2,865, with just over 9,000 individuals in the final wave. The data is weighted to reflect independent

population estimates and to correct for possible attrition[2]. It also includes information on individual's highest level of education completed in the following categories.

- Higher degree
- Primary degree
- Diploma or equivalent
- Post Leaving Certificate courses
- Leaving certificate (State exam at the end of 2nd level education)
- Junior or Intermediate certificate (State exam after 3 years of 2nd level education)
- Some 2nd level, no exams
- Primary certificate
- No education beyond primary

For the purpose of estimating the marginal returns to education, the above education attainment variables have been transformed to the number of years of education and are described in table 1a[3]. The distribution of the education level in the seventh wave of the data (the wave to be specifically used in our analysis) is described in table 1b.

To estimate the marginal rates of return to education from a net private and fiscal viewpoint at a micro level, a detailed breakdown of the possible tax/benefit implications of varying incomes levels is needed. This is achieved using a tax/benefit static microsimulation model that applies all tax and benefit rules on an individual or household based upon their gross income (or the gross income of the household) for Ireland for the years 1987-2005. The tax/benefit rules in Ireland from 1987-2005 are simulated upon the 2000 population of our data with the income levels of individuals and households are scaled up or down by a GDP deflator depending on the year of tax/benefit rules being applied to the data[4]. Static microsimulation models such as this have been developed to analyse complex interactions at the micro level, especially the impact of tax and social benefit systems on individuals and households with model developed for the UK (POLIMOD), the USA (TRIM), Canada (SPSD) and Australia (STINMOD)[5] and for Ireland with the SWITCH model of the ESRI (Callan, et al 1996).

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[2] For more details on this data please see Flannery and O'Donoghue (2009).

[3] As a note of caution, these transformations are purely approximate as they do not allow for variation in the number of years to complete, however, we have opted on the conservative side if the number of years for each level can vary.

[4] A key aspect involved in using a tax/benefit microsimulation model is to provide validation of the simulated results, the results or our model are broadly in line with the similar validation measures undertaken for the Irish component of EUROMOD (Callan et al, 2005) and can be provided upon request to the author.

[5] See Merz (1991) and Gupta and Kapur (2000) for a description of these particular models.

As this paper uses the tax/benefit systems from 1987 to 2005 for Ireland, table 2 illustrates the main changes in the system between these years to provide some indication of how our measures of the returns to education may vary across the tax/benefit years. In general across our reference period table 3 shows that Ireland experienced falling income tax rates combined with more generous social benefits. With respect to the returns to education to be estimated, this may suggest a falling of tax on human capital accumulation, benefiting the individual and costing the state.

3.1 Estimating Direct Costs and Indirect Costs of Education

To gauge the private and public costs of education we use per student expenditure by education level the OECD for the years 1997-2008, adjusted from US$ to Euro and purchasing power parity. To separate the burden of this cost across private/public delineation we multiply by the public/private share (OECD, 1997-2008). A summary of these costs for each year is seen in table 4[6].

The private and public expenditures are both increasing in absolute levels in nearly every year across all education levels[7], however, public expenditure increases at a higher rate than private expenditure. Public expenditure on tertiary education more than doubles over the period 1987-2005, while private expenditure shows only a small increase. The same can be seen to a lesser extent from both primary and secondary education. This may result in decreasing fiscal returns to investing in education throughout our reference period as the public cost increase substantially across all education levels.

The indirect costs of education vary depending on which type of return is being estimated. However, they all are related to the foregone earnings cost expressed by the term Y_n in equations 4 and 5. This term is derived in this study using age-earnings and employment profiles of cohorts for different education levels. Utilising this we are then able to calculate the foregone costs in terms of the fiscal, private and social.

To calculate Y_n for different education levels we first assume that foregone earnings are zero for an individual that currently has primary level education. This suggests that if this individual had a marginal increase in education, the earnings they would forego would be zero. For the rest of the population we specify four labour states an individual may be in:

1. In employment and not attending education
2. Unemployed,
3. Part-time employment and attending education,
4. Attending education full time with no employment.

[6] As no expenditure figure and the public/private breakdown of this expenditure could be obtained from the OECD for 1987 and 1996 for Ireland, the 1987 figure is the 1994 figure multiplied by a GDP deflator in order to calculate this figure while the 1996 figures are calculated in a similar fashion using the 1997 figures available.

[7] Expenditure levels are also seen to increase in constant terms across the period but are not presented, see OECD (2010) for more details.

As the level of the opportunity cost an individual faces may vary by which level of education they are undertaking, we next identify the individuals in the sample that have indicated lower secondary as their highest level of education complete and are aged between 16 and 17. We also identify the individuals in the sample that have upper secondary as their highest level of education complete and are aged between 17 and 18. Finally we obtain a sample of individuals that have tertiary education as their highest level complete and are aged between 21 and 22. We segment each of these respective samples into the four education/labour states these individuals indicate they are in. To obtain the term Y_n from equations 4 and 5 (which can also be seen as Y'1 - Y'0) we use cross sectional weighted averages of earnings of the population of those in work and not in education from each of the three education/age cohorts we have specified. This gives us the term Y'1 (earnings foregone while in education) for three separate education levels. We also get the weighted average earnings of the individuals in the sample that go to full time education and work part time to arrive at the term Y'0. This is then performed across the three cohorts we have with the varying age and education levels. This gives us a foregone earnings term for both lower and upper secondary education and tertiary education. A similar methodology is used to obtain terms for the foregone taxes, benefits and social contributions needed for an accurate estimate of the foregone costs from a fiscal and private stance. With regards to taxes and social contributions we can view this as $T_1 - T_0$, $ss_{er1} - ss_{er0}$, $ss_{ee1} - ss_{ee0}$ where the subscript 1 relates to the average income tax, employer social contribution and employee social contribution for an individual in work and not in education, again this is performed across our three cohorts separately. The terms denoted with the subscript 0 signify the average income tax, employer social contribution and employee social contribution in our sample for those in education and working part time. The foregone benefit term $b[Y_n]$ from equations 4 and 5 is derived in much the same way as above with the average benefit received from those in work reduced by the average benefit received by individuals while in education and in work. This gives us the terms needed to calculate each of the costs needed to calculate the measures of return to education from a fiscal and net private aspect.

3.2 Simulating a Marginal Change in Education Using an IGM Model

Given the tax/benefit microsimulation model and costs outlined above, the next methodological consideration for estimating the private and fiscal returns is the impact of a marginal increase in education upon gross income. As equation Xx above illustrates the gross income of an individual is the sum of a range of different factors including gross earnings. Given the role education may have in shaping a variety of different facets of gross income an income generation model (IGM) is also utilised to capture the variations in this income that may come about from a marginal change in education.

The IGM model forms its origins from the work of Oaxaca (1973) and is described in detail in Bourguignon, Ferreria and Lustig (2005) and Bourguignon et al (2003) and has been used to assess the redistributive impact of economic change in developing countries. More specifically, they use a series of reduced form models which include; labor force participation models, employee earnings models, self-employed earnings models and capital earnings models to help calculate the distribution of total

household income for East Asian and Latin American countries. The methodology employed involves modelling the incomes and choice outcomes of individuals using various econometric regressions with residuals being interpreted as individual fixed effects. Simulations can then be performed based on the deterministic estimations of these choice outcomes and incomes.

We wish to model the impact of years of education on various outcomes that may have an eventual influence on the gross income level and hence the tax/benefit situation of a household/individual. For the sake of simplicity we limit ourselves to two econometric specifications for our IGM estimations. Logit models were used when faced with a binary choice situation while OLS regressions were employed in the case of continuous dependent variables.

With the former estimation procedure we use the binary decision of labour force participation as an example of the methodology used. In our model this is a discrete choice, with an individual either participating in the labour force or not, whereby you are in the labour force if you have some form of working income and are over the working age (>=16). We represent this with equation 6 below

$$IW_i = \alpha + \beta X_i + \varepsilon_i > 0 \qquad (6)$$

Where IW_i is a binary variable equal to unity if individual i if earning some form of income or zero otherwise. Individuals chose between the two according to some criteria the value of which is specific to the alternative. The option with the highest criterion value is selected. The criterion value associated with non participation in the labour market is set to zero, whereas the value of being in work is a function of intercept α, individual characteristics βX_i and unobserved effects ε_i. An individual will prefer work if the value of the criterion associated with that activity is higher than that associated with inactivity which we have set as zero. This is the situation represented in equation 6 above. The opposite can also be true, if the criterion associated with being in work is less than zero, then the individual will prefer inactivity. The terms α and βX_i can be estimated simply using the logit model estimations. For the unobserved fixed effects ε_i are drawn randomly from the relevant distribution[8]. This methodology is employed for a range of binary choice model outcomes that may alter the tax/benefit situation of an individual or household, the full list of these can be seen in table 5.

To illustrate the methodology used in the context of continuous income variables we take the example of employee earnings. This can be represented by equation 1 seen previously where the logarithm of employee earnings of individual i LnY_i is a function of his/her years of education S_i, labour market experience T, personal characteristics X_i and unobserved characteristics ν_i. This is viewed as estimating the relationship between gross employee earnings and years of education. The relevant coefficients and residual terms can be estimated using ordinary least squares regression on a sample of individuals that are seen to draw their income from being in

[8] See Bourguignon et al (2003) for more details on this process

employment. For non-working individuals in the base data, ν_i is missing. We sample from the relevant distribution to get an estimate of ν_i for this group

In our estimations an attempt was made to keep the explanatory variables for the various estimations consistent with one another where appropriate with years of education, regional dummies, age and its square and martial status some of the regressors included. Separate estimations for all the models were run for males and females and all estimations are presented in appendix A of the paper. We briefly note that employee earnings, self employee earnings the probability of being in work are positively related to the years of education obtained and the other estimations do behave as expected with regard to education.

3.3 Simulation using the IGM and Tax/benefit models

From the deterministic part of each model we simulate the impact of an extra year of education on each of the outcomes from table 5. To simulate an extra year of education we simply hold all estimates constant with the exception of the years of education explanatory variable which is allowed to increase by one year for all individuals. This simulated change may shift individuals from previous states, such as being out of work, to being in work by adjusting the criteria value we saw above in equation 6[8]. If this occurs and the individual now satisfies the stipulated criteria, their status is changed. This then feeds into estimates of income levels such as employee income, if the individual is found to have moved into work, they are now assigned some level of work income (employee, self-employed or farm income) based upon our previous OLS estimations with unobserved characteristics ν_i treated as fixed effects.

When the simulation is complete we now have two datasets. We have the base 2000 data and the 2000 data with a simulated increase in education, the latter incorporating the various changes this increase may bring about such as higher gross earnings and more individuals in work. These can be used as inputs into the static tax/benefit microsimulation module outlined above to arrive at our two measures of the marginal returns to education. Tax/benefit microsimultion models, by simulating tax liabilities and benefit entitlements, can estimate the net impact of government policies on an individual. A Tax/benefit microsimulation model can thus be described in mathematical terms as follows:

$$Y^n = f(Y_{i,j}, G_{k,j}, X_j \mid \forall\, i \in I, \mid \forall\, k \in K, \forall\, j \in H) \qquad (7)$$

where $Y_{i,j}$ is the set of exogenous incomes i, such as wages, self employment income, investment income and other incomes for individuals j in household H. $G_{k,j}$ is the set of government incomes, k simulated in the model, such as pension and unemployment benefits. X_j is the vector of other characteristics such as marital status, employment status, number of children, number of years of education etc. Using the output of the IGM model combined the simulated taxes and benefits we obtain a 'before and after' picture of all of these exogenous incomes and government incomes with respect to a marginal change in education, thus providing us with the platform to estimate the fiscal and net private return to education as outlined in equations 4 and 5.

4 EMPIRICAL RESULTS

The results of the average marginal fiscal and net private return to education for Ireland using the 1987-2005 tax/benefit rules are presented in table 6. We analyse our results in a number of different ways, first comparing the results across the varying tax/benefit rules.

4.1 Marginal Rates of Return across Varying Tax/Benefit Rules

Looking at the various measures of returns as we vary the tax/benefit rules and the cost of education in Ireland we see there is a decline in the fiscal return to education as we move from the 1987 rules and education cost structure up to the 2005 scenario. From table 6 we see the fiscal return at its highest under the 1987 tax/benefit rules at 8.9%, however, this falls in every year of our analysis to stand at 6.9% by 2005. The net private return to education trends in the opposite direction, increasing from 9.0% with the 1987 tax/benefit rules, to a high of 11.1% with the 2005 system. As the movement across the period 1987-2005 here is the result of variations in the tax/benefit rules and higher education cost structures, it can be suggested that across this time period the tax and cost burden placed on extra education has been reduced to such an extent that it has helped increase the return to the individual from education while at the same time reducing the state's return.

The results from the private return to education would seem to be in line with Callan and Harmon (1999) who use the gross earnings of workers in Ireland to estimate the private returns to education in Ireland using an earnings function approach with data from 1987 and find a marginal private rate of return to year of schooling of between 7%-10%[9]. Therefore it may be suggested that incorporating the tax/benefit and employment effects of a marginal increase in education may nullify each other and bring out estimates close to the simple gross earnings estimates. O'Donoghue (1999) showed a fiscal and net private return to education for Ireland of 5.3% and 14.4% respectively using 1994 tax/benefit rules with 1987 data, indicating our estimates using the 2000 dataset slightly higher with respect to the fiscal return and lower with respect to the net private return. However given the differences in methodological approaches between the two papers it is difficult to draw any firm reasoning for such a divergence.

McGuinness et al (2008) show decreasing marginal private returns across the 1990's for Ireland using gross earnings data while our results show an increasing trend. This may be explained by the fact the McGuinness study uses different sample populations in its estimates and so the varying returns to education within this study are driven by labour market/macro economic affects. The increasing returns to education presented within our study are solely as a result of policy changes with regard to tax/benefit rules and education cost structures with the sample population constant. The contradicting results may indicate that incorporating the tax/benefit system within estimates of the returns to education over time for Ireland may offset some of the possible reductions in the private return to education due to the shifting

[9] This paper uses both OLS and IV methods in their calculations

education/earnings distribution that may have occurred across the period[10]. It is clear that the variations in the tax/benefit system over our reference period have combined to reduce the state return to education, perhaps suggesting a move towards placing the financial burden of education on the individual may be warranted. While the issue of education financing is particularly focused towards third level education in Ireland, a more generous tax/benefit system, combined with a falling fiscal return to education seen in table 6 suggests that more of the financial burden of education should be placed upon the individual and away from the state. It must be noted that the results here are only estimated for a general marginal change in education (not just higher education) but may still be informative to the policies surrounding higher education finance.

4.2 Marginal Rates of Return Broken Down by Various Components

Due to the simulation process involved in constructing the marginal benefits of the various returns to education it is relatively simple to breakdown these estimates by the various benefits that drive them. This is seen in tables 7 to 8, with various estimates of the marginal private and fiscal returns presented by segmenting the components of the numerator (benefits) for each return. The cost element is held constant across these estimates for each respective tax/benefit year, and is the same denominator for each respective return seen in equations 4 and 5. This may help establish the particular elements of the tax/benefit changes from 1987-2005 that drove the varying private and fiscal returns to education. Also, as the cost element varies from 1987-2005, this procedure may also allow us to comment on the impact of varying costs on the returns estimated.

The return to the individual is initially presented under the scenario of no tax/benefit system in place, no employment effect and no pension or capital income effect of a change in education. Therefore column A of table 7 represents the marginal private return with the benefits only stemming from the change in earnings a marginal change in education may bring about. As the marginal benefit within the sample for this measure will remain constant, the varying return to the individual across 1987-2005 seen in table 7 can be explained by the variations in the marginal cost to the individual. The marginal costs consists of the direct and indirect costs, however, given the methodology in constructing the indirect costs of education from a private viewpoint, these will remain relatively constant across the varying tax/benefit years. This, allied to the magnitude of the changes in column A from table 7 as we move from 1987-2005 suggest that the variations in direct private costs of education across these years have a relatively small positive impact on the private return.

As we move across columns in table 7 more components of the marginal benefit to education are added while the marginal cost remains constant. This illustrates that the return to the individual rises as the pension and capital income effects of changes in education are accounted for, while this return falls as variations in taxes, benefits and employee SIC are included. We can see from the magnitudes of these changes that

[10] Although not presented within this paper for parsimony, the authors have estimated the fiscal and net private return to education across the 1987-2005 tax/benefit rules using the 1994 wave of the Living in Ireland dataset with the results supporting this viewpoint of a decreasing marginal private return to education due to labour market variations but an increasing marginal private return due to tax/benefit and education polices.

the initial earnings effect, the role of taxes and the employment effect have the greatest influence in determining the final estimate we have for the private return to education. Private pension income is also seen to have a substantial impact on the return to the individual, while SIC's and capital income effects are relatively small. As we vary the tax/benefit year analysed we see that the negative impact of taxes on this return falls substantially as we move towards the tax/benefit rules of 2005, suggesting changes in the tax system in Ireland have played a significant role in increasing the marginal net private return to education. While the impact of incorporating changes in social benefits and SIC's on this return falls over the period 1987-2005, they are not as substantial as those seen for income tax.

It is also noticeable from the estimates in table 7 that the inclusion of the tax/benefit system drives the private return to education below the estimate when using only the earnings effect, as seen by comparing the estimates given in column A and column F. It is the employment effect of a marginal increase in education that drives this return over and above the basic return. Given the fact most studies of the private rate of return to education only account for the earnings effect of education (usually only the earnings of employees) in their estimates, our results illustrate the wide variation in these estimates that may occur, given the various other components that may be included in their estimation.

The various components of the marginal fiscal returns for the respective samples are seen in table 8. They are presented in a similar fashion to that seen for the private returns above, with different measures of the fiscal return estimated as more components of the marginal fiscal benefit are added (as we move across columns to the right in table 8). This is again estimated with a constant cost within tax/benefit years. Column A illustrates the fiscal return will be zero if the tax/benefit system is ignored within estimates of the fiscal returns to education, as is the case with most of the prevailing literature. However, as we add different elements of the tax/benefit system we see the fiscal return rise. The results indicate that it is the increase in income tax revenue that forms the most substantial element of the marginal benefit to the state from a marginal change in education. The employment effect[11] also has a significant impact while the role of varying benefits and SIC is relatively small. We also note that the tax component of the fiscal returns is falling as we move from 1987 to 2005. This illustrates the falling tax rates and also the increasing marginal cost for the state due to higher public financing of education through these years.

5 CONCLUSION

The main focus of empirical estimates of the rate of return to education has focused upon the return to the individual based upon the relationship between gross earnings and education. The incorporation of the tax/benefit system, possible employment effects and other transitions brought about by a change in education that may impact the returns to education has largely been ignored. The return to the state emanating from this relationship between education, gross income and the tax/benefit system

[11] The employment effect in this instance incorporates the increase in taxes, SIC and reduction in benefits brought about by those that move from inactivity to in-work from the marginal increase in education.

have also not featured heavily in studies concerning the returns to education. Studies that have attempted to estimate these returns to education have done so using national representation of tax/benefit systems and may not have fully captured the full effects of a marginal increase in education. In this paper we show that microsimulation techniques can be utilised to estimate a marginal net private and fiscal return to education at the micro level, while also facilitating an analysis of the key components of the tax/benefit system that influence these measures. This is illustrated for Ireland for the period 1987-2005.

Within the empirical results we find that the average marginal net private rate of return to education in Ireland has increased as the tax/benefit rules have moved from 1987-2005. We also find that the average marginal return to the state has fallen over the same period. This indicates that a more generous tax/benefit system, combined with a greater state burden of the cost of education may have helped increase the individual's return to education, while reducing the state return from investing in education. The results also show that the employment effect and the role of income taxes can have a huge positive impact on the return to the individual. The marginal fiscal return to education also largely consists of these two particular effects, with the role of varying benefits and SIC's having a minor impact on the return to the state.

From a methodological viewpoint, the techniques presented here could be utilised internationally given the fact that many countries have static micro tax/benefit models already established. Variations in tax/benefit policy across time could then help shape education policy by comparing the state versus private return. Also, using larger datasets could also help develop the methodology behind these estimations, to help correct for any possible endogeneity bias present.

TABLES AND FIGURES

Table 1a: Transformation of the education variables for Living in Ireland survey.

Level of education attained	Number of years taken
No Education beyond Primary	6
Primary Cert. Or equivalent	8
Some 2nd. Level	9
Junior or Inter Certificate.	11
Leaving Certificate.	13
Post Leaving Certificate	14
Diploma	15
Primary Degree	16
Higher Degree	18

Source: Living in Ireland Survey

Note: These figures are approximations. The numbers denoted here are the typical times taken to achieve that qualification.

Table 1b: Distribution of years of education for Ireland (Sample: those aged over 16 not in full time education)

Number of years taken of education	Proportion of Sample
6	4.08%
8	11.71%
9	8.02%
11	21.27%
13	26.59%
14	4.83%
15	9.98%
16	7.53%
18	5.98%

Source: Living in Ireland Survey (2000)

Table 2: Average monthly labour income, simulated income tax and simulated benefits for Ireland by years of education (Sample: those aged over 16 not in full time education)

	Number of years taken of education								
	6	8	9	11	13	14	15	16	18
Average monthly labour income (€)	86.6	253.9	369.2	668.3	687.5	778.4	1084.0	1242.5	1804.8
Average monthly Simulated income tax (€)	12.0	44.1	57.6	104.0	114.7	111.7	203.7	288.7	450.5
Average monthly Simulated benefits (€)	385.7	341.6	261.5	170.2	92.12	73.0	66.6	59.4	61.2

Source: Living in Ireland Survey (2000)

Table 3: Individual Social Welfare Amounts and Income Tax Rates in Ireland 1987-2005

Scheme	1987(€)	1994(€)	2000(€)	2005(€)
Social Insurance	53.72	74.47	98.42	148.8
Unemployment Benefit	69.97	90.17	121.92	179.3
Contributory Old age Pension	0	0	112.4	163.7
Carer's Benefit	53.72	77.47	98.42	148.8
Disability Benefit	53.72	74.47	98.42	148.8
Social Assistance				
Non-Contributory Old age Pension	59.82	77.47	108.58	166
Lone Parent Allowance	73.4	74.47	98.42	148.8
Unemployment Assistance	48	74.47	98.42	148.8
Child Benefit	19.11	25.4	43.82	131.6
Tax Rates				
Rate 1	35%	27%	22%	20%
Rate 2	48%	48%	44%	42%
Rate 3	58%	.	.	.

Source: Department of Social and Family Affairs (1998, 2001 and 2006).
Note: Social welfare amounts are in current prices converted to Euro using the Euro/IR punt exchange rate where necessary

Table 4: Expenditure per student in 1987-2005 by level of education and public/private share

Year	Primary		Secondary		Tertiary	
	Private (€)	Public (€)	Private (€)	Public (€)	Private (€)	Public (€)
1987	59	1425	96	2319	1620	3780
1994	68	1629	110	2651	1851	4321
1995	71	1700	112	2692	1796	4191
1996	63	2037	95	3058	1827	4698
1997	66	2138	99	3210	1918	4933
1998	75	2434	107	3488	2103	5687
1999	82	2676	120	3886	2387	6455
2000	129	3111	177	4263	2228	8384
2001	186	3551	261	4976	1498	8491
2005	187	5668	245	7419	1711	8986

Source: OECD, 1997-2008

Note: all the figures presented here are in current prices

Table 5: List of Estimations Performed in Income Generation Model

Model Estimated	Specification	*Sample*
Is an individual in work or out of work?	logit	*those >=16 years of age and not in education*
Are those that are in work in employed work or not	logit	*those >=16 years of age, not in education and in work*
Whether those out of work are retired or not	logit	*those >=50 years of age and out of work*
Whether those out of work are classed as unemployed or not	logit	*those >=16 and <=64, years of age, not in education, out of work and not retired*
Whether those out of work receive invalidity benefit	logit	*those >=16 years of age, not in education, and out of work*
Whether those receiving invalidity benefit are receiving the short term or long term benefit	logit	*Those >16 years of age and receiving some form of invalidity benefit*
Are employees in public service or not?	logit	*those >=16 years of age, not in education, in work and employed*
The no. of hours worked by an individual	OLS	*those >=16 years of age, not in education and in work*
Whether an individual has an contributory pension or not	logit	*those >=65 years of age and not in work*
Whether an individual has occupational pension income or not	logit	*those >=65 years of age and not in work*
The level of income from an occupational pension income	OLS	*Those >=65 years of age and in receipt of occupational income*
Whether an individual is contributing to an occupational pension	logit	*Those >=16 and <=65 years of age and working as an employee*
The level of occupational pension contributions	OLS	*Those >=16 and <=65 years of age and contributing to an occupational pension*
The level of employee earnings	OLS	*All those >=16 years of age, not in education, in work and employed*
The level of self employed earnings	OLS	*those >=16 years of age, not in education, in work and self employed (not farming)*
The level of farming income	OLS	*those >=16 years of age, not in education, in work and in farming*
Whether an individual has capital income or not	logit	*those >=16 years of age and not in education*
The level of capital income	*OLS*	*those >=16 years of age, not in education and with capital income*

Table 6: Average net private and fiscal marginal returns to education for Ireland with tax benefit years 1987-2005

Tax/benefit Year	Private	Fiscal
1987	9.0%	8.9%
1994	9.3%	8.4%
1995	9.7%	8.7%
1996	9.8%	8.3%
1997	9.9%	8.2%
1998	10.4%	7.7%
1999	10.0%	7.5%
2000	11.2%	6.2%
2001	11.1%	6.3%
2005	11.1%	6.9%

Source: Author's Calculations – *Living in Ireland Survey*, (2000).
Note: This sample includes all those aged over 16 and not in full time education

Table 7: Average net private marginal returns to education segmented by various components

Tax/benefit Year	Earnings A	+ pensions B	+ capital income C	+ taxes D	+benefits E	+SIC F	+employment effect G
1987	9.6%	12.7%	12.8%	6.8%	6.3%	6.0%	9.0%
1994	9.0%	11.9%	12.0%	7.0%	6.6%	6.3%	9.3%
1995	9.3%	12.3%	12.4%	7.2%	6.8%	6.5%	9.7%
1996	9.3%	12.3%	12.4%	7.2%	6.9%	6.6%	9.8%
1997	9.3%	12.3%	12.4%	7.2%	6.9%	6.7%	9.9%
1998	9.4%	12.5%	12.6%	7.6%	7.2%	7.0%	10.4%
1999	9.1%	12.1%	12.2%	7.2%	6.8%	6.6%	10.0%
2000	9.6%	12.7%	12.8%	8.2%	7.8%	7.6%	11.2%
2001	9.2%	12.1%	12.2%	8.1%	7.7%	7.5%	11.1%
2005	9.3%	12.3%	12.4%	8.1%	7.6%	7.5%	11.1%

Source: Author's Calculations – *Living in Ireland Survey*, (2000).
Note: SIC indicates social insurance contributions

Table 8: Average fiscal marginal returns to education segmented by various components

Tax/benefit Year	Earnings A	+taxes B	+benefits C	+SIC D	*+employment effect* *E*
1987	0.0%	5.5%	6.1%	6.9%	*8.9%*
1994	0.0%	5.2%	5.8%	6.6%	*8.4%*
1995	0.0%	5.6%	6.1%	6.9%	*8.7%*
1996	0.0%	5.9%	6.3%	6.6%	*8.3%*
1997	0.0%	5.9%	6.3%	6.5%	*8.2%*
1998	0.0%	5.3%	5.7%	6.0%	*7.7%*
1999	0.0%	5.4%	5.7%	6.0%	*7.5%*
2000	0.0%	4.4%	4.7%	5.0%	*6.2%*
2001	0.0%	4.5%	4.8%	5.1%	*6.3%*
2005	*0.0%*	*4.9%*	*5.3%*	*5.6%*	*6.9%*

Source: Author's Calculations – *Living in Ireland Survey*, (2000).
Note: SIC indicates social insurance contributions

Appendix: Income Generation Model Selected Estimations

Results of in/out of work logit model

Variables	Males		Females	
In/out of work dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.11	0	0.20	0
Marriage Dummy	0.10	0.20	-0.091	0.26
No. of Children	0.17	0	.019	0.543
Dublin	-0.15	0.17	0.327	0.004
Mid-Eastern region	0.009	0.94	0.16	0.242
Midlands region	0.38	0.008	0.18	0.209
Mid-West region	0.064	0.63	0.273	0.051
South-East region	0.227	0.06	0.423	0.001
South-West region	-0.466	0	-0.092	0.453
Western region	-0.016	0.89	-0.13	0.35
Potential Experience	0.058	0	0.056	0
Potential Experience^2	-0.0012	0	-0.0015	0
Chronic Illness Dummy	-1.38	0	-1.67	0
Constant	-1.7	0	-3.13	0
Observations	5352		Observations	5318
R-squared	0.166		R-squared	0.15

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The in/out of work dummy is specified with 1 = in work and 0 = out of work
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The Chronic illness dummy is specified with 1 = having a chronic illness and 0 = not having a chronic illness
Note: The border region of Ireland is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of employed work logit model

Variables	Males		Females	
Employment dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.06	0.001	-0.024	0.54
Marriage Dummy	0.29	0.03	0.014	0.95
No. of Children	-0.29	0	-0.13	0.23
Dublin	0.87	0	1.00	0.003
Mid-Eastern region	0.25	0.22	0.48	0.20
Midlands region	-0.059	0.77	0.18	0.64
Mid-West region	0.11	0.57	0.64	0.11
South-East region	-0.0005	0.99	-0.22	0.47
South-West region	-0.1	0.58	0.36	0.29
Western region	-0.21	0.28	0.33	0.38
Potential Experience	-0.04	0	0.017	0.43
Potential Experience^2	-0.0002	0.33	-0.001	0.006
Constant	1.62	0	3.07	0
Observations	2279		Observations	1988
R-squared	0.15		R-squared	0.07

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The employment dummy is specified with 1 = employed and 0 = not employed
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of retirement logit model

Variables	Males		Females	
Retirement dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.07	0.01	0.1	0
Marriage Dummy	0.61	0.002	-1.32	0
No. of Children	0.06	0.81	-0.27	0.23
Dublin	0.085	0.77	0.036	0.88
Mid-Eastern region	-0.71	0.04	-0.14	0.68
Midlands region	0.162	0.68	-0.44	0.21
Mid-West region	-0.36	0.3	-1.1	0.01
South-East region	-0.34	0.31	-0.03	0.9
South-West region	-0.71	0.01	0.2	0.2
Western region	-0.31	0.3	-0.05	0.86
Potential Experience	0.6	0	0.57	0
Potential Experience^2	-0.004	0	-0.004	0
Constant	-19.86	0	-19.1	0
Observations	1126		Observations	1582
R-squared	0.36		R-squared	0.17

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The retirement dummy is specified with 1 = retired and 0 = not retired
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of unemployment logit model

Variables	Males		Females	
Unemployment dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	-0.18	0	-0.07	0.07
Marriage Dummy	-0.42	0.05	-1.17	0
No. of Children	0.17	0.05	-0.14	0.25
Dublin	-0.37	0.12	-1.09	0.001
Mid-Eastern region	-0.67	0.04	-0.38	0.27
Midlands region	-0.96	0.02	-0.5	0.18
Mid-West region	-0.21	0.49	-0.27	0.43
South-East region	-0.032	0.9	-0.31	0.34
South-West region	-0.44	0.08	-1.22	0.001
Western region	-0.43	0.16	-0.9	0.01
Potential Experience	0.06	0.001	0.044	0.07
Potential Experience^2	-0.001	0.005	-0.001	0.02
Constant	0.036	0.93	-1.02	0.06
Observations	1750		Observations	2403
R-squared	0.05		R-squared	0.09

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The Unemployment dummy is specified with 1 = Unemployed and 0 = not unemployed
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of public sector woker logit model

Variables	Males		Females	
Public sector dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.19	0	0.23	0
Marriage Dummy	0.54	0.001	0.23	0.10
No. of Children	-0.03	0.63	0.17	0.004
Dublin	0.26	0.14	0.14	0.42
Mid-Eastern region	-0.23	0.28	-0.38	0.09
Midlands region	0.31	0.16	-0.091	0.71
Mid-West region	-0.11	0.61	-0.15	0.49
South-East region	-0.52	0.02	-0.19	0.37
South-West region	-0.34	0.1	-0.25	0.22
Western region	-0.09	0.67	-0.037	0.87
Potential Experience	0.069	0	0.038	0.01
Potential Experience^2	-0.0007	0.01	-0.0004	0.18
Constant	-5.12	0	-5.02	0
Observations	2606		Observations	2201
R-squared	0.11		R-squared	0.05

Source: Author's Calculations – *Living in Ireland Survey*, (2000)

Note: The public sector dummy is specified with 1 = in work in the public sector and 0 = not in work in the public sector

Note: The marriage dummy is specified with 1 = married and 0 = not married

Note: The border region is used a the base category for the regionally dummies

Note: The sample specifications are outlined in table 5

Results of invalidity benefit logit model

Variables	Males		Females	
Invalidity benefit dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	-0.28	0	-0.25	0
Marriage Dummy	0.05	0.8	-0.76	0
No. of Children	-0.23	0.08	-0.29	0.02
Dublin	0.32	0.26	0.5	0.15
Mid-Eastern region	0.33	0.35	0.78	0.05
Midlands region	0.45	0.2	0.67	0.10
Mid-West region	-0.12	0.77	0.71	0.09
South-East region	0.39	0.23	0.15	0.73
South-West region	-0.22	0.48	0.39	0.3
Western region	0.13	0.71	0.64	0.12
Potential Experience	0.17	0	0.175	0
Potential Experience^2	-0.003	0	-0.003	0
Constant	-1.5	0.009	-1.5	0.006
Observations	2569		Observations	3323
R-squared	0.16		R-squared	0.14

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The invalidity benefit dummy is specified with 1 = in receipt of invalidity benefit and 0 = not in receipt of invalidity benefit
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of Short term Invalidity benefit logit model

Variables	Males		Females	
Short term invalidity benefit dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.13	0.053	0.173	0.008
Marriage Dummy	0.53	0.26	0.19	0.63
No. of Children	0.53	0.022	0.44	0.12
Dublin	0.27	0.63	-0.67	0.3
Mid-Eastern region	0.14	0.83	-0.86	0.27
Midlands region	0.19	0.79	-2.2	0.01
Mid-West region	-0.48	0.48	-0.04	0.95
South-East region	-0.26	0.69	-0.71	0.37
South-West region	-0.41	0.53	-1.04	0.14
Western region	0.083	0.9	-1.055	0.17
Potential Experience	-0.039	0.42	-0.04	0.33
Potential Experience^2	-0.00006	0.94	0.0005	0.44
Constant	-1.1	0.31	-0.8	0.46
Observations	202		Observations	164
R-squared	0.14		R-squared	0.13

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The Short term invalidity benefit dummy is specified with 1 = in receipt of short term invalidity benefit and 0 = not in receipt of short term invalidity benefit
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of Hours Worked OLS model

Variables	Males		Females	
Log weekly working hours	Coefficient	p-value	Coefficient	p-value
Years of Education	-0.0018	0.42	0.015	0
Marriage Dummy	0.03	0.08	-0.064	0.002
No. of Children	-0.0064	0.34	-0.057	0
Dublin	0.027	0.1	-0.051	0.05
Mid-Eastern region	0.065	0	-0.011	0.73
Midlands region	0.037	0.13	0.0058	0.86
Mid-West region	0.052	0.03	-0.02	0.53
South-East region	0.023	0.30	0.009	0.77
South-West region	-0.021	0.32	-0.013	0.65
Western region	0.011	0.62	-0.009	0.78
Potential Experience	0.0062	0	-0.003	0.08
Potential Experience^2	-0.0001	0	3.86E-05	0.4
Constant	3.62	0	3.41	0
Observations	2058		Observations	1678
R-squared	0.04		R-squared	0.08

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of contributory pension income logit model

Variables	Males		Females	
Contributory pension income dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	-0.06	0.02	-0.06	0.04
Marriage Dummy	0.21	0.24	-0.53	0.01
Duration in Work	0.006	0.35	0.031	0
Dublin	1.01	0	0.31	0.29
Mid-Eastern region	0.31	0.36	-0.43	0.35
Midlands region	-0.3	0.38	-0.73	0.11
Mid-West region	-0.39	0.29	-0.46	0.32
South-East region	0.1	0.56	-0.43	0.22
South-West region	0.06	0.8	-0.62	0.08
Western region	-0.44	0.13	-0.41	0.26
Age	-0.07	0.79	0.1	0.75
Age^2	0.0002	0.88	-0.00097	0.67
Constant	3.53	0.73	-3.57	0.78
Observations	760		Observations	827
R-squared	0.05		R-squared	0.7

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The contributory pension income dummy is specified with 1 = have contributory pension income and 0 = do not have contributory pension income
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of occupational pension income logit model

Variables	Males		Females	
Occupational pension income dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.18	0	0.15	0
Marriage Dummy	0.077	0.7	-0.63	0.01
Duration in Work	0.026	0	0.044	0
Dublin	1.4	0	0.81	0.03
Mid-Eastern region	0.26	0.49	0.37	0.48
Midlands region	0.65	0.08	0.13	0.8
Mid-West region	0.4	0.29	0.31	0.54
South-East region	0.37	0.26	-0.17	0.71
South-West region	-0.18	0.58	-0.02	0.95
Western region	-0.16	0.65	-0.14	0.77
Age	0.2	0.51	0.57	0.14
Age^2	-0.001	0.42	-0.0039	0.13
Constant	-10.42	0.36	-25.34	0.08
Observations	760		Observations	827
R-squared	0.15		R-squared	0.15

Source: Author's Calculations – *Living in Ireland Survey*, (2000)

Note: The occupational pension income dummy dummy is specified with 1 = have occupational pension income and 0 = do not have occupational pension income

Note: The marriage dummy is specified with 1 = married and 0 = not married

Note: The border region is used a the base category for the regionally dummies

Note: The sample specifications are outlined in table 5

Results of occupational pension income OLS model

Variables	Males		Females	
Log monthly occupational pension income	Coefficient	p-value	Coefficient	p-value
Years of Education	0.17	0	0.19	0
Marriage Dummy	0.29	0.08	-0.035	0.87
Duration in Work	-0.01	0.14	-0.0031	0.65
Dublin	-0.44	0.07	0.5	0.17
Mid-Eastern region	-0.67	0.03	0.38	0.45
Midlands region	-0.63	0.04	-0.32	0.51
Mid-West region	-0.5	0.11	0.87	0.07
South-East region	-0.68	0.018	0.27	0.54
South-West region	-0.31	0.29	0.22	0.6
Western region	-0.08	0.78	0.3	0.51
Age	0.21	0.36	0.16	0.68
Age^2	-0.0015	0.33	-0.0011	0.67
Constant	-0.36	0.96	0.01	0.99
Observations	243		Observations	102
R-squared	0.32		R-squared	0.4

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of contribution to occupational pension logit model

Variables	Males		Females	
Contributions to occupational pension dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.1	0	0.11	0
Marriage Dummy	0.17	0.25	0.1	0.45
No. of Children	0.06	0.28	0.024	0.7
Duration in Work	0.046	0	0.055	0
Dublin	-0.007	0.96	0.29	0.1
Mid-Eastern region	0.06	0.75	0.13	0.55
Midlands region	0.38	0.09	0.2	0.41
Mid-West region	0.05	0.80	0.11	0.6
South-East region	0.4	0.05	0.57	0.01
South-West region	-0.53	0.003	-0.19	0.33
Western region	-0.21	0.30	-0.28	0.21
Age	0.034	0.12	-0.01	0.69
Age^2	-0.0007	0.007	0.00004	0.88
Constant	-1.05	0.03	-0.74	0.19
Observations	2602		Observations	2201
R-squared	0.05		R-squared	0.05

Source: Author's Calculations – *Living in Ireland Survey*, (2000)

Note: The Contributions to occupational pension dummy is specified with 1 = do make contributions to occupational pension and 0 = do not make contributions to occupational pension

Note: The marriage dummy is specified with 1 = married and 0 = not married

Note: The border region is used a the base category for the regionally dummies

Note: The sample specifications are outlined in table 5

Results of contribution to occupational pension OLS model

Variables	Males		Females	
Log contribution amounts to occupational pension	Coefficient	p-value	Coefficient	p-value
Years of Education	0.13	0	0.18	0
Marriage Dummy	0.28	0	-0.09	0.09
No. of Children	0.04	0.06	0.012	0.61
Duration in Work	0.026	0	0.03	0
Dublin	0.25	0	0.08	0.23
Mid-Eastern region	0.14	0.05	-0.002	0.98
Midlands region	-0.069	0.38	-0.006	0.95
Mid-West region	0.14	0.05	-0.008	0.92
South-East region	-0.018	0.79	-0.13	0.1
South-West region	-0.049	0.48	-0.14	0.09
Western region	-0.1	0.15	0.0072	0.94
Age	0.084	0	0.036	0
Age^2	-0.001	0	-0.0004	0
Constant	2.47	0	2.56	0
Observations	2243		Observations	1960
R-squared	0.36		R-squared	0.27

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The marriage dummy is specified with 1 = married and 0 = not married
Note: The border region is used a the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of employee earnings OLS model

Variables	Males		Females	
Log monthly gross earnings	Coefficient	p-value	Coefficient	p-value
Years of Education	0.052	0	0.74	0
Potential Experience	0.062	0	0.021	0
Potential Experience^2	-0.001	0	-0.0005	0
Dublin	0.201	0	0.039	0.54
Mid-Eastern region	0.088	0.15	-0.02	0.7
Midlands region	0.064	0.3	0.019	0.82
Mid-West region	0.02	0.7	-0.052	0.51
South-East region	-0.05	0.4	-0.132	0.08
South-West region	-0.013	0.8	-0.06	0.37
Western region	0.016	0.7	-0.01	0.8
Inverse Mill's ratio	-.95	0	.2	.625
Constant	9.2	0	8.84	0
Observations	2056		Observations	1778
R-squared	0.329		R-squared	0.25

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The border region is used as the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of self employed earnings OLS model

Variables	Males		Females	
Log monthly gross earnings	Coefficient	p-value	Coefficient	p-value
Years of Education	0.07	0	0.08	0.44
Potential Experience	0.027	0.01	0.019	0.4
Potential Experience^2	-0.0004	0.05	-0.0006	0.26
Dublin	0.62	0	0.46	0.3
Mid-Eastern region	0.51	0.009	0.59	0.24
Midlands region	0.178	0.4	0.44	0.4
Mid-West region	0.3	0.13	0.68	0.24
South-East region	0.41	0.02	0.75	0.1
South-West region	0.24	0.19	1.55	0.005
Western region	0.25	0.2	0.94	0.09
Inverse Mill's ratio	-1.05	0	1.9	.233
Constant	8.25	0	8.2	0
Observations	305		Observations	74
R-squared	0.14		R-squared	0.21

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The border region is used as the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of Farm Income OLS model

Variables		
Log monthy gross earnings	Coefficient	p-value
Years of Education	0.069	0
Potential Experience	0.0061	0.71
Potential Experience^2	-0.00003	0.91
Dublin	0.49	0.43
Mid-Eastern region	0.89	0.001
Midlands region	0.68	0
Mid-West region	0.77	0.001
South-East region	0.99	0
South-West region	1.2	0
Western region	-0.05	0.75
Constant	7.72	0
Observations	274	
R-squared	0.28	

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The border region is used as the base category for the regionally dummies
Note: The sample specifications are outlined in table 5

Results of Capital Income Logit model

Variables	Males		Females	
Capital income dummy	Coefficient	p-value	Coefficient	p-value
Years of Education	0.1	0	0.08	0
Age	0.034	0	0.03	0
Age^2	-0.00008	0.48	-0.0001	0.23
No. of Children	-0.04	0.3	0.063	0.18
Work Income	0.00003	0	0.00003	0
Dublin	0.59	0	0.78	0
Mid-Eastern region	0.13	0.42	0.54	0.003
Midlands region	-0.17	0.36	-0.1	0.65
Mid-West region	-0.17	0.32	-0.01	0.94
South-East region	0.2	0.18	0.46	0.008
South-West region	0.15	0.31	0.21	0.21
Western region	0.53	0.001	0.27	0.14
Constant	-4.8	0	-4.6	0
Observations	5228		Observations	5195
R-squared	0.12		R-squared	0.06

Source: Author's Calculations – *Living in Ireland Survey*, (2000)

Note: The capital income dummy is specified with 1 = have capital income 0 = do not have capital income

Note: The border region is used as the base category for the regionally dummies

Note: The sample specifications are outlined in table 5

Results of Capital Income OLS model

Variables	Males		Females	
Log monthly capital income	Coefficient	p-value	Coefficient	p-value
Years of Education	0.06	0.006	0.1	0
Age	0.05	0.01	0.023	0.24
Age^2	-0.0001	0.6	0.0001	0.58
No. of Children	-0.04	0.53	0.0067	0.93
Work Income	9.12E-06	0.002	7.80E-06	0.1
Dublin	-0.24	0.27	0.071	0.78
Mid-Eastern region	0.15	0.57	0.180	0.56
Midlands region	0.39	0.23	0.39	0.3
Mid-West region	0.16	0.58	-0.11	0.7
South-East region	0.58	0.02	0.27	0.36
South-West region	0.094	0.71	0.26	0.37
Western region	0.16	0.52	0.27	0.39
Constant	2.23	0	1.82	0.006
Observations	1027		Observations	728
R-squared	0.12		R-squared	0.1

Source: Author's Calculations – *Living in Ireland Survey*, (2000)
Note: The border region is used as the base category for the regionally dummies
Note: The sample specifications are outlined in table 5