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Funding higher education and wage uncertainty: Income contingent loan versus mortgage loan☆

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ABSTRACT

We propose a simple theoretical model which shows how the combined effect of wage uncertainty and risk aversion can modify the individual willingness to pay for a HE system financed by an ICL or a ML. We calibrate our model using real data from the 1970 British Cohort Survey together with the features of the English HE financing system. We allow for individual heterogeneity by considering different family backgrounds and occupations. We find that graduates from poor families, males and graduates working in the private sector are more willing to pay to switch to an ICL. Using the UK Labour Force Survey we evaluate the distributive effects of our model. We compute the repayment burdens and taxpayer subsidies for average, low and high earnings graduates. The results confirm the important insurance benefits of an ICL compared to a ML, with lower burdens and higher subsidies for poorer graduates.

1. Introduction

Increasing expansion of higher education and persistent budget problems have induced governments to rethink the ways of financing HE public provision. It is now widely accepted that students participation to the costs of their education needs to be increased, the problem is to find new methods that do not reduce participation, make HE more efficient and guarantee equality of opportunity to everybody. In the last two decades many countries (e.g. Australia, New Zealand, England) have introduced financing systems based on student loans and the two main methods are mortgage-loans (ML) and income-contingent loans (ICL). However, students may not be indifferent between these and their preferences may relate to factors such as family background, risk aversion, earnings volatility. The latter are also unlikely to be gender neutral (Gneezy & Rustichini, 2004). This paper attempts to address this issue by integrating risk into the analysis of human capital investment where borrowing is possible. While existing studies (e.g. Chen, 2008) have considered the role of risk attitudes and uncertainty on educational outcomes, this paper considers how risk attitudes and earnings volatility influence students preferences by funding methods.

Early works on schooling and uncertainty considered the effect of attitude to risk on return to education. For instance, Weiss (1974) demonstrated that risk adjusted average rate of return to schooling sharply decreases as risk aversion increases. Olson et al. (1979) allowed for some form of borrowing to finance education and estimated small but positive risk premium for attending college. Padula and Pistaferri (2001) extended this by including both employment risk and wage uncertainty and find that when these forms of risk are not accounted for the returns to education are downwardly biased.

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Other broad body of research focuses on wage uncertainty but abstracts from financing methods, like for example in Hartog and Vijverberg (2007) and Hartog and Serrano (2007). The first measure the uncertainty associated to post-schooling earnings finding that workers are not only risk averse but also exhibit skewness affection. The second analyze the effects of stochastic post schooling earnings on the optimal schooling length and find negative effect of risk on investment in HE education. Belzil and Leonardi (2007) instead study how risk aversion can explain differences in schooling attainment.

Finally, there is a large literature on funding higher education, including student loans (e.g. see Chapman, 2006, 2007 for a comprehensive summary) which focuses mainly on public finance outcomes. In particular, the concept of ICL as a means to fund human capital investments started with Friedman (1975) and Nerlove (1975), since then several works such as Barr (1993) and Barr and Crawford (2005) consider the proper design of student loans and the conflicts with the regulated market forces. Chapman (1997) evaluates the usefulness of ICLs as a source of funding HE, Goodman and Kaplan (2003) contrast ICLs and free education in the English HE system, whereas Dearden, Fitzsimons, Goodman, and Kaplan (2008) consider the distributional effect of the 2004 English HE reform. Recently, Chapman and Lounkaew (2010) and Chapman, Lounkaew, Polsiri, Sarachitti, and Sitthipongpanich (2010) show the importance of repayment burdens and taxpayer subsides in the evaluation of students loans, focusing on the ICL system in Thailand.

Our contribution is an attempt to integrate the literature on education and risk with the literature on funding higher education. This paper addresses the issue of how the combined effect of wage uncertainty and risk aversion change the individual willingness to pay for a HE system financed by an ICL versus an alternative system financed by a ML. Our interest in the combination of earnings uncertainty and student loan design is motivated by two reasons: the observed uncertainty in the real earnings of graduates; and the reform of the higher education financing system in England with a mortgage loan (ML) and its subsequent replacement by an income contingent loan scheme (ICL).

In the first part of this work we present a simple theoretical model in which we assume that students receive a loan from the government to finance the cost of HE, and they repay their debt after graduation according to one of two loan schemes: ICL and ML. Graduates receive uncertain future incomes (affected by a single lifetime shock), and we measure the level of uncertainty considering the variance of the incomes. We focus only on the post graduation period and we derive and compare lifetime expected utilities under an ICL and a ML, for risk neutral and risk averse graduates. We first illustrate the main characteristics of the two systems and we prove that the expected repayment burden under an ICL is always lower than the expected repayment burden under a ML. Then, assuming risk neutrality and equal expected costs, we show that graduates with an ICL are better off. Assuming risk aversion, we analytically derive the graduates expected utilities under the two loan schemes, although their comparison is only possible through numerical simulations.

Therefore, the second part of the work is devoted to empirical applications to verify our theoretical intuitions. We use the British Cohort Survey 1970 to evaluate the two loan systems allowing for individual heterogeneity. We can look at earnings of people from different family backgrounds, occupations and degrees and simulate several scenarios by computing graduates' willingness to pay (WTP) to switch from a ML to an ICL. Assuming increasing risk aversion, we typically find that graduates from low educated parental background, males over females, graduates working in the private sector are more willing to pay to switch to an ICL. The latter is usually less preferred when earnings exhibit low variance, something which is typical of the public sector careers.

We then generate age-earnings profiles to evaluate the distributive effects of the two loan systems. We initially assume that the growth rate of the earnings follows a Brownian motion and we compute the willingness to pay to switch from a ML to an ICL using a numerical method. The results confirm our previous findings, and for higher risk aversion an ICL is strongly preferred to a ML.

Finally, we use the UK Labour Force Survey pooling several cross-sections from 1997 to 2009. We generate age-earnings profiles for average, low and high earnings graduates, both males and females. Following Chapman and Lounkaew (2010), we use these profiles to compute the repayment burdens and the taxpayer subsidies under a ML and an ICL, considering some features of the recent English HE reforms.

The results have important policy implications. Under a ML, we observe higher repayment burdens when graduates have lower incomes, because the repayment period is fixed and the installments mandatory. The taxpayer subsidies are small and equal for males and females, because their repayment periods are the same.

Under an ICL, the fact that females have on average lower and less volatile earnings than males is reflected in lower repayment burdens and higher taxpayer subsidies. Moreover, the benefits of an ICL are much evident when graduates are in the lower tail of the earnings distribution. Repayments are delayed, burdens are very small and graduates exploit very high taxpayer subsidies. In particular, for females the debt can be completely written off. This confirms the important insurance benefits of an ICL for graduates who have low earnings at the beginning of their career or because in financial hardship. Conversely, the advantages of an ICL are dramatically lower for rich graduates, who have high repayment burdens and low taxpayer subsides like under a ML.

In the next section we describe the institutional background and the theoretical model, in Section 3 we analyze the cases of risk neutrality and risk aversion. Section 4 describes the data, and Section 5 shows the results of the simulations under risk aversion. In Section 6 we set up the model with the new assumptions on the earnings and show the results of the simulations. Section 7 comments the results on the repayment burdens and taxpayer subsidies. Section 8 concludes.

2. Institutional background and theoretical model

2.1. Institutional background

We now briefly describe the reforms in the UK that justify our analysis. However for illustrative purposes our theoretical model is set up on more general basis.

Higher education (HE) in the UK has been free up to 1998 when the Teaching and Higher Education Act establishes tuition fees of up to £1000. The fees are up-front, fixed across universities and courses. Only students whose family income exceeds a given amount pay the fee in full, the others are exempted. The Higher Education Reform Act approved in 2004 and effective from the academic year 2006/2007 raises the cap on fees up to £3000 p.a. (£3225 in 2009/2010 and £3290 in 2010/2011) and enlarges the number of students liable.[1] Full-time students are eligible to government-funded loan to cover the cost for the tuition fee and maintenance loan to cover living expenses while at the university. Students from poor family background are also entitled to maintenance grants which do not have to be repaid. Up to 1998, the loan repayment system is a 'peculiar' mortgage loan with 60 fixed monthly installments (i.e. a 5-year repayment period no matter of the size of the loan) but graduates begin to pay when their salary is over a certain threshold (£27,050 in 2009). From 1999 the repayment is a full income-contingent scheme. Graduates start to pay back their loan directly out of their wages, at a 9% fixed rate for everything earned above £15,000. The important innovation is that the time taken to repay is based on income and amount borrowed, not on a fixed time period. The debt is written off after 25 years or when the graduates turn 65.

Under both systems, ML and ICL, there is a zero real interest rate (only adjustment to inflation[2]). However, according to the recent (November 2010) reform, that will be effective from the academic year 2012/2013, the government has also added a tapered rate of interest which would rise to 3% depending on earnings. A further £9000 per year cap has been decided, and the earnings threshold at which the loans start to be repaid has been increased from £15,000 to £21,000. The debt, however, will be written off after 30 years.

2.2. Theoretical model

This section presents the main assumptions of the theoretical model that hold both under a mortgage loan and under an income contingent loan. For simplicity, we do not consider any external effects of education on society as a whole. We derive the individual expected utilities under both loan schemes, for risk neutral and risk averse graduates. We also assume non graduates earnings are certain.

Individuals go to university for *s* years full time and education has the same cost for everybody without distinction between courses and subjects. Earnings during the schooling are assumed to be zero. Following Olson et al. (1979), consumption is always equal to earnings. Therefore, during university, consumption is also set to zero. There is no private market for loans, and no informal market for loans e.g. from parents. There is no insurance market because it is not profitable for the private market to insure the investment in HE, since moral hazard and adverse selection cannot be avoided due to the lack of any collateral.

The only source of financing allowed is a government-funded loan, again equal for all the students, of fixed size and that covers all the costs of attending university. The real interest rate on the loan is zero.[3] The loan finances fees – although we could allow it to finance consumption during schooling. Thus the loan size is the same irrespective of scheme and equal to fees. Graduates start to pay back their loan soon after graduation, and until their loan is fully repaid. This implies that there is no default,[4] no early unemployment[5] and in the long run all the cost of education is recovered equally by both schemes.[6]

Upon graduation, we can imagine an initial random draw that fixes earnings at a certain level which remains unchanged for all the working life. In practice, graduates obtain an uncertain wage because it is subject to a random shock with a single lifetime realization (see Hartog & Serrano, 2007), after which earnings remain constant. We assume that earnings are always higher than a certain minimum level y_{min}. Let $\tilde{y} > y_{min}$ (where $y_{min} > 0$) be the shock with $E(\tilde{y}) = 1$ and $Var(\tilde{y}) = \sigma^2$. Individuals cannot insure the wage risk and seek to maximize the expected lifetime utilities. Consumption is equal to earnings and is strictly positive; utility is defined over the individuals' earnings stream.

In this model we focus only on the post-graduation period, but it is important in all the following analysis to distinguish between the repayment period and the post repayment period. Graduates must start repaying their educational loan straight after graduation and for *T* years, after that they receive their entire earnings for the rest of their life, assumed infinite for simplicity. Considering a general repayment scheme, we define *R* as the general per-period payment. The expected utility is:

$$V = E\left\{ \int_{s}^{T+s} e^{-\rho t} u(\tilde{y} - R)\, dt + \int_{T+s}^{\infty} e^{-\rho t} u(\tilde{y})\, dt \right\} \qquad (1)$$

where $R < \tilde{y}$, and ρ is the subjective discount rate that measures how much the present is taken in consideration with respect to the future. A loan scheme is described fully by (T, R).

[1] Except in Scotland where the students do not pay for tuition.

[2] Interest is linked to the rate of inflation and is adjusted each year in line with the Retail Prices Index (RPI).

[3] This is not just a simplifying assumption, but we are using the same features of the students loans as implemented by the government in England.

[4] This point is illustrated in the next paragraph.

[5] While we could consider here a delay in the payments to allow for some form of unemployment after graduation, this would make the algebra more complex and the main conclusion would be the same.

[6] For simplicity and given our interest only on graduates choices, we assume that the government is risk neutral and does not have any preference over the funding systems. Since the government could bear different costs of providing the loan according to the scheme, we also assume a zero real interest rate on the borrowing. Under this assumption the costs for the government are the same under an ICL and a ML, and social welfare depends only on students' utility.

2.3. Mortgage loan and income contingent loan

In our model we consider a 'pure' mortgage loan (different from the English 'peculiar' mortgage loan) and an income contingent loan for higher education. We assume that students when enroll cannot choose between one repayment system or the other but can only borrow a loan equal to the total cost of education C, which is the same under both systems. The way the loan is repaid produces different individual utilities because of the random earnings. If we assume no uncertainty and identical repayment rates the two systems are equal in terms of utility.

2.3.1. Mortgage loan

Under a 'pure' mortgage loan system, the individuals take out a loan and repay each year fixed and mandatory installments, without postponements. Repayments are not related to graduates capacity to pay and, as illustrated by Chapman (2006), Chapman and Lounkaew (2010), this implies two main issues under this scheme. The first is the possibility to default for graduates unable to meet their obligations.[7] This implies also additional costs for the government if it has to pay the remaining debts. The second issue is that graduates are very concerned with potential future hardship since 'by definition' a ML is not sensitive to the level of consumption.

In our model, we assume that all prospective students take out public loans provided by the government. The ML is equal to C and graduates start to repay it soon after graduation through fixed and mandatory installments φ, at a zero real interest. The repayment period T is fixed and set by the government. For the purposes of this theoretical analysis we make the simplifying assumption that graduates will repay completely their debt in T years, and the government recovers all the costs of the loan issued. We are aware that default is an important issue under a ML and we consider it explicitly in a companion paper (see Migali, 2008). In this model, repayments φ do not depend on the graduates earnings and we assume that their magnitude is always lower than the minimum earnings, y_{min}.

Assumption 1. With a ML,

$$\varphi < y_{min}$$

and the expected repayment is

$$E[P_{ML}] = \varphi \times T = C$$

2.3.2. Income contingent loan

Under an income contingent loan system, individuals take out a loan and start to pay back after graduation according to the level of their earnings. Graduates getting a high income repay a greater portion of their debt and all the loan is paid off in less time. Graduates with a low income repay less and take longer to pay off their loan. As highlighted by Chapman (2006), Chapman and Lounkaew (2010) there is an important insurance aspect under an ICL, because graduates in financial hardship or with incapability to pay will not need to default.

In our model, we assume that all prospective students take out public loans provided by the government. The loan is equal to C and graduates soon after graduation repay a fixed percentage (γ) of their earnings, at a zero interest rate. We remind that income is random, positive and once obtained remains always constant. For simplicity, we assume no initial threshold, therefore graduates pay each year the same amount of debt and this amount varies only across graduates according to the level of their earnings. We also assume infinite life and the government always recovers the full cost C of the loan.

In this model we only focus on the post-graduation period and we assume that the constant income is equal to consumption. Therefore we do not have consumption smoothing within the individual lifetime. In practice, under an ICL graduates with a good income shock are temporarily subsidizing graduates with bad shocks. The variance of the random income will affect the level of this subsidy.

Assumption 2. Under an ICL the annual repayment is:

$\gamma \times \tilde{y}$ until the loan is repaid, and the expected repayment is

$$E[P_{ICL}] = \gamma \int_{s}^{\tilde{T}+s} \tilde{y}\, dt = C$$

and the repayment period is:

$$\tilde{T} = \frac{C}{\gamma \tilde{y}}. \quad (2)$$

Compared to a mortgage loan the ICL repayment period, $\tilde{T}$, is *random*. Note, γ is chosen ex ante by government, the repayment period $\tilde{T}$ is determined when the income shock is realized.

2.4. Comparison ML and ICL

An important issue to take into consideration in the evaluation of students loans is the repayment burden faced by graduates when carrying out their debt payments. Chapman et al. (2010) illustrate the problem and the main empirical issues raised in the literature. The repayment burden is the ratio between the annual payment and the annual income, therefore the higher are the repayments the lower is the disposable income for consumption and savings. In practical terms, faced with excessive repayment burdens, many individuals are unable to start businesses, invest, or buy homes and for low income earners there is a higher probability to default.

The structure of the student loan clearly matters in the assessment of the repayment burdens, and mortgage loans and income contingent loans are different in this respect. An ICL, indeed, is usually designed to reduce high burdens. In our theoretical model, given the assumptions stated in Section 2.3 we have

[7] This may damage their credit reputation and the possibility to obtain future loans for other purposes (e.g. home mortgage). There is also empirical evidence (e.g. Dynarski, 1994) that graduates with low initial earnings, graduates from ethnic minorities or from poor family background have higher probability to default. According to the US Education Department the national student loan default rate for the 2009 budget year had risen to 8.8%.

Proposition 1. *Annual repayment burdens under the two systems*

$$RB_{ICL} = \frac{\gamma\tilde{y}}{\tilde{y}} = \gamma$$
$$RB_{ML} = \frac{\varphi}{\tilde{y}}$$

Under an ICL graduates face always the same repayment burden because it is a constant function of the income. Whereas, under a ML low income earners are clearly disadvantaged because the repayment burden is inversely proportional to the income.

To compare on fair basis the two systems we assume that the annual expected repayments are the same under the two systems. Knowing that $E(\tilde{y}) = 1$, we have

Proposition 2. *Expected repayment burdens under the two systems*

$$\text{if} \quad \gamma E(\tilde{y}) = \varphi \longrightarrow \gamma = \varphi$$
$$\text{then} \quad E[RB_{ICL}] < E[RB_{ML}]$$

Proof. See Appendix A.1. □

This proposition proves an important difference between an ICL and a ML, although graduates repay on average the same annual amount of debt, an ICL provides a lower repayment burden. This is related to the fact that the expected repayment period under an ICL is higher than the expected repayment period under a ML, $E[T_{ICL}] > T_{ML}$ (see Appendix A.1). A feature of an ICL is to spread the same cost over a longer repayment period compared to a ML, assuming the same repayment rates. This implies the existence of a higher taxpayer subsidy.[8]

However, it is important to understand why there should be interest rate subsides and how they differ in the two systems. As noted by Chapman and Lounkaew (2010) the rationale of an ICL is to insure individuals against the costs of potential low future earnings. The presence of positive real interests increases the debt in real terms and does not guarantee anymore a complete insurance against adversity. In general, there is no agreement in the literature on the correct form of the real interest rates and the systems are always in evolution. For example, the UK government has recognized some weakness in his system and with the intent to reduce its real costs of borrowing has added a tapered rate of interest from 2012/2013 and it has also postponed from 25 to 30 years the "forgiveness" clause. As suggested by Barr and Crawford (2005) a positive real interest is also justified when the loans are used for income support (as in the UK), in order to avoid borrowers' speculation on the private market at taxpayer's expenses. In our model, we use the current structure of the UK funding system and we assume zero real interest rates under an ICL and for a fair comparison also under a ML. We are aware that a ML of the same size of an ICL and with zero interest rate also incorporates substantial public subsidies in the form of defaults. However, we do not allow for default in our theoretical framework but in Section 7 we compute the repayment burdens and taxpayer subsidies under the two systems using less restrictive assumptions and real data.

3. Comparing mortgage and income contingent loans under risk neutrality and risk aversion

Our purpose is to evaluate the expected lifetime utilities under a ML and an ICL for risk neutral and risk averse graduates. When individuals are risk neutral $u(\tilde{y}) = \tilde{y}$ and we need only to consider the expected present value of the repayments. For a fair comparison of the two funding schemes we assume equal annual expected repayments.

Proposition 3. *Assuming risk neutral individuals and* $\gamma = \varphi$

$$V_{ICL} > V_{ML}$$

Proof. See Appendix A.3. □

This proposition proves analytically that risk neutral graduates are better off under an ICL and social welfare is enhanced.

When considering risk averse graduates, we are able to derive their expected utilities under a ML and an ICL but we cannot prove analytically which system is more welfare improving. We therefore proceed through numerical simulations and compute the graduates willingness to pay for an ICL compared to a ML. We omit the majority of calculations that are shown in more detail in Appendix B. We maintain the assumptions stated in Sections 2.2 and 2.3.

Under a mortgage loan, the expected utility is obtained by substituting $R = \varphi$ into Eq. (1):

$$V_{ML} = \int_{s}^{T+s} e^{-\rho t} E[u(\tilde{y} - \varphi)]\, dt + \int_{T+s}^{\infty} e^{-\rho t} E[u(\tilde{y})]\, dt. \qquad (3)$$

To get a closed-form solution for V_{ML}, we use a second order Taylor expansion around the mean $E[\tilde{y} - \varphi] = 1 - \varphi$[9] for the utility during the repayment period, and around $E[\tilde{y}] = 1$ for the utility after the repayment period. We develop our analysis using a CRRA utility function[10] and we get:

$$V_{ML_{CRRA}} = \frac{e^{-\rho s}}{\rho} \left\{ (1 - e^{-\rho C/\varphi}) \left[\frac{(1-\varphi)^b}{b} + \frac{1}{2}(b-1)(1-\varphi)^{b-2}\sigma^2 \right] + e^{-\rho C/\varphi} \left[\frac{1}{b} + \frac{1}{2}(b-1)\sigma^2 \right] \right\}. \qquad (4)$$

[8] This because of positive discounting and zero real interest. The subsidy still exists providing a real interest rate lower than the time preference rate ρ. In Appendix A.2 we have also considered the possibility to rule out the hidden subsidy assuming equal expected repayment periods under the two systems. However, this clearly implies higher expected costs under an ICL.

[9] See Padula and Pistaferri (2001) and Hartog and Serrano (2007).

[10] We developed the analysis also using a constant absolute risk aversion functional form, CARA. The results are substantially unchanged and are available upon request from the Author. Alternative functional forms involve more than one parameter and are less simple to manipulate and we do not want to add further complexity to our analysis.

where $b = 1 - a$ and a is the risk aversion parameter. More details are reported in Appendix B.1.

Under an income contingent loan we do not know how long people take to repay their education debt. Therefore in the general equation of the expected utility the random earnings appear twice: first in the integral's bounds as random repayment period, second as an argument of the utility function.

$$V_{ICL} = E\left\{\int_{s}^{(C/\gamma\tilde{y})+s} e^{-\rho t} u[\tilde{y}(1-\gamma)]\,dt + \int_{(C/\gamma\tilde{y})+s}^{\infty} e^{-\rho t} u(\tilde{y})\,dt\right\} \quad (5)$$

Solving the integral, applying a second order Taylor expansion around the mean $E[\tilde{y}] = 1$ and considering a CRRA utility function, after simplifying, we get the expected utility[11]:

$$V_{ICL_{CRRA}} = \frac{e^{-(s+(C/\gamma))\rho}}{2b\gamma^2\rho}\{e^{\rho C/\gamma}(1-\gamma)^b\gamma^2[2+(b-1)b\sigma^2] - [(1-\gamma)^b - 1]\cdot[2\gamma^2 + ((b-1)b\gamma^2 + 2(b-1)C\gamma\rho + C^2\rho^2)\sigma^2]\}. \quad (6)$$

All the procedure is explained in detail in Appendix B.2.

Looking at Eqs. (4) and (6) is clear that the only possible comparison has to be based on numerical calibrations. In both equations we observe the parameters that define the characteristics of the two loan systems, such as the repayment rates, the cost and length of education. More importantly we observe the risk aversion parameter and the earnings uncertainty measured by the random income variance. For fair comparison we assume equal annual expected payments, then by assigning numerical values to each parameter and letting them vary we are able to assess the graduates willingness to pay under different empirical environments.

4. Data and descriptive statistics

In our empirical application we use two types of survey data, the 1970 British Cohort Study (BCS70) and the UK Labour Force Survey (LFS). The first dataset is used to obtain graduate earnings and their standard deviation, in four possible environments, in order to get an idea of the wage uncertainty and compute the individual willingness to pay to switch from a mortgage loan to an income continent loan. The LFS is used instead to generate individual age earnings profiles, that we employ to compute the repayments burdens and taxpayer subsidies under a ML and an ICL.

For the purposes of this analysis an important assumption is the absence of selection bias, although we know that it could matter even for variance comparisons (Chen, 2008). However here we are more interested in observing how the theoretical model works under different potentially real situations.[12] We also assume that the loan scheme does not affect the wage distribution.

4.1. BCS70

The 1970 British Cohort Study (BCS70) takes as its subjects around 17,000 British births in the week 5–11 April 1970. Subsequently, full sample surveys took place at ages 5, 10, 16, 26 and 30. BCS70 highlights all aspects of the health, educational and social development of its subjects as they passed through childhood and adolescence. In later sweeps, the information collected covers their transitions to adult life, including leaving full-time education, entering the labour market, setting up independent homes, forming partnerships and becoming parents (Byner & Butler, 2002). The initial sample follow-up in 1999–2000 consists of 11,261 respondents aged 30. The smaller sample size in the 1999–2000 survey relative to the original survey in 1970 depends on sample attrition due to nonresponse and it cannot be avoided.[13] The lowest response rate in the BCS70 study was registered in the postal survey conducted in 1996 at age 26, the loss of observations was mainly due to a postal strike. However in the previous surveys, above all those based on interviews to the parents of the cohort's members, the rate of non response was quite high.[14]

In general, the age 30 survey (1999–2000) was the first systematic attempt with widespread coverage to collect qualification and earnings data. It had a high response rate and it involved face to face interviews. For the purposes of our work, we merge the sweeps 1999–2000, 1980 and 1986. The last two sweeps are used because they provide information on family background: that is, family earnings and parental education. We have to stress the point that BCS is the only dataset that has family background, and it seems useful for looking at earnings variance in graduation.

In our sample we include observations if: respondents have a NVQ4 equivalent qualification in 2000[15]; they are in the labour market and earn a positive wage after

[11] The expected utility with an income contingent loan is equal to the expected utility with a mortgage loan if $\varphi = \gamma$ and the variance of the earnings is zero.

[12] The presence of selection bias is potentially an issue of what we are aware, however there is little evidence in the literature concerning the selection into subjects and into job sectors.

[13] In general, attrition due to non-response is low in the non-adult sweeps (1–3) and increases at the adult sweeps (4–5). For example, the response rates of the sweep 0 observed sample is over 86% at sweeps 1, 2 and 3 falling to around 73% at sweeps 4 and 5 (1970 British Cohort Study Technical Report, 2004).

[14] It should be noted that the reason for non-participation at a later sweep may be because the cohort member has died or permanently emigrated. It is, for example, also possible for data to be missing for one part of the schedule especially as, during the years of childhood, data were obtained from different sources (parents, teachers and medical personnel) (1970 British Cohort Study Technical Report, 2004).

[15] The variable has been generated according to the UK national qualifications framework, NVQ equivalent level 4 includes academic qualifications (Degree and HE Diploma), vocational qualifications (BTEC Higher Certificate/Diploma, HNC/HND) and occupational qualifications (NVQ level 4, Professional degree level qualifications, Nursing/paramedic, Other teacher training qualification, City & Guilds Part 4, RSA Higher Diploma).

Table 1
Graduates earnings and standard deviations – BCS1970.

	Mean	Std. Dev.	%
Total sample	24,023	18,369	
By gender			
Male	27,898	22,577	52.93
Female	19,666	10,407	47.07
By family income in 1980			
Low	32,384	56,744	2.12
Medium	23,053	16,882	64.49
High	25,355	13,182	21.16
By mother qualifications in 1980			
No qualifications	22,306	18,957	30.08
O level	25,773	22,908	22.51
Degree	27,149	15,615	6.12
By father social status in 1986			
Professional occupation	25,970	19,536	41.72
Skilled occupation	21,822	12,974	30.93
By degree subjects			
Sciences	26,782	16,828	24.81
Social sciences	25,858	21,385	12.40
Art and humanity	26,526	25,277	15.72
By job sector			
Private	26,434	21,703	62.53
Public	20,357	9911	30.42

Value in thousands UK sterling at 2000 prices.
Sample size 1177.

graduation.[16] In particular, we consider those that got a degree from 1987 to 2000 and start working not earlier than the same year of graduation. This implies that the longest working period is 13 years, but we only consider the earnings in 1999–2000 and for full time or part time employees.[17] According to these criteria in the final sample there are 1177 respondents.

In Table 1 we show some descriptive statistics of the average annual gross wage and its standard deviation according to the individual characteristics, family background, degree subjects and job sector.

The average earnings in the sample are around £24,000 with a standard deviation of £18,300. Male average earnings are around 40% higher than female earnings, but also more than twice their variance.

It is useful to consider a breakdown of data from family background because it is one of the determinant of participation in HE and because family earnings determine how much the individuals are allowed to borrow in mortgage-loan schemes. We consider then the family earnings of the cohort members in 1980, when they are 10 years old. We define "low" family earnings below £99 per week in 1980 prices; "medium" family earnings between £100 and £200 per week; high family earnings above £200 per week. Unfortunately, we discount the graduates from low earnings families because they just are 2% of the sample. The data for medium and high earnings family look more reasonable and with a relatively low uncertainty compared to the graduate average. Observing the graduate earnings given the mother qualifications in 1980, those with a graduate mother get the highest earnings, but the most uncertain is when the mother hold an 'O level' (secondary school qualification).

In Table 1 we consider three degree subjects, the earnings are above the average in all the cases, and quite similar to each other. However, those that took a degree in sciences (around 25% of the sample) have the lowest standard deviation. Finally, looking at the job sectors: 62% of the graduates work in the private sector and earn around 30% more than those in the public sector. However, in the public sector the age earnings profile is flat and this is reflected by a very low level of uncertainty.

4.2. LFS

The LFS is a quarterly sample survey of households living at private addresses. Its purpose is to provide information on the UK labour market that can then be used to evaluate labour market and educational policies. The survey seeks information on respondents' personal circumstances and their labour market status during a specific reference period, normally a period of one week or four weeks (depending on the topic) immediately prior to the interview. The LFS is designed to produce cross-sectional data such that, in any one quarter, one wave will be receiving their first interview, one wave their second, and so on, with one wave receiving their fifth and final interview.

Our selected sample from the quarterly LFS data consists of employees aged from 25 to 60 years old, born between 1940 and 1984, reporting a positive wage in the first wave of calendar years 1997–2009 inclusive. The main variable of interest is annual earnings, defined using average gross hourly pay[18] provided in the LFS raw data. We further restrict the total number of hours worked in the reference pay period to lie in the range [0...94]. The resulting hourly pay rate is transformed into a real wage rate by dividing by the Retail Price Index (all items) with September 2009 as the base period. The top and bottom 1% of the wage distribution were trimmed to avoid outliers arising from measurement error in the wage rate.

Our analysis concentrates on individuals having NVQ4 equivalent qualifications, and the total resulting sample size of 64,719 comprises 32,573 males and 32,146 females. Descriptive statistics are provided in Table 2.

To generate the age-earnings profiles used for the computation of the repayment burdens and taxpayer subsidies, we estimate OLS regression of the form

$$W_i = \alpha + \delta age_i + \rho age_i^2 + \mu t + \epsilon_i \quad (7)$$

where W is the log of wages, $i = 1 \ldots N$ individuals and $t = 1997 \ldots 2009$ years.

[16] We exclude those working before and during education because this is a specific assumption in the theoretical model.

[17] This restriction allow us to clean from many inconsistencies in the earnings, and it is based on work undertaken by Lorraine Dearden and Alissa Goodman, Institute for Fiscal Studies.

[18] It is a derived variable defined as the ratio of usual earnings to usual hours (from main job) including paid overtime. Usual earnings are obtained using information asked directly to all employees and those on schemes, e.g. gross pay before deductions (self-assessed), expected gross earnings (self-assessed).

Table 2
Descriptive statistics – LFS 1997–2009.

	Males		Female	
	Mean	Std. Dev.	Mean	Std. Dev.
Gross hourly pay	15.8	7.713	12.689	6.113
Gross annual pay	40,915	24,191	27,314	18,213
Total hours in main job	42.314	11.714	34.895	13.496
Quartiles of gross annual pay				
Q1: low earnings	13,468	4292	11,654	4825
Q2: medium earnings	24,511	2978	24,026	3002
Q3: high earnings	35,991	3954	35,566	3973
Total sample	32,573		32,146	

Value in UK sterling at 2009 prices.

Table 3
OLS models.

Dep var: log hourly wage				
	All sample	Q1	Q2	Q3
Males				
Age	0.0120***	0.0058***	0.0037***	0.0036***
	(0.0003)	(0.0006)	(0.0003)	(0.0002)
Age^2	−0.0011***	−0.0005***	−0.0003***	−0.0002***
	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Constant	2.9018***	2.2734***	2.5447***	2.8203***
	(0.0035)	(0.0096)	(0.0045)	(0.0030)
N	32,573	4425	7395	9264
Females				
Age	0.0055***	0.0035***	0.0048***	0.0034***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)
Age^2	−0.0005***	−0.0003***	−0.0004***	−0.0004***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Constant	2.6282***	2.2739***	2.6061***	2.8367***
	(0.0035)	(0.0052)	(0.0038)	(0.0038)
N	32,146	11,755	8785	6916

Std. err. in parenthesis.
Q1, Q2 and Q3 are 1st, 2nd and 3rd quartile of the earnings distribution.
Annual dummies included in each model.
*Significance level: 10%.
**Significance level: 5%.
*** Significance level: 1%.

We keep our specification very simple,[19] and Eq. (7) is modeled as the sum of quadratic age effects, time effects and individual error term.[20]

The lifetime earnings distributions are constructed using the parameters estimated in the wage equation. We make our calculations for the default individual, so then we need to consider only the intercept and the coefficients of age and age square. We assume that individuals start working at 25 years old after getting an undergraduate degree and remain in the workforce for 40 years. We also adjust upwards (1% per year) the profiles to capture productivity growth.[21] Fig. 1 shows the obtained profiles, and we observe the well-know convex shape for males and a more linear pattern for females.

However, we are also interested in the distributive effects of a ML and an ICL. Following, Chapman and Lounkaew (2010) we re-estimate Eq. (7) for graduates in the first, second and third quartile of the earnings distribution and then derive the corresponding "truncated" age-earnings profiles.[22] In Table 3 we report all the regression estimates.

5. Simulations under risk aversion

In this section we test directly our theoretical model by calibrating Eqs. (4) and (6) and we present as result of our simulation the graduates' willingness to pay (WTP) to switch from a ML to an ICL. This is expressed as a percentage of their cost of education. We consider heterogenous types of graduates and evaluate the distributive effects of the two loan systems, under different scenarios. We use for this purpose the data from the Brithish Cohort Study 1970, described in Section 4.1. In all the computations we set the parameters according to the English system and to aid comparison with other studies. In particular, after the 2004 British Higher Education reform the annual cost of education was set up to a max of £3000 pounds, while before the reform the cost was £1150 a year.[23] Assuming a 3-year degree, we set two levels of total cost: £3450 and £9000. The risk aversion parameter can take the discrete values $a = \{0.25, 0.5, 0.75, \quad 1.5\}$, following the literature (Olson et al., 1979). The time preference parameter is set to $\rho = \{0.08, 0.15, 0.3\}$. In our analysis, when we change one parameter we keep the others constant at these levels: ICL repayment rates 9% (for English relevance), subjective discount rate 8%, cost £9000 (English current cost for 3-year degree), risk aversion 0.5. The simulations are always performed assuming equal annual expected repayments under the two systems. For brevity, we do not report every conceivable combination of parameters. However, our qualitative results on the effect of any parameter is not sensitive to the assumed values of the other parameters.

In Fig. 2, we compare graduates by gender and in each of the analyzed cases the ICL is always preferred. For increasing costs of education, males' WTP to switch to an ICL rises from 4% to 14%, whereas females' WTP rises from 2% to 6%. The preference for an ICL over a ML depends strongly on the wage uncertainty. Higher uncertainty makes an ICL more convenient, indeed the higher WTP for males is due to the fact that the standard deviation of their earnings is almost double compared to females (see Table 1). Having a more uncertain wage matters also for increasing levels of risk aversions. In fact, looking at the bottom left of Fig. 2, keeping the cost at the higher level males' WTP quickly rises along with the risk aversion. Whereas for females, whose wage is less volatile, the increase is much lower. The WTP for an ICL slightly decreases if graduates have

[19] For a more extensive analysis which separates age effects and cohort effects and allows for endogenous education see Migali and Walker (2011).
[20] The standard Mincerian model assumes that log earnings are quadratic in experience. We do not have a good measure of experience, people use age minus schooling which puts an interaction term.
[21] This parameter has been set equal to the Brownian motion deterministic growth rate used in the simulations in Section 6.
[22] For a discussion of the limitation of this method and alternative methods see Chapman and Lounkaew (2010, p. 701). Due to space limitation we do not show these profiles which are available upon request.
[23] In practice all institutions have charged the maximum.

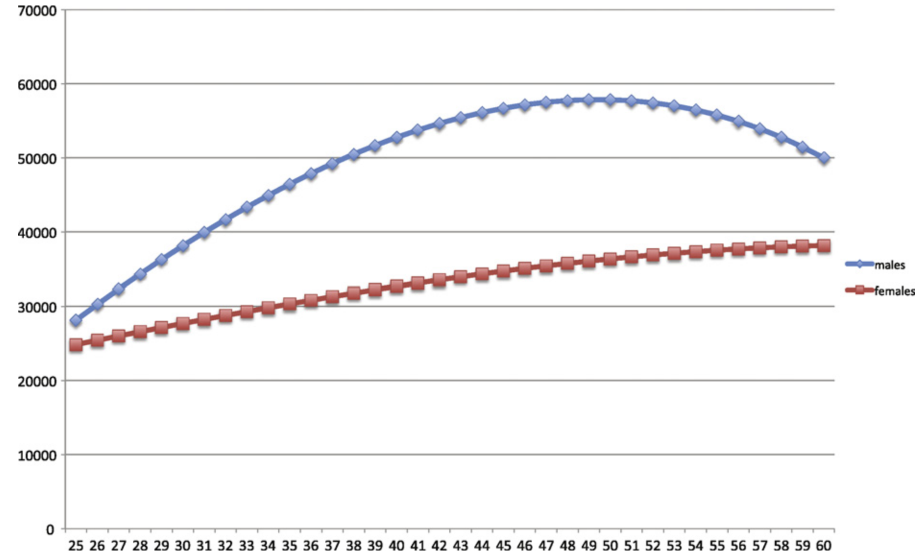

Fig. 1. Age earnings profiles – LFS 1997–2009.

higher subjective discount rates or if they have higher expected costs due to increasing ICL repayment rates.

In Fig. 3 we show how the WTP varies according to the family background. We first consider two levels of family income in 1980. Graduates from rich families have a low variance wage (Table 1) and this is reflected in a WTP between 5% and 10% for increasing risk aversion. Whereas graduates from medium family income obtain lower earnings on average but more uncertain. If they are very risk averse, would be willing to pay up to 25% more to switch to an ICL.

If we observe graduates according to their mother education, those with a less educated mother would pay around 17% more for an ICL when the cost of education

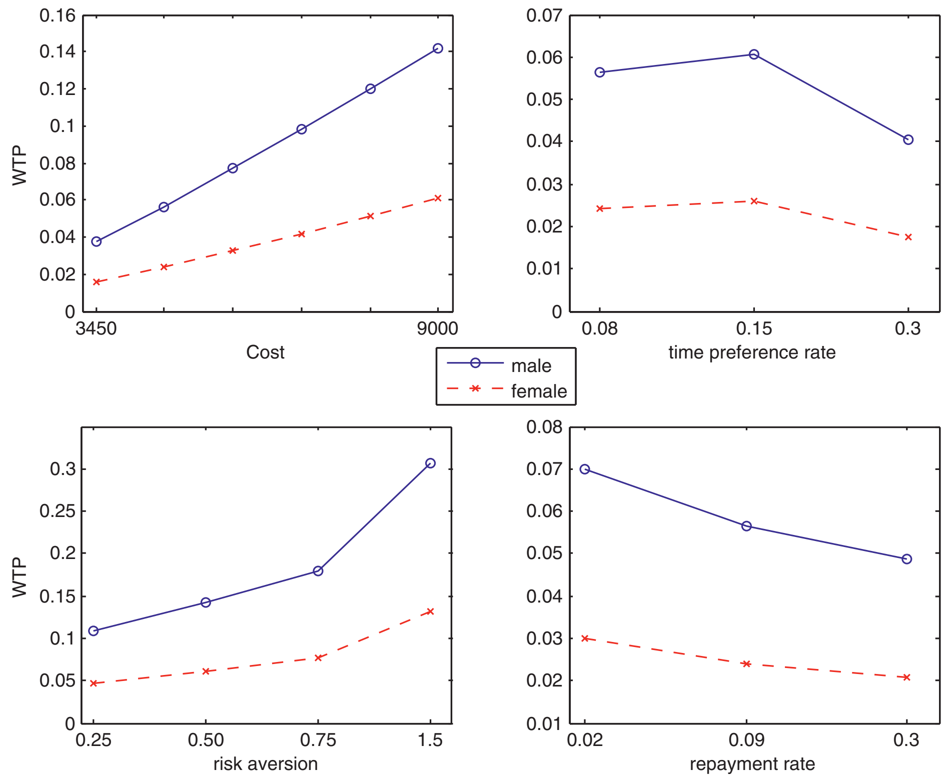

Fig. 2. WTP ML to ICL – individual characteristics.

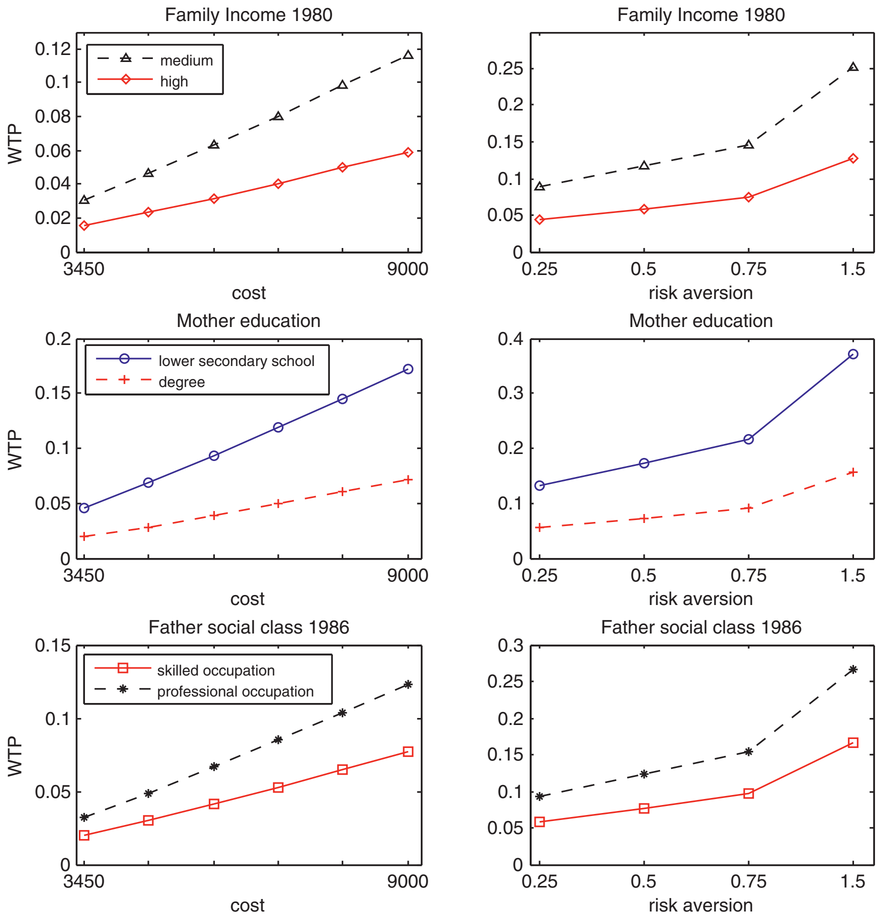

Fig. 3. WTP ML to ICL – family background.

is £9000, and almost 40% more if they are extremely risk averse. Graduates with highly educated mother are almost indifferent between a ML and an ICL if the cost of education is just £3450, but their preference for an ICL increases if they become more risk averse. These different results between the two groups of graduates are related to the length of the repayment period, if graduates have higher wages they pay off their loan sooner and they exploit less the taxpayer subsidy implicit in an ICL.

If we consider graduates' father social class in 1986 (bottom of Fig. 3), those with a father in a professional occupation seem to exploit more the benefits of an ICL, and indeed have a higher WTP compared to graduates whose father has a skilled job.

Focusing on the degree subject, graduates' earnings are relatively similar except for their volatility (see Table 1). The lowest earnings variance is with a science degree and in fact graduates have the lowest WTP (Fig. 4). Those with a degree in humanities have the most uncertain earnings, and they are willing to pay up to 20% more to switch to an ICL, for increasing costs of education. If we allow for increasing time preference rate, we observe similar decreasing WTP for graduates in humanities and social science and always lower WTP for graduates in science. The gap is reducing when the time preference rate is very high.

We finally compare graduates working in the private sector and graduates working in the public sector (Fig. 5). Graduates in the private sector, who get higher but more uncertain earnings, are willing to pay up to 15% more to switch to an ICL, assuming high costs of education; whereas, for the same costs, graduates working in the public sector have a WTP of just 5%. The difference in WTP between these two categories of graduates is largely increasing for higher risk version, from a minimum of 8% to a maximum of 20%. When the career is less dynamic and flatter, as in the private sector, an ICL becomes less appealing although still the preferred system.

In the graph at the bottom right corner of Fig. 5, we compare the WTP to switch from the public to the private sector according to the loan scheme. Graduates in a ML system would pay from 50% to 55% more of their current costs to move to the private sector, where they would expect higher wages although more volatile. The opposite trend is observed for those within an ICL system, their WTP is slightly decreasing from 47% to less than 44%.

6. Increasing earnings

In this section we extend our model to incorporate stochastic changes of earnings over time. We make the

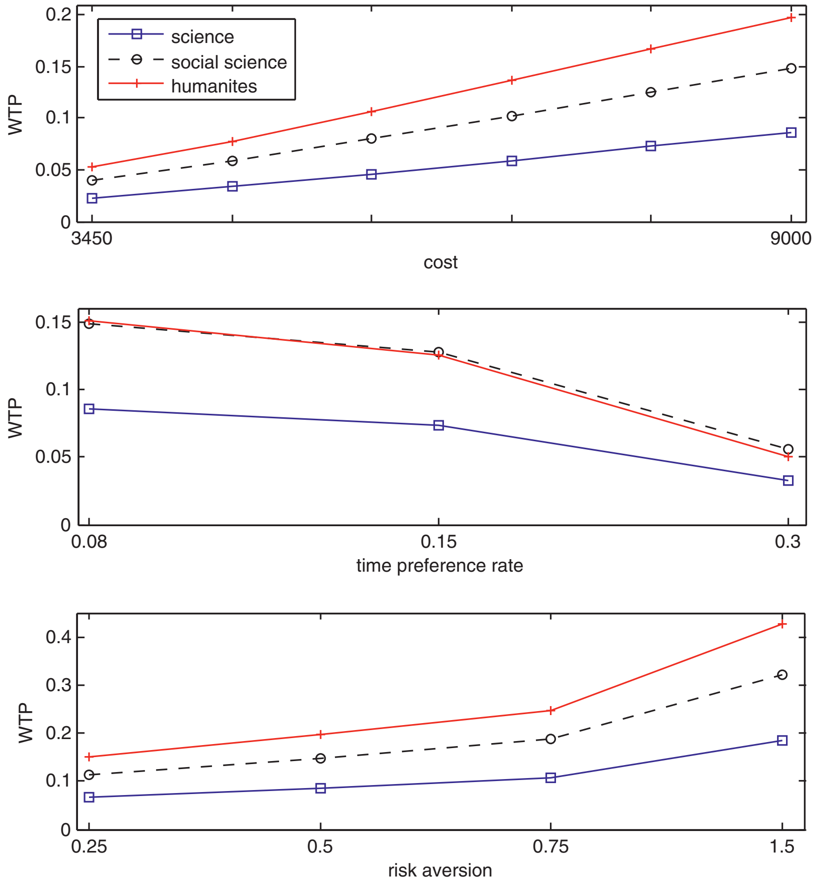

Fig. 4. WTP ML to ICL – degree subjects.

model more realistic and verify which conditions still hold relative to the case of static earnings. We assume that graduate earnings are no longer affected by a single lifetime shock, but there is a shock each year throughout the individual working life. To model this assumption we consider the earnings growth rate following a geometric Brownian motion $W(t)$.[24] This means that $y(t)$ satisfies

$$\frac{dy(t)}{y(t)} = \lambda\, dt + \sigma\, dW(t). \tag{8}$$

This expression can be interpreted heuristically as expressing the relative, or percentage, increment dy/y in y during an instant of time dt. λ is the deterministic growth rate and σ its standard deviation. Solving[25] the stochastic differential equation (8) we obtain the stochastic earnings:

$$y(t) = y(0)\ \exp\left[\left(\lambda - \frac{1}{2}\sigma^2\right)t + \sigma W(t)\right] \tag{9}$$

Eq. (9) represents the new earnings we use to compute the expected utilities under the two loan schemes. Since it is not straightforward to obtain an algebraic solution for the expected utilities under an ICL we adopt a numerical method. We consider a discrete form of Eq. (9) because it is more relevant to our problem. The method is reported in detail in Appendix C. Briefly, we generate many earnings paths of the same length (equal to a working life period of 40 years), and we use them to compute the expected utilities. Each earnings path produces one level of utility, therefore we average over the number of paths created. Ultimately we get the average expected utilities and we compute how much graduates are willing to pay to switch from a ML to an ICL. This is expressed as percentage of their loan, which corresponds to the cost of education.

To generate the age earnings profiles we consider as starting level the first, second and third quartile of the graduates earnings distribution in the Labour Force Survey, for both males and females (see Table 2). We assume a deterministic growth rate λ of 1% per year over 40 years and we set the volatility σ of the Brownian motion equal to 5%, which means that the maximum annual variation of the earnings can be 5% around the growth trend. Using this setting we generate 1000 profiles for each initial level of the earnings. To compute the expected utilities we use the features of the English system. We consider the current cost of education (£9000), the cost before the 2004 reform (£3000) and the future cost with the 2010 reform (£27,000).

An important change relatively to static earnings model is that we also allow for a repayment threshold of £15,000

[24] $W(t)$ is normally distributed with $E(W(t)) = 0$ and $Var(W(t)) = t$.

[25] The solution is standard and more details can be found in Diacu (2000) and Yor (2001).

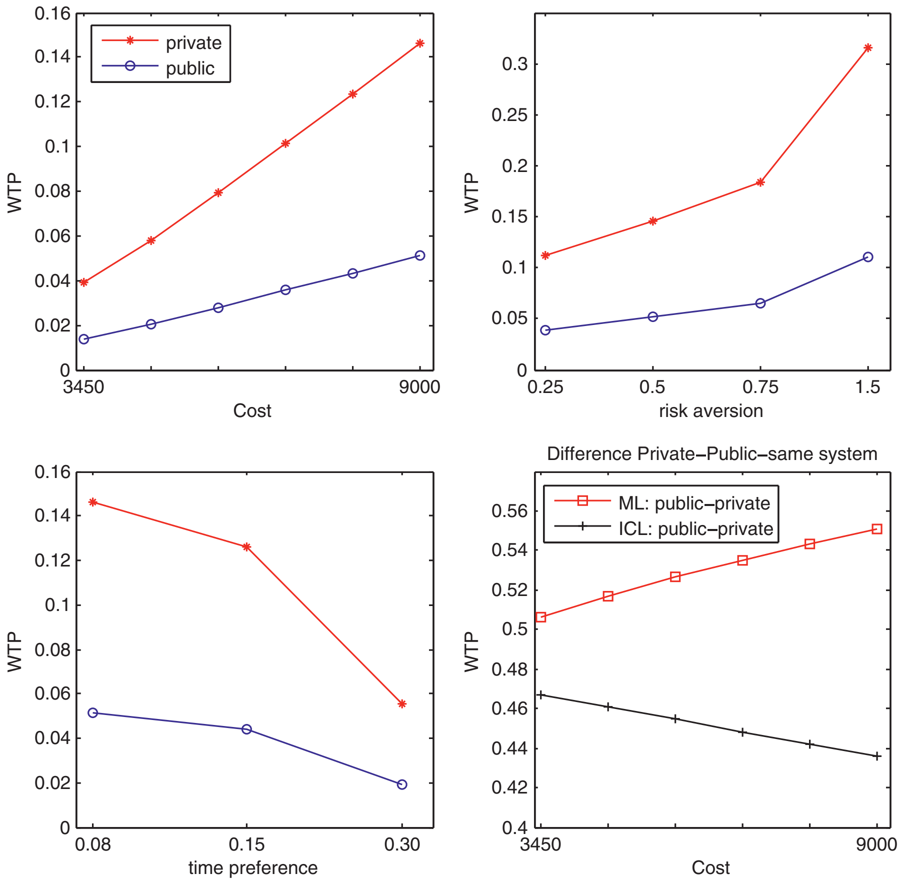

Fig. 5. WTP ML to ICL – public versus private sector.

under an ICL and we assume that the debt is written off after 25 years. Under a ML, we consider a fixed repayment period of 5 years. Given our derived age-earnings profiles the size of the ML installments never falls below the earnings. Moreover, the risk aversion parameter can take the discrete values $a = \{0.25, 0.75\}$ and the time preference parameter is set to $\rho = \{0.08, 0.15, 0.3\}$.

For illustrative purposes, in Fig. 6 we show, for males and females, a random subsample of 10 out 1000 profiles for each initial level of earnings (low, medium and high). Since the low initial earnings for males and females are significantly different (see Table 2), this is reflected in the age-earnings profiles. However, for medium and high earnings there is a small difference between males and females, consequently the age-earnings profiles look very similar. Therefore, in Table 4 where we report the WTP to switch from a ML to an ICL, we decide to show only the most relevant results for both males and females. The simulations here are in line with those using a static earnings model. In general, for increasing annual income uncertainty and income growth rate, the WTP increases. However, the magnitude of these variations is small. For this reason, we have fixed σ at 5% and λ at 1%.

We find that for higher risk aversion an ICL is strongly preferred to a ML, the WTP increases with the costs of education, and low earnings graduates exploit much more the insurance benefits of an ICL. In panel A of Table 4, we observe in fact that low risk averse graduates, both males and females, have a small WTP to switch to an ICL, regardless of their level of earnings. If we consider high risk aversion and low earnings, males would pay between 6% and 8% to switch to an ICL, whereas females' WTP is around 8% for any cost of education. Males with medium and high earnings prefer a ML only when the cost of education is low. Conversely, for higher costs their WTP to switch to an ICL becomes positive and increasing. We do not report the results for females with high and medium earnings because in this case they look very similar to those of males.

In panel B of Table 4 we consider only high risk averse graduates. We notice that for increasing time preference rates and low earnings the WTP is decreasing. In fact if we consider a high cost of education (£27,000), for males and females the WTP drops from 8% to around 5%. When considering the same level of cost but medium earnings, the WTP is less affected by variation of the discount rate.

7. Repayment burdens and taxpayer subsidy

In this section we compute the repayment burdens and the taxpayer subsidies under a mortgage loan and income contingent loan, using the age-earnings profiles generated in Section 4.2.

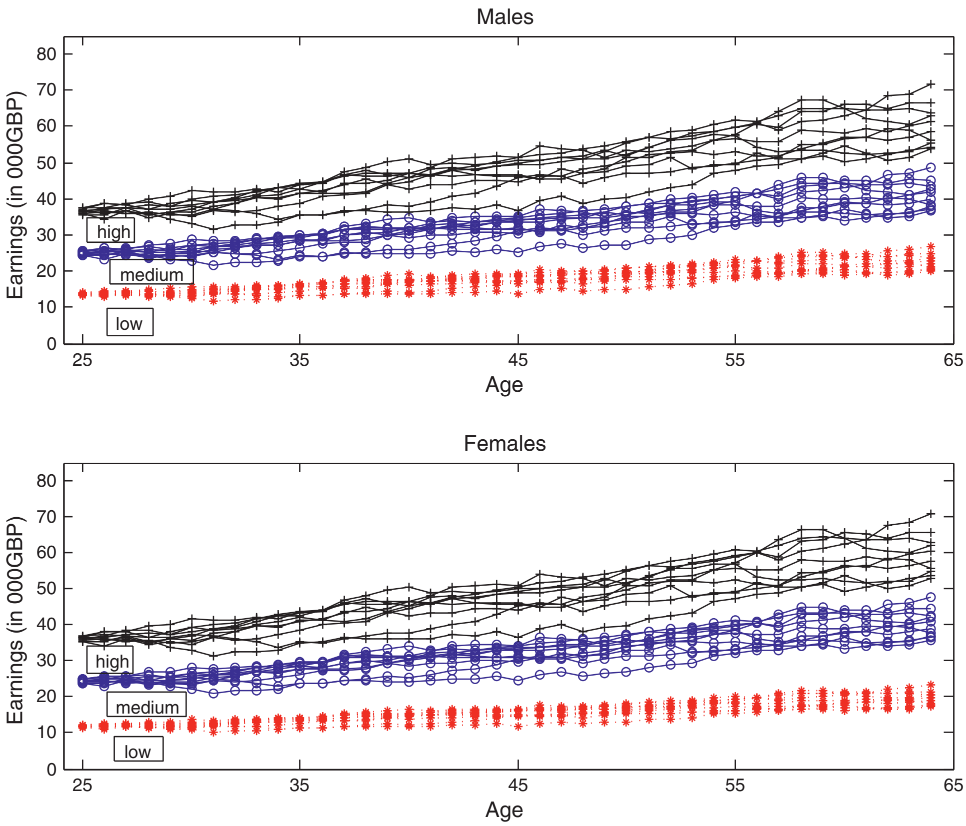

Fig. 6. Age-earnings profiles – Brownian motion growth rate of earnings.

The debate on the proper size of the repayment burden is open. For example, Baum and Schwartz (2006), after considering several works, find that 8% of the gross income could be a basic rule of thumb for the definition of the repayment burden. A Rutgers University study (Godofsky, Zukin, & Van Horn, 2011) finds that in the US after decades of increasing tuition (8.3% in 2010 alone) and stagnant wages, students and graduates now often owe significantly more on their student loans than their degrees are (in dollar terms) worth. In the US, where student loans have mortgage type arrangements (e.g. federal Stafford loans), to address the problem of excessive repayment burdens the Congress has approved a law that lowers the maximum required payment from 15% of discretionary annual income to 10% for eligible borrowers. There is also a proposal of full loan forgiveness for current borrowers who have paid the equivalent of 10% of their discretionary income for 10 years or who are able to do so over the coming years.

In our analysis, we consider two possible ICLs, the first (ICL_1) is similar to the current structure of the English system (effective from the academic year 2006/2007). Graduates start to pay back their loan when their earnings are above £15,000 per year, at a 9% fixed repayment rate and zero real interest rate. The debt is written off 25 years after the loan becomes eligible for repayment. However, for loans taken out before 2006, the debt is cancelled when graduates reach the age of 65. In our simulations we consider both forgiveness rules for ICL_1.

The second structure, ICL_2, is similar to the system introduced in England with the 2010 reform (effective for repayments starting in 2016). The initial income threshold has been raised to £21,000 and the debt is written off 30 years after the loan becomes eligible for repayment.[26]

We also consider two types of mortgage loan. The first, ML_1, assumes a fixed repayment period of 5 years which starts soon after graduation. This corresponds to the 'pure' ML defined in the theoretical Section 2.3.1. Given our estimated age-earnings profiles the size of the ML installments never falls below the income. The second type, ML_2, is a mix between a mortgage loan and an income contingent loan. We still assume a fixed repayment period of 5 years, however it begins when graduates earn over a specified threshold, that we set for simplicity to £15,000. This system is very similar to that in force in England prior to the 1998/1999 academic year, based on 60 monthly installments to be repaid when the graduate salary is above 85% of the national average.[27]

For all systems we assume a zero real interest rate, a 3-year undergraduate degree and two levels of tuition

[26] There is also a fixed interest rate on the loan while studying and a tapered interest rate depending on the annual salary, computed each year on the outstanding debt. For illustrative purposes and due to excessive complications in the calculation we do not consider this case.

[27] For details on English student loans see Student Loans Company Limited (2012).

Table 4
WTP ML to ICL – multiple shocks on earnings.

Panel A: C **and risk aversion changing**

	$T_{ML}=5, \sigma=5\%, \gamma=9\%, \lambda=1\%, \rho=8\%$		
	$C=£3000$	$C=£9000$	$C=£27,000$
Males		$Y=£13,460$	
$ra=0.25$	0.0006	0.0006	0.0007
$ra=0.75$	0.0613	0.0670	0.0778
		$Y=£24,511$	
$ra=0.25$	−0.0001	0.0001	0.0002
$ra=0.75$	−0.0122	0.0070	0.0319
		$Y=£35,991$	
$ra=0.25$	−0.0001	0.0001	0.0001
$ra=0.75$	−0.0219	0.0064	0.0139
Females		$Y=£11,654$	
$ra=0.25$	0.0008	0.0007	0.0009
$ra=0.75$	0.0838	0.0777	0.0816

Panel B: C **and** ρ **changing**

	$T_{ML}=5, \sigma=5\%, \gamma=9\%, \lambda=1\%, ra=0.75$		
	$\rho=8\%$	$\rho=15\%$	$\rho=30\%$
Males		$Y=£13,460$	
$C=3000$	0.0613	0.0652	0.0557
$C=9000$	0.0670	0.0607	0.0454
$C=27,000$	0.0778	0.0654	0.0475
Females		$Y=£11,654$	
$C=£27,000$	0.0816	0.0685	0.0498
Males		$Y=£24,511$	
$C=£27,000$	0.0319	0.0384	0.0316
Females		$Y=£24,026$	
$C=£27,000$	0.0331	0.0363	0.0309

fees: £3000 per year (current level in England) and £9000 per year (2010 English reform). The taxpayer subsidy is obtained as difference between the present value of the repayment stream and the present value of the education costs, like in Chapman and Lounkaew (2010). We use a discount rate of 2.2% per year[28] as in Dearden et al. (2008). We perform our analysis for both males and females.

In Fig. 7 we compare ML_1 and ICL_1 for the average graduate earnings distribution and costs of £9000. Males start repaying at 25 years old under both systems, with a decreasing burden of 6.5% under ML_1 and an increasing burden of around 4% under ICL_1. It is evident that under a mortgage loan males bear a higher burden when they have lower earnings, that is at the beginning of their working life. For females, whose earnings are on average lower than males, the difference in repayment burdens between the two systems is remarkable. They start to repay with a burden of 7% under a ML_1 and less than 4% under an ICL_1. Relatively to males, females' burdens show less variations during the repayment period due to the lower earnings variance.

In Table 5 we show the corresponding taxpayer subsidies for average earnings. Under ML_1, for both males and females the subsidy is 2.1% because the repayment period

[28] This follows the government's present convention for discounting. See Department for Education and Skills (2007).

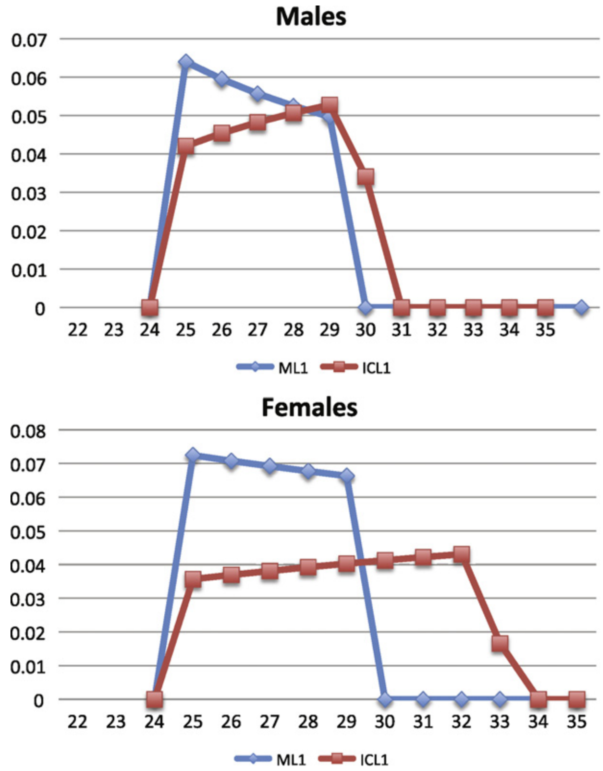

Fig. 7. Repayment burdens – ML_1 versus ICL_1 – average earnings.

Table 5
Taxpayer subsidies (%).

$C=£9000, Tresh_{ICL_1}=£15,000$				
	ML_1	ICL_1	ML_2	ICL_1^b
Average earnings				
Males	2.12	3.41		
Females	2.12	6.15		
Low earnings				
Males	2.12	77.33	17.76	88.66
Females	2.12	93.74	49.05	100
Median earnings				
Males	2.12	7.23		
Females	2.12	7.53		
High earnings				
Males	2.12	1.96		
Females	2.12	2.03		

$C=£27,000, Tresh_{ICL_2}=£21,000$		
	ML_1	ICL_2
Average earnings		
Males	2.12	14.89
Females	2.12	27.52

ICL_1^b: debt's forgiveness at 65 years old.
ML_1: no delayed repayments.
ML_2: threshold £15,000.
$T_{ML}=5$ years, $\gamma=9\%$.

is the same. Under ICL_1, the subsidy is higher compared to ML_1 for both males and females; for the latter it is almost double than males (6.1% versus 3.4%, respectively).

In Fig. 8, we compare ML_1 and ICL_2. We still assume average earnings but the loan size is bigger (£27,000). Under ML_1, for males we notice an initial burden of around 20% which decreases to 15% by the end of the repayment period. Under ICL_2, the initial burden is around 3% and never exceeds 5% after a 15-year repayment period. For females, the burden under ML_1 is heavier, it remains above 20% for all the repayment period. Whereas, under ICL_1 the burden never reaches 5% until the debt is extinguished at the age of 52. Under this system the debt is forgiven after 30 years. Looking at the taxpayer subsidy at the bottom of Table 5, for ML_1 is always 2.1%, but now under ICL_2 males exploit a subsidy of almost 15% and females of 27.5%.

We now analyze the case of low earnings graduates and costs of £9000, by comparing ICL_1 with ML_1 and ML_2. Looking at the top of Fig. 9, under ML_1 graduates are forced to start repaying at 25 years old and with burdens, almost constant, of 13% and 14% for males and females respectively.

The difference with ICL_1 is huge, males start to repay after 9 years, with a burden of around 1% and their debt is written off either at the age of 50 (i.e. after 25 years) or at the age of 65, according to the forgiveness rule applied. Females never start to repay if the debt is forgiven after 25 years, otherwise they would start paying at the age of 57 and for few years up to the age of 65. This case highlights the important insurance aspect of an ICL for individuals with low incomes or in financial hardship, and it well illustrates our theoretical findings in Proposition 1.

At the bottom of Fig. 9, we show the repayment burdens under ML_2 which is more beneficial for low earnings graduates since they can delay their repayments. Males start to

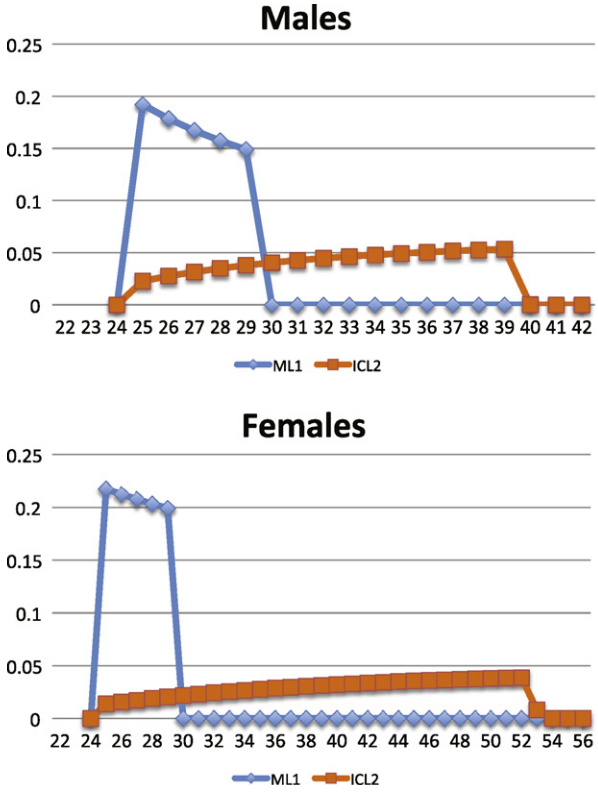

Fig. 8. Repayments burdens – ML_1 versus ICL_2 – average earnings and high costs.

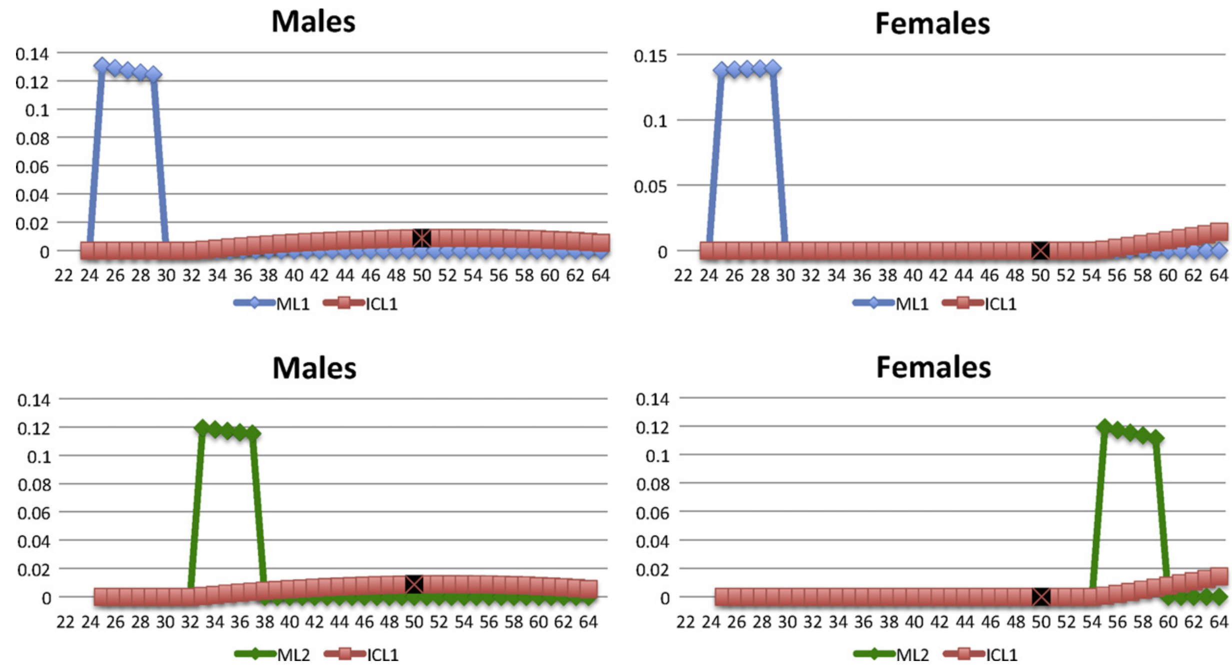

Fig. 9. Repayments burdens – ML_1 versus ICL_1 and ML_2 versus ICL_1 – low earnings.

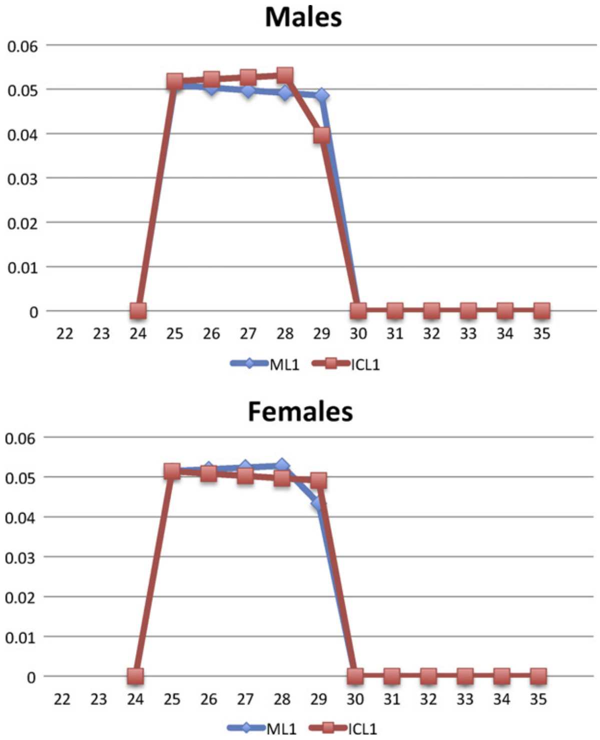

Fig. 10. Repayments burdens – ML_1 versus ICL_1 – high earnings.

repay after 9 years and their burden is slightly below 12% for the whole repayment period. For females this system is much more convenient since they start to repay after 30 years and with a burden below 12%.

Looking at Table 5, for low earnings the subsidy under ICL_1 varies from 77% to 88% for males, according to the forgiveness rule applied. Whereas for females the subsidy is around 94% if the debt is written off after 25 years, or 100% if it is forgiven at the age of 65. Under ML_1 the subsidy is still 2.1% for all graduates, but under ML_2 males exploit a subsidy of around 18% and females of 49%.

We do not show the repayment burdens for the median earnings because they are similar to those for the average earnings. However, in Table 5 we report the corresponding subsidies and we notice that under ICL_1 the subsidy is above 7% for males and females.

Finally, in Fig. 10 we illustrate the case of high earnings and costs of £9000. The results confirm that an income contingent loan is less beneficial for rich graduates, indeed the difference between ML_1 and ICL_1 is almost annulled. We observe the same repayment periods and very close burdens of around 5%, under both systems for males and females. This is also reflected in the taxpayer subsidy, which under ICL_1 is now slightly lower than ML_1 (still 2.1%).

8. Conclusion

In the first part of this work we presented a theoretical model which combined the riskiness of the investment in HE, due to the uncertainty of its outcomes, and two loan-based systems of funding higher education. We assumed that risk averse and risk neutral individuals take out a loan from the government to finance their education. We derived the lifetime expected utilities of graduates who receive a wage affected by a single stochastic shock and we compared graduates willingness to pay to switch from a ML to an ICL.

We analytically proved that risk neutral graduates always prefer an ICL. The findings for risk averse individuals were obtained by calibrating our model using real data on graduate earnings from the British Cohort Survey 1970 and using the features of the English higher education reform which has switched the funding system from a ML to an ICL and increased the university fees.

Our main results are that for high earnings uncertainty and for increasing risk aversion, graduates would pay more to switch to an ICL. We allowed for individual heterogeneity by considering different family backgrounds and occupations and we found that graduates from low educated parents, males and graduates working in the private sector are more willing to pay for an ICL. While female graduates and those with less dynamic careers, such as the public sector employees, have a weaker preference for an ICL.

We then generated graduates age-earnings profiles to evaluate the possible distributive effects of the two systems. First, we assumed a stochastic earnings growth rate and we compared the WTP using a numerical method. The results confirmed that high risk averse graduates are more willing to pay to switch to an ICL.

Second, using the UK Labour Force Survey we generated new age-earnings profiles for average, low and high earnings graduates. We then computed the repayment burdens and the taxpayer subsidies under a ML and an ICL, incorporating some features of the recent English HE reforms. The results confirmed the important insurance aspect of an ICL, which allows repayment delays, low burdens and very high taxpayer subsidies to graduates with low earnings. Therefore, an ICL is very beneficial for graduates who have lower earnings at the beginning of their working life, or for those that are in financial hardship. Conversely, for high earnings all the benefits of an ICL disappear and graduates have similar repayment burdens and subsidies under both loan systems.

Appendix A. Proofs

A.1. Proofs of Proposition 1

We know that $T_{ICL} = C/\gamma\tilde{y}$ and $T_{ML} = c/\varphi$, and given the assumption $E[\tilde{y}] = 1$ we compute the expected value of the repayment period under an ICL.

$$E(T_{ICL}) = E\left(\frac{C}{\gamma\tilde{y}}\right) = \frac{C}{\gamma} \times E\left(\frac{1}{\tilde{y}}\right)$$

by the Jensen's inequality we know that

$$\frac{C}{\gamma} \times E\left(\frac{1}{\tilde{y}}\right) > \frac{C}{\gamma E(\tilde{y})}$$

that implies

$$E\left(\frac{1}{\tilde{y}}\right) > 1.$$

Given this result it is straightforward to prove Proposition 1.

If $\gamma = \varphi$ then

$$E[RB_{ICL}] = \varphi < \varphi E\left(\frac{1}{\tilde{y}}\right) = E[RB_{ML}]$$

and also

$$\frac{C}{\gamma} \times E\left(\frac{1}{\tilde{y}}\right) > \frac{C}{\varphi} \rightarrow E(T_{ICL}) > T_{ML}.$$

A.2. No hidden subsidies

To rule out the hidden subsidies from an ICL we have to assume $E(T_{ICL}) = T_{ML}$ that means

$$\frac{C}{\gamma} \times E\left(\frac{1}{\tilde{y}}\right) = \frac{C}{\varphi}$$

we get γ:

$$\gamma = \varphi \times E\left(\frac{1}{\tilde{y}}\right) \Rightarrow \gamma > \varphi$$

since $E(1/\tilde{y}) > 1$. Therefore the expected repayments under the two systems are not the same.

A.3. Proof of Proposition 2

Under risk neutrality $u(\tilde{y}) = \tilde{y}$ and Eq. (1) becomes

$$V = E\left(\int_{s}^{\infty} e^{-\rho t}\tilde{y}\ dt\right) - E\left(\int_{s}^{T+s} e^{-\rho t}R\,dt\right) \quad (10)$$

So we can compare only the expected present value of the repayments substituting for each scheme the respective repayment period, T and $\tilde{T}$.

Under a ML the present value of the repayment of a loan of size C is:

$$PVP_{ML} = \int_{s}^{T+s} \varphi e^{-\rho t}\,dt = e^{-\rho s}\frac{\varphi}{\rho}[1 - e^{-\rho(C/\varphi)}]. \quad (11)$$

Under an ICL the present value of the repayment of a loan of size C is:

$$PVP_{ICL} = \int_{s}^{\tilde{T}+s} \tilde{y}\gamma e^{-\rho t}\,dt = e^{-\rho s}\frac{\gamma\tilde{y}}{\rho}[1 - e^{-\rho(C/\gamma\tilde{y})}]. \quad (12)$$

Knowing that $E(\tilde{y}) = 1$, we take the expected value of both the equations above.

$$E(PVP_{ML}) = \frac{\varphi}{\rho}[1 - e^{-\rho(C/\varphi E(\tilde{y}))}]e^{-\rho s} \quad (13)$$

$$E(PVP_{ICL}) = E\left[\frac{\gamma\tilde{y}}{\rho}(1 - e^{-\rho(C/\gamma\tilde{y})})e^{-\rho s}\right] \quad (14)$$

Case $\gamma = \varphi$

Under the condition of equal expected annual payments, we can easily observe that the expected values of all the payments throughout lifetime can be written:

$$E(PVP_{ML}) = f[E(\tilde{y})]$$

$$E(PVP_{ICL}) = Ef(\tilde{y})$$

Since $f(\tilde{y}) = (\gamma\tilde{y}/\rho)(1 - e^{-\rho C/\gamma\tilde{y}})e^{-\rho s}$ is a concave function,[29] by the Jensen's inequality we obtain that the expected repayments under an ICL are lower than the expected repayments under a ML: $E(PVP_{ICL}) < E(PVP_{ML})$. According to Eq. (10) the expected utility under an ICL is higher than the expected utility under a ML.

Appendix B. Expected utilities

B.1. Expected utility with a mortgage loan

The Taylor approximations in Eq. (3) are the following

$$\begin{aligned} E[u(\tilde{y} - \varphi)] &= E\left\{u(1-\varphi) + u'(1-\varphi)(\tilde{y}-1) + \frac{1}{2}u''(1-\varphi)(\tilde{y}-1)^2\right\} \\ &= u(1-\varphi) + u'(1-\varphi)E(\tilde{y}-1) + \frac{1}{2}u''(1-\varphi)E(\tilde{y}-1)^2 \\ &= u(1-\varphi) + \frac{1}{2}u''(1-\varphi)\sigma^2. \end{aligned} \quad (15)$$

$$E[u(\tilde{y})] \simeq u(1) + \frac{1}{2}u''(1)\sigma^2. \quad (16)$$

Plugging Eqs. (15) and (16) in Eq. (3), substituting $T = C/\varphi$ and solving the integral, we obtain:

$$\begin{aligned} V_{ML} = &\frac{e^{-\rho s}}{\rho}(1 - e^{-\rho C/\varphi})\left[u(1-\varphi) + \frac{1}{2}u''(1-\varphi)\sigma_s^2\right] \\ &+ \frac{e^{-\rho s}}{\rho}e^{-\rho C/\varphi}\left[u(1) + \frac{1}{2}u''(1)\sigma_s^2\right]. \end{aligned} \quad (17)$$

Finally, substituting a CRRA utility function $u(\tilde{y}) = \tilde{y}^b/b$ in Eq. (17) and simplifying we get Eq. (4).

B.2. Expected utility with an income contingent loan

From Eq. (5) solving the integral we get the following equation:

$$V_{ICL} = \frac{e^{-\rho s}}{\rho}E\{[1 - e^{-\rho C/\gamma\tilde{y}}]u[\tilde{y}(1-\gamma)] + [e^{-\rho C/\gamma\tilde{y}}]u(\tilde{y})\}. \quad (18)$$

To simplify the calculations we define the expression included in the expected value operator as:

$$g(\tilde{y}) = [1 - e^{-\rho C/\gamma\tilde{y}}]u[\tilde{y}(1-\gamma)] + [e^{-\rho C/\gamma\tilde{y}}]u(\tilde{y}) \quad (19)$$

We rewrite Eq. (18)

$$V_{ICL} = \frac{e^{-\rho s}}{\rho}E[g(\tilde{y})] \quad (20)$$

[29] $f''(\tilde{y}) = -(\rho C^2 e^{-(s+(C/\gamma\tilde{y}))\rho})/\gamma\tilde{y}^3$. It is reasonable to assume that γ, ρ and C are all greater or equal than zero. Therefore, the second derivative of $f(\tilde{y})$ is always negative when the shock on earnings is positive: $f''(\tilde{y}) < 0, \forall\, \tilde{y} > 0$.

and we apply a second order Taylor expansion to $E[g(\tilde{y})]$, around the mean $E[\tilde{y}] = 1$, then:

$$E[g(\tilde{y})] = E\left\{g(1) + g'(1)(\tilde{y}-1) + g''(1)\frac{(\tilde{y}-1)^2}{2}\right\}$$
$$= g(1) + g'(1)E(\tilde{y}-1) + \frac{g''(1)}{2}E(\tilde{y}-1)^2$$
$$= g(1) + g''(1)\frac{\sigma_s^2}{2}. \quad (21)$$

Eq. (20) becomes

$$V_{ICL} = \frac{e^{-\rho s}}{\rho}\left[g(1) + g''(1)\frac{\sigma_s^2}{2}\right] \quad (22)$$

From now on we follow this procedure:

1. we work out the value of g(1), in general and with a CRRA utility function;
2. we work out the first derivative and the second derivative of g($\tilde{y}$), both in general and with a CRRA utility function;
3. we calculate $g'(1)$ and $g''(1)$ using a CRRA utility function;
4. we substitute the equations of $g(1)$ and $g''(1)$, using a CRRA utility function, in Eq. (22) and we obtain Eqs. (29) and (6).

- **Value of $g(1)$**

In general,

$$g(1) = [1 - e^{-\rho C/\gamma}]u[(1-\gamma)] + [e^{-\rho C/\gamma}]u(1) \quad (23)$$

Using a CRRA utility function we have

$$g(1)_{CRRA} = \frac{1}{b}[-e^{-\rho C/\gamma}((1-\gamma)^b - 1) + (1-\gamma)^b]. \quad (24)$$

- **Value of $g'(\tilde{y})$**

In general,

$$g'(\tilde{y}) = u'[\tilde{y}(1-\gamma)](1-\gamma)[1 - e^{-\rho C/\gamma\tilde{y}}] + u[\tilde{y}(1-\gamma)]\left[\frac{-\rho C e^{-\rho C/\gamma\tilde{y}}}{\gamma\tilde{y}^2}\right]$$
$$+ u'(\tilde{y})[e^{-\rho C/\gamma\tilde{y}}] + u(\tilde{y})\left[\frac{\rho C e^{-\rho C/\gamma\tilde{y}}}{\gamma\tilde{y}^2}\right] \quad (25)$$

using a CRRA utility function:

$$g'(\tilde{y})_{CRRA} = (\tilde{y}(1-\gamma))^{b-1}(1-\gamma)[1 - e^{-\rho C/\gamma\tilde{y}}] + (\tilde{y}(1-\gamma))^b$$
$$\times\left[\frac{-\rho C e^{-\rho C/\gamma\tilde{y}}}{b\gamma\tilde{y}^2}\right] + \tilde{y}^{b-1}[e^{-\rho C/\gamma\tilde{y}}] + \left[\frac{\tilde{y}^{b-2}\rho C e^{-\rho C/\gamma\tilde{y}}}{b\gamma}\right]. \quad (26)$$

- **Value of $g''(\tilde{y})$**

$$g''(\tilde{y}) = \frac{e^{-\rho C/\gamma\tilde{y}}\rho C(2\gamma\tilde{y} - \rho C)}{\tilde{y}^4\gamma^2}u[\tilde{y}(1-\gamma)] + \frac{e^{-\rho C/\gamma\tilde{y}}\rho C(-2\gamma\tilde{y} + \rho C)}{\tilde{y}^4\gamma^2}u(\tilde{y})$$
$$- \frac{2e^{-\rho C/\gamma\tilde{y}}\rho C(1-\gamma)}{\tilde{y}^2\gamma}u'[\tilde{y}(1-\gamma)] + \frac{2e^{-\rho C/\gamma\tilde{y}}\rho C}{\tilde{y}^2\gamma}u'(\tilde{y})$$
$$+ [1 - e^{-\rho C/\gamma\tilde{y}}](1-\gamma)^2 u''[\tilde{y}(1-\gamma)] + [e^{-\rho C/\gamma\tilde{y}}]u''(\tilde{y}). \quad (27)$$

Now we work out $g''(\tilde{y})$ using a a CRRA and evaluating in $\tilde{y} = 1$

$$g''(1)_{CRRA} = \frac{1}{b\gamma^2}\{e^{-\rho C/\gamma}[(b-1)b\gamma^2[1 + (e^{\rho C/\gamma\tilde{y}} - 1)(1-\gamma)^b]$$
$$+ 2\rho C(b-1)\gamma(1-(1-\gamma)^b) + C^2\rho^2(1-(1-\gamma)^b)]\}. \quad (28)$$

- **Results**

Substituting $g(1)$ and $g''(1)$ in Eq. (22) we get the general expected utility under an income contingent loan:

$$V_{ICL} = [1 - e^{-\rho C/\gamma}]u[(1-\gamma)] + [e^{-\rho C/\gamma}]u(1)$$
$$+ \left[\frac{e^{-\rho C/\gamma}\rho C(2\gamma - \rho c)}{\gamma^2}u[1-\gamma] + \frac{e^{-\rho C/\gamma}\rho C(-2\gamma + \rho c)}{\gamma^2}u(1)\right.$$
$$- \frac{2e^{-\rho C/\gamma}\rho C(1-\gamma)}{\gamma}u'[1-\gamma] + \frac{2e^{-\rho C/\gamma}\rho C}{\gamma}u'(1)$$
$$\left. + [1 - e^{-\rho C/\gamma}](1-\gamma)^2 u''[1-\gamma] + [e^{-\rho C/\gamma}]u''(1)\right]\frac{\sigma_s^2}{2}. \quad (29)$$

Substituting in Eq. (22) the equations for $g(1)$ and $g''(1)$ with a CRRA utility function, we obtain Eq. (6).

Appendix C. Numerical method – Brownian motion

1. We generate a path of annual earnings for an individual working life. Since the problem requires a discrete solution, we apply the Euler–Maruyama method that takes the form

$$y_j = y_{j-1} + y_{j-1}\lambda\,\Delta t + y_{j-1}\sigma(W(\tau_j) - W(\tau_{j-1})). \quad (30)$$

To generate the increments $W(\tau_j) - W(\tau_{j-1})$ we compute discretized Brownian motion paths, where $W(t)$ is specified at discrete t values. As explained in Higham (2001) we first discretize the interval $[0, I]$. We set $dt = I/N$ for some positive integer N, and let W_j denote $W(t_j)$ with $t_j = j\,dt$. According to the properties of the standard Brownian motion $W(0) = 0$ and

$$W_j = W_{j-1} + dW_j \quad (31)$$

where dW_j is an independent random variable of the form $\sqrt{dt}N(0,1)$. The discretized Brownian motion path is a 1-by-N array, where each element is given by the cumulative sum in Eq. (31). To generate Eq. (30), we define $\Delta t = I/L$ for some positive integer L, and $\tau_j = \Delta t$. As in Higham (2001) we choose the stepsize Δt for the numerical method to be an integer multiple $R \geq 1$ of the Brownian motion increment dt: $\Delta t = R\,dt$. Finally, we get the increment in Eq. (30) as cumulative sum:

$$W(\tau_j) - W_(\tau_{j-1}) = W(jR\,dt) - W((j-1)R\,dt)$$
$$= \sum_{h=jR-R+1}^{jR} dW_h. \quad (32)$$

The Brownian motion of Eq. (31) is produced setting $I = 1$ and $N = 160$ in order to have a small value of

dt. Using a random number generator we produce 160 "pseudorandom" numbers from the $N(0, 1)$ distribution. The increments of Eq. (32) are computed setting $R = 4$, in order to have 40 annual earnings.

2. Income contingent loan. We work out the yearly repayments as fixed percentage of the stochastic earnings generated. If the earnings are higher than £15,000 the payments are positive, otherwise they are zero. We then built a vector whose elements are the cumulative sum of the repayments, in order to see the amount of loan repaid. To obtain the repayment period, we observe the years in which the cumulative sum of the payments is equal[30] to the cost of education. We work out the individual utility as discounted sum of the net earnings during and after the repayment period, up to the end of the working life. We use a CRRA utility function.
3. Mortgage loan. We set the fixed repayment period as the ratio between the cost of education and the annual installment. The individual utility is given by the discounted sum of the net earnings during and after the repayment period. We use a CRRA utility function.
4. From steps (2) and (3) we obtain a single value for the utility for an individual earnings path generated in point (1). We generalize our method generating a high number of earnings paths (1000) and for each path we compute a level of utility. We then work out the average utility under both financing scheme.
5. We let the various parameters change, we repeat steps (1)–(4), and we compute how much graduates are willing to pay to switch from a ML to an ICL. This is expressed as a proportion of the initial debt, i.e. the cost of education.

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[30] Since it is almost impossible to get a value equal to the cost, when the repayment is slightly greater than it we assume the debt has been paid off.