Financing schemes for higher education

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Abstract

Most industrial countries have traditionally subsidized the provision of higher education. Several alternative financing schemes, which rely on larger contributions from students, have been recently proposed. Schemes such as income contingent loans and graduate taxes provide insurance against uncertain educational outcomes. This paper analyses alternative financing schemes for higher education, with particular emphasis on the role of insurance, and provides new insights to the current policy debate.

Keywords: higher education finance, insurance, moral hazard

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1 Introduction

Most industrial countries have traditionally subsidized the provision of higher education. Several alternative financing schemes, which rely on larger contributions from students, have been recently proposed. Schemes such as income contingent loans provide insurance against uncertain educational outcomes, which is considered a desirable feature. This paper analyses alternative financing schemes for higher education with particular emphasis on the role of insurance.

García-Peñalosa and Walde (2000) argue that the traditional tax-subsidy scheme is regressive. For this reason, they consider three alternative financial schemes: 1) a pure loan scheme, 2) a system of income contingent loans, and 3) a graduate tax. A pure loan scheme is a public loan with mortgage-type repayments. Each individual pays back exactly the amount she has borrowed plus interest. A system of income contingent loans makes repayments conditional on whether the income of the student exceeds a pre-specified level and computes repayments as a percentage of her earnings. From an analytical perspective, the main feature is that low-earning graduates do not fully pay back their education cost and are subsidized by general taxation. In the terminology we choose to employ, taken from Chapman (forthcoming), this description characterises a risk-sharing income contingent loan, because the risk is shared with the whole population. The graduate tax that García-Peñalosa and Walde consider consists of a public subsidy to education, which also makes repayments contingent on income, but where repayments by high-earnings graduates, exceeding the cost of their education, are used to subsidize low-earnings graduates. This system is self-financed since there are no subsidies from general taxation to higher education nor surplus. As will be made clear in this paper, this description rather corresponds to a system of income contingent loans of the risk pooling type, since students pool risks. In what is generally known as a graduate tax there is no relation between revenue and the cost of higher education: graduates simply pay a given percentage of their earnings during a given period that can be their whole working life. The revenue thus obtained may be used to finance higher education or other expenses.[1]

García-Peñalosa and Walde (2000) show that, when education outcomes are uncertain, the graduate tax is better than a pure loan, because it provides greater insurance, and it is also preferable to an income contingent loan scheme, on the grounds that the latter implies some reverse redistribution. Redistributional effects are however not fully explored, since the model used to analyze the loans and the graduate tax, unlike the one used to study the tax-subsidy system, does not account for general equilibrium effects of higher education participation rates on wages.

To our knowledge, the only contribution that deals with higher education finance in the presence of moral hazard considerations is Cigno and Luporini (2003). They argue that student loans, even income contingent ones, are not optimal, where optimality takes into consideration both efficiency and redistribution. Potential university students with the appropriate character-

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[1]Department for education and skills of the UK government (http://www.dfes.gov.uk/)

istics should be offered a scholarship, dependent on both need and merit. The scheme should be financed by a graduate tax[2] that redistributes from the better paid to the academically more successful. While merit requirements to access the scholarship limit the effect of adverse selection, redistribution towards the academically more successful limits the effect of moral hazard. The fact that both the scholarship and the repayment that characterize the optimal policy depend on the grades obtained in higher education may imply, in our view, some non-negligible problems of practical implementation. Further, we opt in this paper to abstract from the issue of redistribution and focus instead on determining the most efficient way to finance higher education.

Our model is fundamentally based on García-Peñalosa and Walde's. However, it differs in several respects. First, in our model, individuals differ in ability to accumulate human capital rather than inheritance. When individuals differ in inheritance, at the social optimum it is optimal that either none or all study. When individuals differ in ability, the output is maximized when only the most able undertake education. In our view, this provides a better benchmark.

Second, we consider a single framework with exogenously given wages, where we analyze and compare in efficiency terms the following alternative finance schemes for education: 1) the traditional tax subsidy system - where the cost of education is shared by all the population-, 2) pure loans - where each student pays for her own education-, 3) income contingent loans of the risk sharing type - where successful graduates pay the full cost of their education and the cost of the education of unsuccessful graduates is shared by the whole population (including, of course, unsuccessful students themselves, a fact that is often forgotten when evaluating income contingent loans), and 4) income contingent loans of the risk pooling type - where successful students pay the full cost of the education of their cohort. The graduate tax is not evaluated, as it does not constitute in our view a pure education finance scheme.

We show that, under risk neutrality, the traditional tax subsidy system induces the highest participation, at inefficient levels. The income contingent loan with risk sharing produces a lower number of graduates, although still inefficiently high. Both the loan and the income contingent loan with risk pooling induce the optimal degree of participation in higher education.

Risk aversion reduces participation under each finance scheme and, for a sufficiently large level of risk aversion, the ordering of participation levels across schemes may change. We provide a sufficient condition for this ordering to remain the same. For all levels of risk aversion, participation is lowest under the pure loan scheme.

Finally, we analyze the relative role of insurance in the three schemes and propose a new one that, by fully insuring the last individual who enrolls in higher education, induces the optimal level of participation.

The paper is organized as follows. We first present the model and identify the social optimum in sections 2 and 3. Then, in section 4, we study each finance scheme when preferences are

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[2]Once again the system is self financed, which does not correspond to what is generally known as a graduate tax

3

characterized by risk neutrality and risk aversion, respectively. In section 5 we analyze relative participation. In section 6 we investigate the role of insurance implicit in each funding scheme and in section 7 we conclude.

2   The model

We consider a very simple economy in which N individuals live for 2 periods. In the first period they can either work for a low skilled wage or study. Education is tuition free or fully subsidized in the first period. E is the per capita cost of education (i.e., the size of the subsidy). Individuals who study forgo the low skilled wage and they are not subsidized for this loss.

In the second period all individuals work and some of them (maybe all) contribute to finance the education of their cohort. Those who did not study continue to receive the low skilled wage. Those who studied are unlucky with probability $(1-p)$ and earn a low skilled wage, and they are lucky with probability p and earn a high skilled wage that depends on their ability a (distributed with density function $f(a)$). In other words, luck is independent of ability but only the productivity of lucky individuals reflects both their ability and education. Unlucky graduates simply receive a fixed low skilled wage.[3] Wages are assumed to be exogenously given, with with $w_H(a) > w_L$ for all a.[4]

The government subsidizes education and raises the necessary revenue in a manner that differs according to the financing scheme. In all systems, a potentially different amount of individuals, H, enroll in higher education and receive the subsidy E in the first period.[5] In the tax-subsidy system, all the population shares the costs in the second period. Therefore each individual pays HE/N in present value terms, irrespective of her situation. In the risk sharing income contingent plan, successful graduates pay back the cost of their education. However, unsuccessful graduates do not and the cost of their education is equally shared by all the population (including themselves). In present value terms, successful graduates pay $E + (1-p)HE/N$ and unsuccessful graduates and non educated individuals pay $(1-p)HE/N$ (i.e., their share of the cost of unsuccessful graduates). In the risk pooling income contingent plan, successful graduates pay the full cost of higher education (i.e., neither unsuccessful graduates nor non-educated individuals contribute). In present value terms, successful graduates pay E/p. Under a pure loan scheme, students pay back the cost of their education in the second period, whether they are successful or not (i.e., the penalty for default is extreme).

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[3]Uncertainty can take different forms: a student might not be employed as skilled worker once education is completed, or the probability to succeed depends on effort, ability, requirements of course undertaken. We focus so far on the simplest form of uncertainty: exogenous p. An agent who invests in education is employed as high-skill with probability $p \in (0,1)$.

[4]It would be interesting to consider in the future complementarities between skilled and unskilled workers in the production technology. The wages would then depend on the number of skilled and unskilled individuals in the population, as in García-Peñalosa and Walde (2000) for the case of the tax-subsidy.

[5]For this preliminary description of the financing schemes, we ignore superscripts on H. These will be introduced when each financing scheme is analyzed in turn.

To sum up, we consider individuals that differ only in ability. Their ability affects their wage only if they are successful graduates. Otherwise, wages are exogenously given. Education is subsidized in the first period and paid for in the second by means of transfers. The probability of success (or luck) is, for the moment, given.

It is worthwhile to recall that our objective is to determine which higher education financing scheme maximizes output. The only role for government is to subsidize education and raise the necessary revenue. We compare different ways of raising the revenue. We are not considering redistribution or externalities.

3 The social optimum

Individuals differ in ability, which affects the potential benefits of education. In this section we look for the threshold ability above which individuals should invest in education if the objective is to maximize output.

It is optimal that an individual studies when her expected earnings as a graduate net of the cost of her education exceed her earning as a non-graduate. If R is the exogenous discount rate, the condition is:

$$R\left[pw_H\left(a\right) + \left(1 - p\right)w_L\right] - E > \left(1 + R\right)w_L$$

It is possible to determine a threshold ability level, $\widehat{a}$, above which an individual should study and below which an individual should not study:

$$R\left[pw_H\left(\widehat{a}\right) + \left(1 - p\right)w_L\right] - E = \left(1 + R\right)w_L \tag{1}$$

The optimal number of graduates is $H^* = \int_{\widehat{a}} f(a)da$.

We will hereafter consider the determination of threshold ability levels and the number of graduates under the different financing schemes outlined above. We do so for a benchmark case of risk neutrality and for the more interesting case of risk aversion. In order to represent risk aversion we adopt first an expected utility approach and we assume that preferences are represented by a concave utility function $U\left(.\right)$.

4 Alternative financing schemes

In this section, we determine the threshold ability levels above which individuals are willing to invest in higher education for each financing scheme.

4.1 Traditional tax-subsidy scheme

The relevant policy parameters considered are E, the subsidy received in the first period by those who study, and T, the lump-sum tax paid in the second period. The government budget

constraint is, hence,

$$T^{TS}R = \frac{EH^{TS}}{N}.$$

The expected lifetime income of a graduate of ability a is

$$(1-p)Rw_L + pRw_H(a) - \frac{H^{TS}E}{N},$$

where the superscript TS stands for tax-subsidy system. If we compare it with the lifetime income of a non-graduate, in this case

$$(1+R)w_L - \frac{H^{TS}E}{N},$$

we can determine a threshold ability level $\widehat{a}^{TS}$ for risk neutral agents that satisfies

$$(1-p)Rw_L + pRw_H\left(\widehat{a}^{TS}\right) = (1+R)w_L. \tag{2}$$

It is worth noticing that $\widehat{a}^{TS} < \widehat{a}$. Thus, more than the optimal amount of individuals become educated. This is due to the fact that individuals who do not study are worse-off under the tax-subsidy policy, and some of them prefer then to invest in education.

Let $G^{TS}(a)$ denote the expected net utility gain from investing in higher education under the tax-subsidy system for an individual with ability a. Hence,

$$G^{TS}(a) \equiv (1-p)U\left(Rw_L - \frac{H^{TS}E}{N}\right) + pU\left(Rw_H(a) - \frac{H^{TS}E}{N}\right) - U\left((1+R)w_L - \frac{H^{TS}E}{N}\right) \tag{3}$$

with

$$\frac{dG^{TS}(a)}{da} = pU'\left(Rw_H(a) - \frac{H^{TS}E}{N}\right)Rw_H'(a) > 0.$$

The expected net utility gain from investing in higher education thus increases with ability.[6] More able individuals have higher expected utility from studying than less able individuals, and will be more likely to choose higher education.

We denote by $\underline{a}^{TS}$ the ability of the individual who is indifferent between investing in education and not investing, or threshold ability, when there is risk aversion under the tax-subsidy system. This threshold level is given by

$$G^{TS}\left(\underline{a}^{TS}\right) = 0. \tag{4}$$

The total number of students is

$$H^{TS} = \int_{\underline{a}^{TS}} f(a)\,da. \tag{5}$$

$\underline{a}^{TS}$ and H^{TS} are simultaneously determined by (4) and (5).

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[6]This holds for all schemes considered.

Risk aversion reduces participation (i.e., $\underline{a}^{TS} > \widehat{a}^{TS}$). To see this, evaluate equation (3) at $\widehat{a}^{TS}$ and use (2). Then,

$$
\begin{aligned}
G^{TS}(\widehat{a}^{TS}) &= (1-p)U\left(Rw_L - \frac{H^{TS}E}{N}\right) + pU\left(Rw_H\left(\widehat{a}^{TS}\right) - \frac{H^{TS}E}{N}\right) \\
&\quad -U\left(R\left[(1-p)w_L + pw_H\left(\widehat{a}^{TS}\right)\right] - \frac{H^{TS}E}{N}\right) < 0
\end{aligned}
$$

due to risk aversion. Since $G^{TS}(a)$ is increasing and $G^{TS}(\underline{a}^{TS}) = 0$ this implies that $\underline{a}^{TS} > \widehat{a}^{TS}$: participation falls with risk aversion.

It is in principle ambiguous whether $\underline{a}^{TS}$ is greater or smaller than the optimal ability threshold, $\widehat{a}$. For mild risk aversion, $\widehat{a}^{TS} < \underline{a}^{TS} < \widehat{a}$, whereas $\widehat{a}^{TS} < \widehat{a} < \underline{a}^{TS}$ if individuals are sufficiently risk averse.

4.2   Pure loan scheme

Under a pure loan scheme, any individual who studies pays the full education cost, E, irrespective of whether or not she succeeds in education. The expected lifetime income of a graduate of ability a is:

$$
(1-p)Rw_L + pRw_H(a) - E.
$$

If we compare this with the lifetime income of a non-graduate, in this case $(1+R)w_L$, we can obtain the threshold ability level $\widehat{a}^L$ (i.e., the threshold ability level for the loan scheme if individuals are risk-neutral). The optimal amount of individuals become educated (i.e., $\widehat{a}^L = \widehat{a}$).

Let $G^L(a)$ denote the expected net utility gain from investing in higher education under the pure loan scheme for a risk averse individual with ability a. Hence,

$$
G^L(a) \equiv (1-p)U(Rw_L - E) + pU(Rw_H(a) - E) - U((1+R)w_L). \tag{6}
$$

We denote by $\underline{a}^L$ the ability of the individual who is indifferent between investing in education and not investing when there is risk aversion under the pure loan scheme. This threshold level is given by

$$
G\left(\underline{a}^L\right) = 0.
$$

The total number of students is then

$$
H^L = \int_{\underline{a}^L} f(a)\,da.
$$

Ss before, risk aversion reduces participation. As a result, the number of students will be smaller than the optimal one (i.e., $\widehat{a} < \underline{a}^L$). Hence, when there is risk aversion, the provision of loans does not result in the efficient allocation.

4.3 Income contingent loan with risk sharing

Several countries have recently introduced income contingent loan schemes in order to finance higher education expenses. The Higher Education Contribution Scheme (hereafter, HECS), established in Australia in 1989, was the first broadly based income contingent loan policy adopted in the world.

An income contingent loan is a loan the student receives from the state with the following characteristics: repayment only takes place in the event that the income after the period of education exceeds a pre-specified level, annual repayments do not constitute more than a certain proportion of her income, and repayment ceases once the loan plus interest has been repaid.[7] Successful graduates pay the amount of their loan plus interest while the cost of the education of unsuccessful graduates is shared by the whole population.

We model this type of income contingent loan as in García-Peñalosa and Walde (2000). We add however the term "risk sharing". All individuals who want to study borrow E. Only those individuals who are successful have to repay the amount in full. However, a lump-sum tax is levied on all individuals in order to raise the revenue needed to cover the education cost of unsuccessful students, $(1-p)H^{RS}E$, where the superscript RS stands for risk-sharing income contingent loan scheme. The total revenue, in present value terms, is $RT^{RS}N$. Note that

$$RT^{RS} = \frac{(1-p)H^{RS}E}{N} < E.$$

The lump sum tax is then smaller than the cost of education. This is so because successful graduates already pay their own cost of education, and the lump sum tax is used to finance the cost of education of unsuccessful graduates only.

The expected lifetime income of a graduate of ability a is

$$R\left[(1-p)w_L + pw_H(a)\right] - E\left[\frac{(1-p)H^{RS}}{N} + p\right].$$

Note that

$$(1-p)\frac{H^{RS}}{N} + p < 1,$$

since, as just mentioned, students do not expect to pay the full cost of education, which is partly subsidized by non students. If we equate the expected lifetime income of a graduate of ability a with the lifetime income of a non-graduate, in this case $(1+R)w_L - RT^{RS}$, we can determine a threshold ability level $\widehat{a}^{RS}$:

$$(1-p)Rw_L + pRw_H\left(\widehat{a}^{RS}\right) - pE = (1+R)w_L. \tag{7}$$

---

[7] In Australia the debt is indexed by the rate of inflation but there is no additional interest charged. It can thus be considered that the real interest rate is zero. There is some controversy on whether this is indeed the case since the 25% discount to charges paid up-front could imply an implicit interest rate on the loan. In the case the real interest is zero, there is an implicit subsidy for both high- and low-earning graduates. The magnitude of the implicit subsidy depends crucially on the rate of preference for time and the pattern of repayments.

It can be shown that

$$\widehat{a}^{TS} < \widehat{a}^{RS} < \widehat{a} = \widehat{a}^{L}.$$

More than the optimal amount of individuals become educated, but less than under the tax-subsidy system. This is due to the fact that higher education is subsidized by non students, although less than in the tax-subsidy system.

The expected utility gain from investing in education is given by

$$
\begin{aligned}
G^{RS}(a) \;\; &\equiv \;\; (1-p)U\left(Rw_L - (1-p)\frac{HE}{N}\right) + pU\left(Rw_H\left(a\right) - E(1 + (1-p)\frac{HE}{N})\right) - \\
&\quad -U\left((1+R)w_L - (1-p)\frac{HE}{N}\right)
\end{aligned}
\tag{8}
$$

We denote by $\underline{a}^{RS}$ the ability of the individual who is indifferent between investing in education and not investing when there is risk aversion under the risk-sharing income contingent loan scheme. This threshold level is given by

$$G^{RS}\left(\underline{a}^{RS}\right) = 0. \tag{9}$$

The total number of students is given by

$$H^{RS} = \int_{\underline{a}^{RS}} f\left(a\right) da. \tag{10}$$

$\underline{a}^{RS}$ and H^{RS} are simultaneously determined by equations (9) and (10).

Once again, risk aversion reduces participation (i.e., $\underline{a}^{RS} > \widehat{a}^{RS}$), but it is in principle ambiguous whether $\underline{a}^{RS}$ is greater or smaller than the optimal ability threshold, $\widehat{a}$. For mild risk aversion, $\widehat{a}^{RS} < \underline{a}^{RS} < \widehat{a}$, whereas $\widehat{a}^{RS} < \widehat{a} < \underline{a}^{RS}$ if individuals are sufficiently risk averse.

4.4   Income contingent loan with risk pooling

All income contingent loan schemes must contend with the fact that some participants in the scheme will default or have insufficient incomes to fully repay their loan balances. A risk pooling income contingent plan consists of a mutual fund in which participants are grouped in a common repayment cohort with collective, rather than individual, repayment responsibilities over a certain period. Then, the repayment deficit from lower earners is compensated by the repayment surplus of higher earners.

The Yale Tuition Postponement Option was among the first and best known implementations of an income contingent loan scheme as mutual fund. For a few years in the 1970s, students at Yale could borrow from the University to fund education with repayment being contingent on income earned in the years after graduation. All students graduating in any year with an outstanding debt were grouped in repayment cohorts with collective repayment responsibilities. An individual student's contractual obligation did not terminate upon repayment of her individual loan balance, instead her obligations concluded only when her cohort repaid the aggregate

loan balance, or after 35 years. Clearly, under these conditions, higher earners face participation disincentives. Given that the Yale Plan was not universal this led to important problems of adverse selection. Nevertheless, in order to be consistent with the schemes previously considered, we will focus on risk pooling income contingent loan plans that are universal.

As noted previously, proposals such as graduate taxes require graduates to pay a fixed proportion of their income to a government or mandated authority till retirement, or for life. Moreover, proceeds do not necessarily finance higher education. Important features of this scheme, which distinguishes it from the risk pooling income contingent plan previously mentioned, are that there is no termination date and the aggregate payments are not fixed. Graduate taxes may in fact be viewed as a special case of those loans where the penalty for opting out and the term of the loan are infinite and all proceedings are used for education finance. In those conditions adverse selection is likely to be an important problem, and most proposals suggest, accordingly, compulsory participation.

Under a risk pooling income contingent plan, as defined here, all individuals who want to study borrow E, but only those individuals who are successful have to repay the amount in full. However, successful individuals also have to pay the debt of the unsuccessful students. Successful students pay

$$E + \frac{(1-p)H^{RP}E}{pH^{RP}} = \frac{E}{p},$$

where the superscript RP stands for risk-pooling.

The expected lifetime income of a graduate of ability a is

$$R\left[(1-p)w_L + pw_H\left(a\right)\right] - E.$$

This can be compared with the expected lifetime income of a non-graduate, $(1+R)\,w_L$. If we denote by $\widehat{a}^{RP}$ the threshold ability level under this loan scheme if individuals are risk-neutral, then

$$R\left[(1-p)w_L + pw_H\left(\widehat{a}^{RP}\right)\right] - E = (1+R)\,w_L. \tag{11}$$

The optimal amount of individuals become educated (i.e., $\widehat{a}^{RP} = \widehat{a}$).

If $G^{RP}(a)$ denotes the expected gain from investing in education,

$$G^{RP}(a) = (1-p)U\left(Rw_L\right) + pU\left(Rw_H\left(a\right) - E/p\right) - U\left((1+R)\,w_L\right), \tag{12}$$

then $G^{RP}\left(\underline{a}^{RP}\right) = 0$ yields the threshold ability level, $\underline{a}^{RP}$, of the individual who is indifferent between investing in education and not with risk aversion. The total number of students is given by:

$$H^{RP} = \int_{\underline{a}^{RS}} f\left(a\right)da. \tag{13}$$

If agents are risk-averse, the resulting number of students will be smaller than the optimal one (i.e., $\widehat{a} < \underline{a}^{RP}$). It can also be shown that, for any given degree of risk aversion, $\underline{a}^{RP} < \underline{a}^{L}$, (i.e., participation is larger with the risk pooling scheme as compared with the straight loan).

10

For any a, the expected utility is greater in the risk pooling case and the safe option is the same in both. So $G^{RP}(a) > G^L(a)$ for all a.

5   Analyzing participation with risk aversion

We have shown that, under risk neutrality,

$$\widehat{a}^{TS} < \widehat{a}^{RS} < \widehat{a} = \widehat{a}^L = \widehat{a}^{RP}.$$

We have also shown that risk aversion reduces participation in each system with respect to participation levels corresponding to risk neutrality.

Because the risk pooling and the loan threshold levels under risk neutrality coincide with the optimal one, less than the optimal number of students study with risk aversion for both schemes. Moreover, for any a, the expected utility is greater in the risk pooling case than in the pure loan case, while the safe option (not to study) is the same in both. So $G^{RP}(a) > G^L(a)$ for all a and

$$\widehat{a} < \underline{a}^{RP} < \underline{a}^L.$$

It can also be shown that both $\underline{a}^{TS}$ and $\underline{a}^{RS}$ are smaller than $\underline{a}^L$ since, in both cases, the expected utility with education is higher and the utility without education lower, as compared to the pure loan. However, $\underline{a}^{TS}$ and $\underline{a}^{RS}$ can be below or above the optimum depending on the degree of risk aversion. The relationship between $\underline{a}^{TS}$, $\underline{a}^{RS}$, and $\underline{a}^{RP}$ also depends on the degree of risk aversion.

For low degrees of risk aversion, we know that $\underline{a}^{TS} < \underline{a}^{RS} < \underline{a}^{RP}$, and, hence, $H^{TS} > H^{RS} > H^{RP}$. We also know that the thresholds move to the right as risk aversion increases, reducing participation, but they may do so at different rates. For a sufficiently large level of risk aversion, the ordering of participation levels across schemes may change. We now provide a sufficient condition for the ordering to remain the same.

Assume that $H^{TS} > H^{RS}$. Hence, $H^{TS} > (1-p) H^{RS}$ and the utility without education is smaller under the tax-subsidy scheme. If the expected utility with education under the tax-subsidy scheme is larger or equal than under the risk-sharing income contingent loan then $G^{TS}(a) > G^{RS}(a)$, consistent with $H^{TS} > H^{RS}$.

In Figure 1 we represent, for each finance scheme $j = TS, RS, RP, L$, the income obtained by a successful student, y_S^j, against the income she obtains when unsuccessful, y_U^j. The 45-degree line is known as the certainty line. Iso-expected income lines, which are tangent to indifference curves at the 45-degree line, have slope $-(1-p)/p$. Indifference curves are convex due to risk aversion.
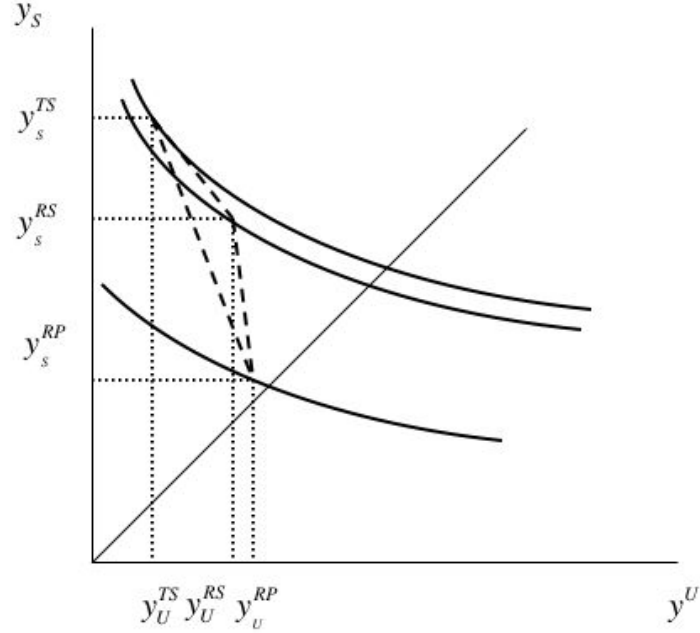
11

Figure 1: Representation of the tax-subsidy, risk-sharing and risk-pooling allocations

The expected utility of any point (y_U^j, y_S^j) is higher the higher the indifference curve that goes through it. The expected utility of (y_U^{TS}, y_S^{TS}) is higher when the slope of the indifference curve at (y_U^{TS}, y_S^{TS}) is lower or equal than the slope of the line that links (y_U^{TS}, y_S^{TS}) and (y_U^{RS}, y_S^{RS}):

$$|MRS_{y_S, y_U}^{TS}| \leq \frac{N}{H^{TS} - (1-p)H^{RS}} - 1$$

This condition, that guarantees that $G^{TS}(a) > G^{RS}(a)$, also guarantees that $G^{RS}(a) > G^{RP}(a)$. To see this note that the utility of without education is always lower under the risk sharing than under the risk pooling scheme. For $G^{RS}(a) > G^{RP}(a)$ it is sufficient if the expected utility with education under the risk-sharing scheme is larger or equal than under the risk-pooling scheme. This will be the case if the slope of the indifference curve at (y_U^{RS}, y_S^{RS}) is lower or equal than the slope of the line that links (y_U^{RS}, y_S^{RS}) and (y_U^{RP}, y_S^{RP}):

$$|MRS_{y_S, y_U}^{RS}| \leq \frac{N}{pH^{RS}} - 1$$

$H^{TS} > H^{RS}$ implies that

$$\frac{N}{H^{TS} - (1-p)H^{RS}} - 1 < \frac{N}{pH^{RS}} - 1,$$

12

whereas $H^{TS} > (1-p)H^{RS} H^{TS} > (1-p)H^{RS}$ is sufficient for

$$\frac{(1-p)U'\left(Rw_L - \frac{H^{TS}E}{N}\right)}{pU'\left(Rw_H(a) - \frac{H^{TS}E}{N}\right)} = |MRS^{TS}_{y_S,y_U}| > |MRS^{RS}_{y_S,y_U}| = \frac{(1-p)U'\left(Rw_L - (1-p)\frac{H^{RS}E}{N}\right)}{pU'\left(Rw_H(a) - E - (1-p)\frac{H^{RS}E}{N}\right)}.$$

To sum up,

$$|MRS^{RS}_{y_S,y_U}| \leq \frac{N}{pH^{RS}} - 1$$

is a sufficient condition for $G^{TS}(a) > G^{RS}(a) > G^{RP}(a)$, and hence $H^{TS} > H^{RS} > H^{RP}$. In addition, it has been established before that the pure loan system always yields the lowest participation.

6   The insurance role

Inefficiencies in higher education investment are usually attributed to the existence of liquidity constraints. In this model, the government advances the funds required to study and rules out liquidity constraints considerations. Yet, inefficiencies arise due to the fact that education is a risky investment and individuals are risk averse.

In this framework, the pure loan scheme can be taken as a benchmark in which the only role of the government is to advance the necessary funds. Since all individuals are required to pay back the amount they borrowed, there is no insurance or subsidization of the investment on higher education. In this section we investigate the relative insurance properties of the schemes proposed.

The risk-pooling income contingent loan provides the same expected income to the student as the loan, but the income gap between successful and successful students is lower. Hence, the risk pooling scheme can be seen as an actuarially fair partial insurance policy in which students woud pay a premium $(1-p)E/p$ to receive an indemnity E/p if unsuccessful. The fraction of the total loss - $R(w_H(a) - w_L)$ - that is covered is $k^{RP} = E/pR(w_H(a) - w_L)$. Successful students pay an extra amount of $(1-p)E/p$ over the cost of education in order to insure a minimum income of Rw_L in case of bad luck. Because the insurance is incomplete, the risk pooling scheme will induce insufficient participation when individuals are risk averse.

In contrast, the tax subsidy scheme provides no insurance, but transfers from non students to students (whether successful or not) the amount $E(N - H^{TS})/N$. Although participation could be optimal in specific circumstances, it is impossible to generally guarantee so. The reason is that, although risk aversion reduces participation in the absence of insurance, the subsidy from non-educated to educated individuals counters this effect. In the end, participation could be optimal or even excessive if the subsidy is large enough.

Risk sharing income contingent loans provide both a subsidy and insurance. Departing from the pure loan allocation, the income contingent loan provides a subsidy that enables both

successful and unsuccessful students to access a higher level of income. The subsidy from non-educated to educated individuals (whether successful or not) is $E(1-p)(N-H^{RS})/N$. This subsidy also encourages participation, although it is in general smaller than the subsidy in the tax-subsidy scheme. However, the income-contingent loan also insures against the eventuality of failure, thus further encouraging participation. Students woud pay a premium $(1-p)E$ to receive an indemnity E if unsuccessful. The insurance cover provided by this scheme is however smaller than that implicit in the risk-pooling income contingent loan. The fraction of the loss $(R(w_H(a)-w_L))$ that is covered is $k^{RP} = E/R(w_H(a)-w_L)$, where $k^{RS} = pk^{RP}$. Yet, together with the subsidy, the scheme could induce optimal or even excessive participation.

In Figure 2 we represent (y_U^j, y_S^j) for $j = TS, RS, RP$. (y_U^L, y_S^L) and (y_U^{TS}, y_S^{TS}) are placed on a same line of slope 1. This implies that both successful and unsuccessful students receive the same additional amount as compared to the loan allocation. On the other hand, (y_U^L, y_S^L) and (y_U^{RP}, y_S^{RP}) are on the same iso-expected income line. The risk-pooling scheme can be viewed as an actuarially fair pure insurance policy because it implies movements along the iso-expected income line, with slope $-(1-p)/p$. The insurance element implicit in the risk pooling scheme can be identified by the distance between (y_U^L, y_S^L) and (y_U^{RP}, y_S^{RP}).
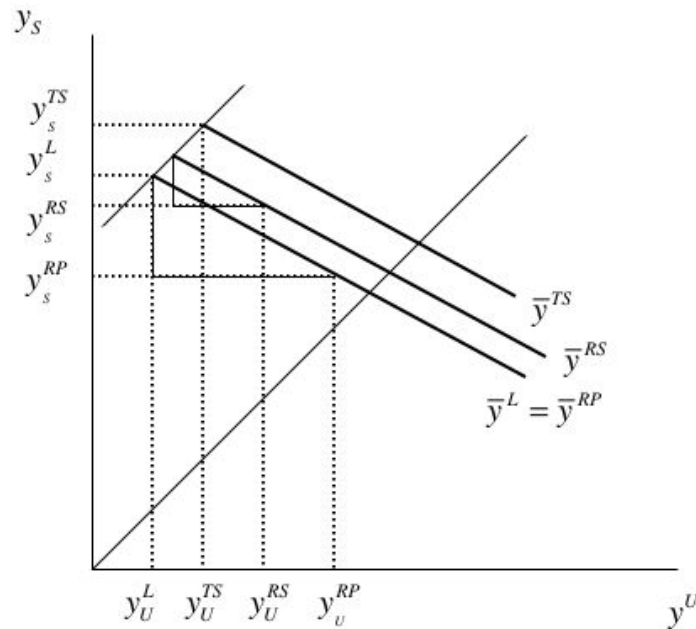

Figure 2: Subsidy and insurance components of the alternative financing schemes

The movement from (y_U^L, y_S^L) to (y_U^{RS}, y_S^{RS}) can be decomposed in a movement along a 45-degree line to an allocation that provides the same subsidy $E(1-p)(N-H^{RS})/N$ to all students and the same expected income than that of the risk-sharing allocation, and a movement along this iso-expected income line to the final allocation (y_U^{RS}, y_S^{RS}). This last movement could be viewed as an actuarially fair partial cover insurance. The resulting cover is lower than that implicit in the risk-pooling scheme. The level of cover in the risk-pooling system is E/p whereas the level of cover in the risk-sharing system, when decomposed this way, is E.

To sum up, participation is suboptimal when the role of the government is limited to advancing the funds in the first period, thus overcoming liquidity constraints. We can induce higher participation levels by means of subsidies from non-educated to educated individuals (like in the tax-susbidy system), partially insuring the student (like in the risk-pooling system), or both (like in the risk-sharing system). However, if the underlying reason for under-participation is risk aversion, it seems reasonable to enquire about the possibility of providing full insurance to students.

An actuarially fair full insurance policy would imply a guarantee for each student a to receive the expected income $\bar{y} = R(pw_H(a) + (1-p)Rw_L) - E$ regardless of her being successful or not. This policy comprises the payment of a prime $(1-p)R(w_H(a) - w_L)$, where $R(w_H(a) - w_L)$ represents the difference between success and failure, which is the amount the individual receives in the event of being unsuccesful.

Note that fully insuring all students would require knowing their abilities. An alternative scheme that induces the optimal level of participation with lower informational requirements consists of fully insuring the last individual who should gain access to higher education (i.e., individual with ability $\hat{a}$). With this policy all students pay the prime $(1-p)R(w_H(\hat{a}) - w_L)$ and unsuccessful students receive $R(w_H(\hat{a}) - w_L)$. Note however that individuals of ability $a > \hat{a}$ are worse off than under full insurance. Thus, greater simplicity is gained at the cost of lower utility for all individuals with ability above $\hat{a}$.

7   Concluding comments

Higher education is a risky investment. We have studied different financing schemes that are usually proposed in the literature and that differ in the way educational costs and risks are shared among the population. In this model liquidity constraints are ruled out, because the government overcomes the problem of incomplete capital markets by advancing the funds to those individuals willing to study, but inefficiencies arise due to risk aversion. The provision of insurance can help overcome this type of inefficiency. Indeed, income-contingent loan schemes provide some insurance but the partial level of cover is exogenously set. Fully insuring all students would induce the optimal participation but implementing this policy may imply non-negligeable informational requirements. We have proposed an alternative insurance policy that is based on fully insuring the individual with the lowest ability level that should optimally study.

This alternative policy induces optimal participation and it is simple to implement.

This is still work in progress. The disincentive effects of full insurance are well known and we need to account for them. At the moment our conjecture is that a combination of partial insurance and subsidies to education may be the best way to reconcile these cross-purposes. If this was the case, the income contingent loan of the risk-sharing type, such as the one adopted in Australia, could be the optimal way to deal with participation and effort incentives in higher education.

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