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Elena Del Rey
Departament d'Economia, FCEE. Universitat de Girona.

María Racionero
Research School of Economics
College of Business and Economics
Australian National University

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Elena Del Rey* and María Racionero†

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Abstract

We consider risk-averse individuals who differ in two characteristics – ability to benefit from education and inherited wealth – and analyze higher education participation under two alternative financing schemes – tax subsidy and (risk-sharing) income-contingent loans. With decreasing absolute risk aversion, wealthier individuals are more likely to undertake higher education despite the fact that, according to the stylized financing schemes we consider, individuals do not pay any up-front financial cost of education. We then determine which financing scheme arises when individuals are allowed to vote between schemes. We show that the degree of risk aversion plays a crucial role in determining which financing scheme obtains a majority, and that the composition of the support group for each financing scheme can be of two different types.

Keywords: voting, higher education finance, income-contingent loans

JEL Classification: H52, I22, D72

*Departament d'Economia, FCEE. Universitat de Girona. Campus de Montilivi, 17071 Girona (Spain). Tel.: + 34 972 41 87 49. Fax: + 34 972 41 80 32. E-mail: elena.delrey@udg.edu

†Corresponding author: Research School of Economics, Australian National University, ACT0200 Canberra (Australia). Tel.: + 61 2 61254466. Fax:. + 61 2 61255124. E-mail: maria.racionero@anu.edu.au

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1 Introduction

Higher education financing schemes that rely partly on contributions from students are being increasingly adopted. One acknowledged problem of relying on cost-sharing by students is that liquidity constraints may negatively affect higher education participation. Even if mortgage-type loans are made available to overcome these liquidity constraints, education is often viewed as a risky investment, and deserving but risk averse individuals may decide not to take these loans. Funding schemes that rely on income-contingent loans, like the Australian Higher Education Contribution Scheme first instituted in 1989 or the more recent funding arrangements in the UK, provide insurance against uncertain educational outcomes. Income-contingent loans are hence supposed to partly, if not fully, overcome the negative effects of risk-aversion, and as such they have been generally regarded as an improvement on mortgage-type loans to enhance higher education participation. The assessment of income-contingent loans versus tax-subsidy schemes, which have been traditionally employed in many European countries to finance higher education, is less conclusive.

Financing schemes for higher education differ in the way educational costs and risks are shared among the population. García-Peñalosa and Wälde (2000) and Del Rey and Racionero (2010) are among the few theoretical contributions in the literature that consider a relatively comprehensive set of higher education financing alternatives, including both tax-subsidy and income-contingent loans. In García-Peñalosa and Wälde (2000) individuals are assumed to differ only in inheritance, whereas in Del Rey and Racionero (2010) individuals differ only in ability. When individuals differ in inheritance, the social optimum implies that either none or all should study. When individuals differ in ability, it is possible to determine an optimum threshold ability level (i.e. an optimal level of participation in higher education) and assess whether alternative financing schemes yield insufficient or excessive participation. Indeed, Del Rey and Racionero (2010) focus on the effects of the insurance and subsidy components of alternative financing schemes on participation, and show that an income-contingent loan with risk-pooling can induce the optimal level of participation provided that it covers both financial costs of education and forgone earnings. However, universal income-contingent loans of the risk-pooling type, where successful students are essentially responsible for the full cost of the education of their cohort, are relatively rare. Tax-subsidy schemes, where the cost of education is financed by general taxes, have been historically common, particularly in Europe. Income-contingent loans of the risk-sharing type, where successful graduates contribute to a large extent to the cost of their education, possibly the full cost if there are no implicit subsidies, and the cost of the education of unsuccessful students is financed by general taxes, are being increasingly adopted or considered (see Chapman (2006) for an overview of the international experience with income-contingent loans).

In this paper we focus on the tax-subsidy and risk-sharing income-contingent loans schemes. Contrary to García-Peñalosa and Wälde (2000) and Del Rey and Racionero (2010) we consider individuals that differ in two characteristics: ability and inherited wealth. In this sense the model follows De Fraja (2001), which incorporates both differences in parental income and ability, but departs in other respects: most notably, we incorporate income-contingent loans as a financing scheme option. We analyze participation under both schemes, paying particular attention to the welfare individuals of different ability and wealth achieve under each. We use this information subsequently to study which financing scheme is preferred by a majority when individuals are able to vote between the two schemes.

Recent contributions dealing with the political economy of higher education finance include De Fraja (2001), Anderberg and Balestrino (2008), and Borck and Wimbersky (2009). De Fraja (2001) considers two education policies - an admission test and a subsidy financed out of general taxation - and shows that both enhance equality of opportunity, but have ambiguous equity and efficiency effects. The ambiguous equity effects of the policies are reflected in the voting behavior of individuals: when voting on the extent of the subsidy a partial "ends against the middle" phenomenon arises where better-off households unambiguously like a lower subsidy as would some worse-off households with less able children, whereas the poor households with more able children prefer an increase in the subsidy. Anderberg and Ballestrino (2008) consider tax-subsidy schemes in a model where endogenous credit constraints play a key role and show that a voting equilibrium, if it exists, is such that voters in the two tails of the income distribution support a reduction, while the "middle-class" supports an expansion, of the education subsidy. Borck and Wimbersky (2009) study voting over higher education financing schemes in an economy where risk averse households differ in wealth and wages are endogenously determined. They consider four alternative systems: a traditional subsidy scheme, a pure loan scheme, income-contingent loans and graduate taxes. Their numerical simulations suggest that poor households tend to prefer traditional tax-subsidy financing to graduate taxes or income-contingent loans, due to a positive effect on endogenous unskilled wages, and that majorities for income-contingent loans or graduate taxes become more likely if risk-aversion increases and/or the income distribution is less unequal. We incorporate an additional dimension of individual heterogeneity: ability. The financing schemes that we study are relatively inflexible, when compared to the flexible endogenous subsidy rates that Borck and Wimbersky (2009) consider, but by concentrating on the choice between schemes we are able to provide relatively clear and intuitive results.

We focus exclusively on the choice between tax-subsidy and (risk-sharing) income-contingent loans because they are two of the most commonly employed higher education finance schemes and several countries are switching, or planning to do so, from the former to the latter. Many countries have progressively introduced, or raised, their tuition fees to be able to support an increasing number of students. The British government, for instance, first introduced upfront charges for students in 1998. They were replaced in England in 2004 with a scheme with higher fees but that allowed students to receive income-contingent loans, designed in such a way that students effectively share the risk with the general taxpayer: there is no real interest rate charged on the loan, students start to repay only after they earn more than a threshold level of income, among other concessions. In late 2010 proposed tuition fees increases in England, which in some cases were expected to triple the fees previously charged, generated some heated protests from students. At the same time the British government was seeking to slash its direct funding of university teaching, which should put less pressure on, and be hence supported by, the average taxpayer. This paper aims to shed more light on the political economy aspects of the switch from tax-subsidy to risk-sharing income-contingent loans schemes.

The paper is organized as follows. We first present the model and describe each financing scheme in section 2. In section 3 we determine the tax that is required under each financing scheme for a given participation level. In section 4 we analyze participation and in section 5 we characterize the voting outcome. We conclude in section 6.

2 The model

We consider an economy in which a continuum of individuals of mass N live for 2 periods. Individuals differ in their ability a and their initial wealth b, which we take as exogenously given, with $a \in [\underline{a}, \overline{a}]$ and $b \in [\underline{b}, \overline{b}]$. That is, each individual is characterised by a pair (a, b). We assume initially that ability and wealth are independently distributed in $[\underline{a}, \overline{a}] \times [\underline{b}, \overline{b}]$. The marginal distributions are denoted by $F(a)$ with $F'(a) = f(a)$, and $H(b)$ with $H'(b) = h(b)$.

Individuals derive utility from consumption, c, which depends on wealth and earned income over the lifetime. We assume a von Neumann-Morgensten utility function $u(c)$ with, for every $c > 0$, $u'(c) > 0, u''(c) \leq 0, \lim_{c \to \infty} u'(c) = +\infty$, and

$$\frac{d\left[-\frac{u''(c)}{u'(c)}\right]}{dc} < 0$$

(i.e. the utility function displays decreasing absolute risk aversion (DARA)).

In the first period, the individual decides whether or not to undertake higher education. Individuals who study forego earnings w_L in the first period. In the second period all individuals work and earn income. If the individual invested in education, her labour market income is given by w_H with probability $p(a)$, and by $w_L < w_H$ with probability

$1 - p(a)$, with $p(a) \in (0,1)$, with $p'(a) > 0$ for all $a \in [\underline{a}, \overline{a}]$. If the individual did not go to university, then her income is given by w_L for sure.

There are three possible states: the individual studies and is successful, the individual studies and is unsuccessful or the individual does not study. We denote them by subscripts S, U and N respectively. Labour supply is exogenous and is normalized to 1. Hence, the lifetime earned labour income of the individual is δw_H, δw_L and $(1+\delta) w_L$, where δ is the discount factor, for individuals S, U and N respectively. We assume that $\delta w_H > (1+\delta) w_L$.

We denote by k the per capita cost of education. The government provides education free of charge in the first period and raises the necessary revenue in the second period in a manner that differs according to the financing scheme. A potentially different amount of individuals H^j, where j represents the funding scheme, enrol in higher education in the first period. We focus on two financing schemes for higher education: tax-subsidy, denoted by TS, and risk-sharing income-contingent loan, denoted by IC. In the tax-subsidy system, the cost of education is financed by general lump-sum taxes in the second period. We model the income-contingent loan as the risk-sharing income-contingent loan in Del Rey and Racionero (2010): all individuals who want to study borrow k, only those individuals who are successful have to repay the amount in full, and a lump-sum tax is levied on all individuals in order to raise the revenue needed to cover the education cost of unsuccessful students.

The timing of decisions is the following: first individuals choose by majority voting the higher education financing scheme. Then, for the higher education financing scheme chosen, they decide whether or not to participate. Finally, they contribute. We start by determining the level of lump-sum taxes required for each financing scheme for a given level of participation.

3 Tax cost of alternative schemes

Let $a^{TS}(b)$ denote the threshold ability level (i.e. the ability level of an individual who is indifferent between studying or not) of an individual with wealth b for the tax-subsidy financing scheme. The number of individuals who undertake higher education is

$$H^{TS} = \int_{\underline{b}}^{\overline{b}} \int_{a^{TS}(b)}^{\overline{a}} f(a)\, h(b)\, dadb, \tag{1}$$

and the lump-sum tax required to finance their education is

$$T^{TS} = \frac{k}{N} \int_{\underline{b}}^{\overline{b}} \int_{a^{TS}(b)}^{\overline{a}} f(a)\, h(b)\, dadb. \tag{2}$$

Let $a^{IC}(b)$ now denote the ability level of an individual with wealth b who is indifferent between studying or not for the income-contingent financing scheme. The number of individuals who undertake higher education is now

$$H^{IC} = \int_{\underline{b}}^{\overline{b}} \int_{a^{IC}(b)}^{\overline{a}} f(a)\, h(b)\, dadb, \tag{3}$$

and the lump-sum tax required to finance their education is

$$T^{IC} = \frac{k}{N} \int_{\underline{b}}^{\overline{b}} \int_{a^{IC}(b)}^{\overline{a}} (1 - p(a))\, f(a)\, h(b)\, dadb. \tag{4}$$

4 Participation

For a given higher education finance scheme and anticipating the lump-sum contribution, individuals decide whether or not to enrol. We first identify the optimal level of participation that we use as a benchmark against which we compare the participation achieved for each scheme.

4.1 Optimal participation

Focusing exclusively on efficiency, it is optimal that an individual studies when her expected earnings as a student net of the cost of her education exceed her earnings as a non-student. 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:

$$\delta\left[p\left(\widehat{a}\right)w_H+\left(1-p\left(\widehat{a}\right)\right)w_L\right]-k=\left(1+\delta\right)w_L. \tag{5}$$

The optimal amount of graduates is $H^*=\int_{\widehat{a}}^{\overline{a}}f(a)da$. Note that the optimal ability level is independent of family wealth b.

4.2 Tax-subsidy

Let $G^{TS}\left(a,b\right)$ denote the expected net utility gain from investing in higher education under the tax-subsidy scheme for an individual with ability a and wealth b:

$$G^{TS}\left(a,b\right)\equiv\left(1-p\left(a\right)\right)u\left(c_U^{TS}\right)+p\left(a\right)u\left(c_S^{TS}\right)-u\left(c_N^{TS}\right). \tag{6}$$

The expected net utility gain from investing in higher education increases with ability:

$$\frac{dG^{TS}\left(a,b\right)}{da}=p'\left(a\right)\left[u\left(c_S^{TS}\right)-u\left(c_U^{TS}\right)\right]=p'\left(a\right)\left[u\left(b+\delta w_H\right)-u\left(b+\delta w_L\right)\right]>0 \tag{7}$$

since $p'\left(a\right)>0$ and $w_H>w_L$. Higher ability individuals have larger expected utility from studying than lower ability individuals, and are hence more likely to undertake higher education.

The threshold ability level of an individual with wealth b for the tax-subsidy financing scheme, $a^{TS}\left(b\right)$, satisfies $G^{TS}\left(a^{TS}\left(b\right),b\right)=0$. That is,

$$\left(1-p\left(a^{TS}\right)\right)u\left(b+\delta w_L-T^{TS}\right)+p\left(a^{TS}\right)u\left(b+\delta w_H-T^{TS}\right)=u\left(b+\left(1+\delta\right)w_L-T^{TS}\right). \tag{8}$$

Proposition 1 *If, for a bequest $b\in\left[\underline{b},\overline{b}\right]$, there exists a level of ability $a^{TS}\in\left[\underline{a},\overline{a}\right]$ such that $G^{TS}\left(a^{TS},b\right)=0$, then a^{TS} is unique and the function $a^{TS}\left(b\right)$ is strictly decreasing in b.*

Proof. From (7) we obtain that, if for some value of $b\in\left[\underline{b},\overline{b}\right]$ there exists a level of ability $a^{TS}\in\left[\underline{a},\overline{a}\right]$ such that $G^{TS}\left(a^{TS},b\right)=0$, then a^{TS} is unique. Using the implicity function theorem,

$$\frac{\partial a^{TS}}{\partial b} = -\frac{\frac{\partial G^{TS}(.)}{\partial b}}{\frac{\partial G^{TS}(.)}{\partial a}} < 0 \tag{9}$$

given (7) (for a given level of b the expected net gain of investing in higher education increases with ability) and

$$\begin{aligned} \frac{\partial G^{TS}(.)}{\partial b} \equiv\ & (1-p(a))\, u'\left(b+\delta w_L - T^{TS}\right) + p(a)\, u'\left(b+\delta w_H - T^{TS}\right) \\ & -u\left(b+(1+\delta)\, w_L - T^{IC}\right) > 0 \end{aligned} \tag{10}$$

(for a given level of a a higher income individual is more willing to bear risk and invest in higher education due to the DARA assumption).■

This result was previously proven by De Fraja (2001) in a slightly different setting with two coexisting generations - mother and daughter - where the mother makes the decisions: most notably she chooses her own consumption, a monetary transfer to her daughter and how much to invest in her daughter's education, as well as voting on the tax rate that is imposed on the mother's income to subsidize the costs of education and that has to be paid irrespective of whether the daughter studies or not.[1]

The fact that $a^{TS}(b)$ is strictly decreasing in b implies that wealthier individuals are more likely to undertake higher education. This is so despite the fact that, under the scheme considered, individuals do not pay upfront any financial cost of education. The presence of foregone earnings and the assumption of decreasing absolute risk aversion play crucial roles. Investment in education is risky and when individuals display decreasing absolute risk aversion the wealthier ones are more willing to bear risk; in other words, they require a lower expected return in order to opt for an investment of a given riskiness.

The threshold ability does not depend on b in the particular case of risk neutrality since b, and T^{TS} as well, cancel out from the equation:

$$G^{TS}(a,b) = (1-p(a))\,\delta w_L + p(a)\,\delta w_H - (1+\delta)\, w_L = G^{TS}(a). \tag{11}$$

[1] Maxine Montaigne's 2010 ANU Economics Honours Sub-thesis replicated De Fraja (2001)'s result in a model with two generations, but with no mother's own consumption or intergenerational transfer and similar schemes to the ones we employ.

We denote by $\widehat{a}^{TS}$ the threshold ability level of risk neutral individuals under the tax-subsidy system.

Proposition 2 *Risk neutral individuals overinvest in education under TS:* $\widehat{a}^{TS} < \widehat{a}$.

Proof. $\widehat{a}^{TS}$ is implicitly defined by

$$\delta\left[\left(1-p\left(\widehat{a}^{TS}\right)\right)w_L + p\left(\widehat{a}^{TS}\right)w_H\right] = (1+\delta)\,w_L. \tag{12}$$

Using (5) we obtain

$$\delta\left[\left(1-p\left(\widehat{a}^{TS}\right)\right)w_L + p\left(\widehat{a}^{TS}\right)w_H\right] = \delta\left[p\left(\widehat{a}\right)w_H + \left(1-p\left(\widehat{a}\right)\right)w_L\right] - k.$$

It follows that $\widehat{a}^{TS} < \widehat{a}$.■

Proposition 3 *Risk aversion reduces participation for all income levels:* $a^{TS}(b) > \widehat{a}^{TS}$ $\forall b$.

Proof. We evaluate $G^{TS}(a,b)$ at $\widehat{a}^{TS}$, characterised implicitly by (12), and obtain

$$\begin{aligned} G^{TS}\left(\widehat{a}^{TS},b\right) &= \left(1-p\left(\widehat{a}^{TS}\right)\right)u\left(b+\delta w_L - T^{TS}\right) + p\left(\widehat{a}^{TS}\right)u\left(b+\delta w_H - T^{TS}\right) \\ &\quad - u\left(b+\delta\left[\left(1-p\left(\widehat{a}^{TS}\right)\right)w_L + p\left(\widehat{a}^{TS}\right)w_H\right] - T^{TS}\right) < 0 \end{aligned}$$

since, with risk aversion, the utility of expected income is higher than the expected utility. Using (7) and $G^{TS}\left(a^{TS}(b),b\right)=0$ it turns out that $\widehat{a}^{TS} < a^{TS}(b)$. The above holds for any $b \in \left[\underline{b},\overline{b}\right]$.■

Since $\widehat{a}^{TS} < \widehat{a}$ and $\widehat{a}^{TS} < a^{TS}(b)$ participation could be efficient under the tax subsidy scheme for risk averse individuals with a particular level of wealth. In contrast, it is not possible that $a^{TS}(b) = \widehat{a}$ for all b since $a^{TS}(b)$ is strictly decreasing. If participation was efficient for individuals with a given threshold wealth, denoted by $\widehat{b}$, then below $\widehat{b}$ individuals would be under-represented, and above $\widehat{b}$ individuals would be over-represented in higher education.

Example. In order to illustrate how different degrees of risk aversion affect participation we represent in Figures 1-3 the efficient participation together with participation under the tax-subsidy scheme when individuals are risk neutral and risk averse (the shaded area represents participation when individuals are risk averse). In the simulation, we use the constant relative risk aversion function

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma} \tag{13}$$

where $\sigma = -c\frac{u''(c)}{u'(c)}$ represents the coefficient of relative risk aversion. Borck and Wimbersky (2009) employ $\sigma = 2.25$ but Brodaty et al. (2010) suggest $\sigma = 0.75$ as reasonable for the education decision. We compare the results for three different degrees of risk aversion σ: 0.75 (low), 1.5 (intermediate) and 3 (high). The other parameters are set the same throughout: the low skilled wage is normalized to 1, the skilled wage is assumed to be 3, the cost of higher education is assumed to be 0.5 and $\delta = 1.5$.[2] We also set $p(a) = a$ and calculate T^{TS} according to (2). Both wealth and ability are assumed to be uniformly distributed in the population between 0 and 1. [3]

4.3 Income-contingent loan

Let now $G^{IC}(a,b)$ denote the expected net utility gain from investing in higher education for an individual with ability a and wealth b under the risk-sharing income-contingent loan (IC) scheme:

$$\begin{aligned} G^{IC}(a,b) \equiv\ & (1-p(a))\,u\left(b+\delta w_L - T^{IC}\right) + p(a)\,u\left(b+\delta w_H - T^{IC} - k\right) \\ & -u\left(b+(1+\delta)\,w_L - T^{IC}\right). \end{aligned} \tag{14}$$

[2] According to the OECD (Chart A7.2 Education at a Glance 2010) the ratio of earnings from employment with tertiary type A and advanced programs relative to below upper secondary education ranges from aprox 1,5 (New Zealand, Australia) to 5 (Brazil). Direct costs of higher education are typically smaller than forgone costs (Chart A8.3 Education at a Glance 2010). A discount factor of 1.5 is chosen to account for the fact that although the individuals discount the future the second period is longer than the first period.

[3] We have also considered an alternative lognormal distribution, with a higher density of individuals at lower income levels. The qualitative results remain the same but the uniform distribution is more tractable and convenient for the graphical illustration.

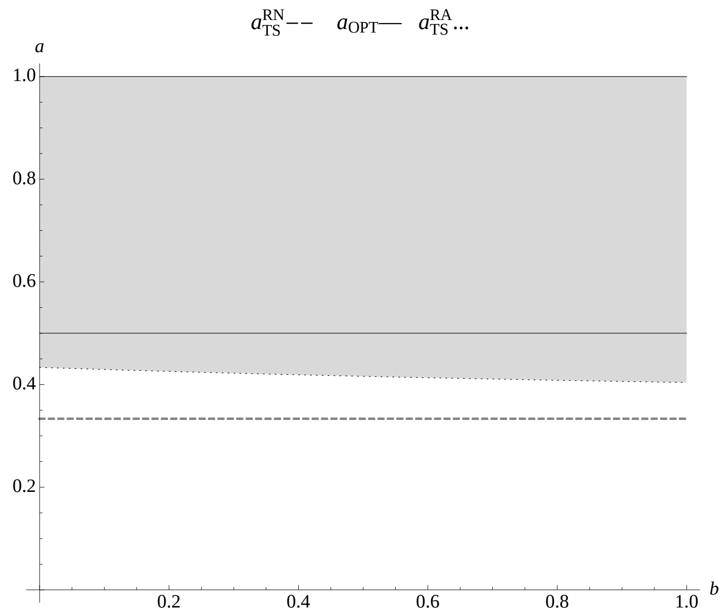

Figure 1: Participation under TS: risk neutrality versus risk aversion (σ=0.75)

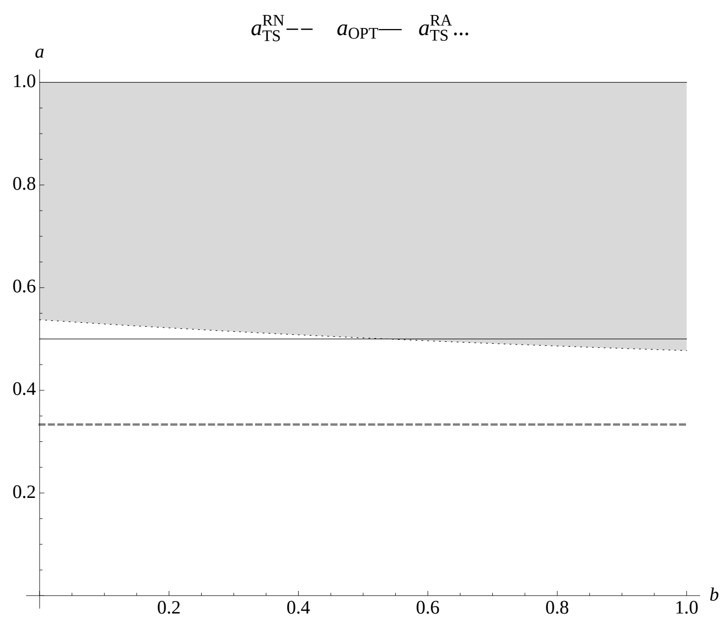

Figure 2: Participation under TS: risk neutrality versus risk aversion (σ=1.5)

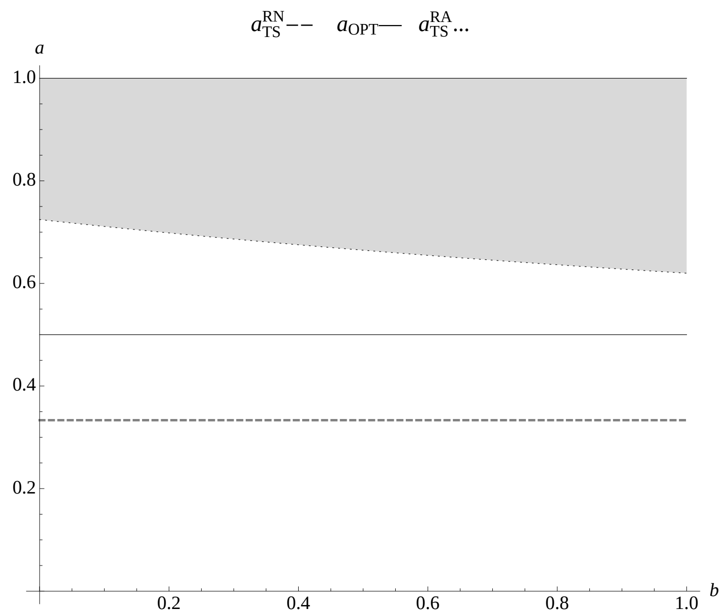

Figure 3: Participation under TS: risk neutrality versus risk aversion (σ=3)

The expected net utility gain from investing in higher education also increases with ability under this financing scheme:

$$\frac{\partial G^{IC}(.)}{\partial a} = p'(a)\left[u\left(b + \delta w_H - T^{IC} - k\right) - u\left(b + \delta w_L - T^{IC}\right)\right] > 0 \tag{15}$$

since $p'(a) > 0$ and $\delta(w_H - w_L) > k$, or else no individual should study. If for some value of $b \in \left[\underline{b}, \overline{b}\right]$ there exists a level of ability $a^{IC} \in [\underline{a}, \overline{a}]$ such that $G^{IC}\left(a^{IC}, b\right) = 0$, then $a^{IC}(b)$ is unique. $\frac{\partial G^{IC}(.)}{\partial b} > 0$ due to the DARA assumption, which yields

$$\frac{\partial a^{IC}}{\partial b} = -\frac{\frac{\partial G^{IC}(.)}{\partial b}}{\frac{\partial G^{IC}(.)}{\partial a}} < 0. \tag{16}$$

That is, $a^{IC}(b)$ is strictly decreasing in b, which proves the following proposition:

Proposition 4 *If, for a bequest $b \in \left[\underline{b}, \overline{b}\right]$, there exists a level of ability $a^{IC} \in [\underline{a}, \overline{a}]$ such that $G^{IC}\left(a^{IC}, b\right) = 0$, then a^{IC} is unique and the function $a^{IC}(b)$ is strictly decreasing in b.*

The threshold ability level in the particular case of risk neutrality, denoted by $\widehat{a}^{IC}$, satisfies:

$$p\left(\widehat{a}^{IC}\right)\delta\left(w_H - w_L\right) = w_L + p(\widehat{a}^{IC})k. \tag{17}$$

It follows that $\widehat{a}^{TS} < \widehat{a}^{IC} < \widehat{a}$. On the one hand, higher education participation is lower than with the tax-subsidy system. This is due to the fact that the cost of education is partly subsidized by non-students but to a lesser extent than in the tax-subsidy system. At the same time, more individuals get educated than at the optimum since, in expected terms, students are only responsible for part of the cost of their education. Note that the expected cost of becoming educated is $p(a)k$, which is smaller than k, since the lump-sum tax contribution is paid irrespective of whether the individual studies or not.

Proposition 5 *Risk neutral individuals overinvest in education under IC, but less so than under TS:* $\widehat{a}^{TS} < \widehat{a}^{IC} < \widehat{a}$.

Finally,

Proposition 6 *Risk aversion reduces participation for all income levels:* $a^{IC}(b) > \widehat{a}^{IC}$ $\forall b$.

Proof. $\widehat{a}^{IC}$ is characterised implicitly by (17). If we evaluate $G^{IC}(a,b)$ at $\widehat{a}^{IC}$ we obtain

$$\begin{aligned} G^{IC}\left(\widehat{a}^{IC}, b\right) \equiv & \left(1 - p\left(\widehat{a}^{IC}\right)\right) u\left(b + \delta w_L - T^{IC}\right) + p\left(\widehat{a}^{IC}\right) u\left(b + \delta w_H - T^{IC}\right) \\ & -u\left(b + \delta\left[\left(1 - p\left(\widehat{a}^{IC}\right)\right) w_L + p\left(\widehat{a}^{IC}\right) w_H\right] - T^{IC}\right) < 0 \end{aligned}$$

since, with risk aversion, the utility of expected income is higher than the expected utility. Since (15) and $G^{IC}\left(a^{IC}(b), b\right) = 0$ it turns out that $\widehat{a}^{IC} < a^{IC}(b)$. The above holds for any $b \in \left[\underline{b}, \overline{b}\right]$. $\blacksquare$

Example. As in Del Rey and Racionero (2010) it is not possible to provide a general ordering of higher education participation under alternative financing schemes when individuals are risk averse. This is so because for both schemes participation decreases with

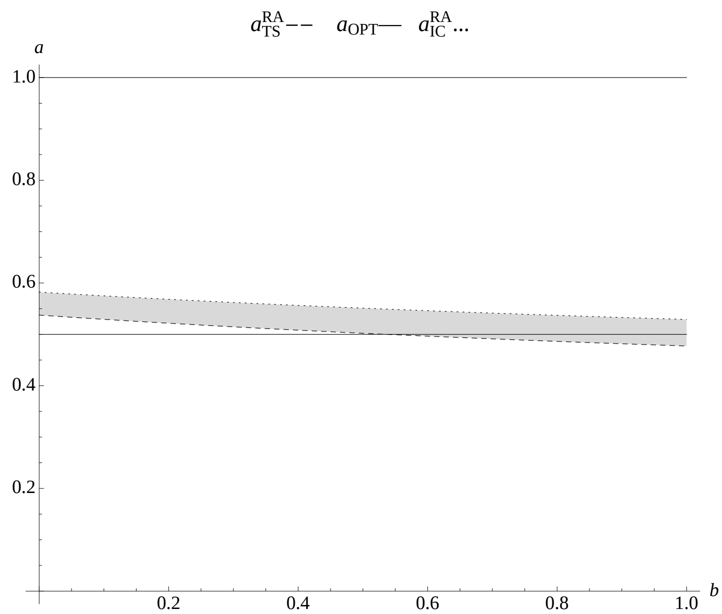

Figure 4: Participation with risk aversion: TS vs IC ($\sigma = 1.5$)

risk aversion but it does so at different rates and the theoretical possibility of participation becoming larger with the income-contingent loan, relative to the tax-subsidy scheme, cannot be ruled out for sufficiently large degrees of risk aversion. We perform however some numerical simulations to shed more light on the relative magnitude of degree of risk aversion required. Figure 4 represents the efficient participation together with the participation thresholds for both TS and IC for the benchmark parameter specification described above (the shaded area represents the difference in participation between the two schemes). IC yields lower participation for the values of σ considered reasonable. Increasing the degree of risk aversion coefficient from $\sigma = 1.5$ to $\sigma = 3$ decreases participation for both schemes, and the difference in participation becomes smaller (see Figure 5).

5 Voting over the financing scheme

In this section we analyze the preferences of individuals concerning the higher education financing scheme when they are able to anticipate both participation decisions and the corresponding lump-sum tax. We do so first for the benchmark case of risk neutrality, to

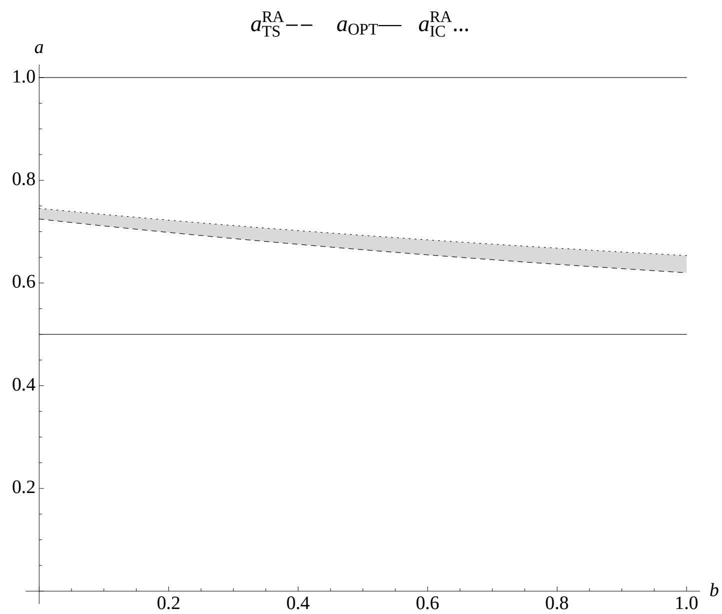

Figure 5: Participation with risk aversion: TS vs IC ($\sigma = 3$)

provide intuition, and proceed next to the more relevant case of risk aversion.

5.1 Risk neutrality

We showed above that $\widehat{a}^{TS} < \widehat{a}^{IC} < \widehat{a}$. Since participation is lower and graduates contribute more with the income-contingent loan scheme, it follows that $T^{TS} > T^{IC}$. We explore first whether it is possible to identify an ability threshold below which one financing scheme is preferred and above which the other one is preferred instead. In that case we can compare the number of individuals at each side of the threshold and conclude what the majority prefers. We are able to establish the following:

Proposition 7 ***Decisive individuals under risk neutrality:*** *If* $T^{TS} < T^{IC} + kp\left(\widehat{a}^{IC}\right)$, *there exists a threshold* $a^{I} \in \left[\widehat{a}^{TS}, \widehat{a}^{IC}\right]$ *below which individuals prefer IC and above which individuals prefer TS. If* $T^{TS} > T^{IC} + kp\left(\widehat{a}^{IC}\right)$, *the threshold becomes* $a^{II} > \widehat{a}^{IC}$.

Proof. Below $\widehat{a}^{TS}$, individuals do not study regardless of the financing scheme and they prefer IC because they pay less. In the range $\left[\widehat{a}^{TS}, \widehat{a}^{IC}\right]$ individuals study with TS

but do not study with IC. They prefer IC if and only if

$$b+(1+\delta)\,w_L-T^{IC}>(1-p(a))\left(b+\delta w_L-T^{TS}\right)+p(a)\left(b+\delta w_H-T^{TS}\right),$$

which can be simplified to

$$p(a)<\frac{w_L+T^{TS}-T^{IC}}{\delta\,(w_H-w_L)}.$$

If there exits an ability level in the range $\left[\widehat{a}^{TS},\widehat{a}^{IC}\right]$ such that the individual is indifferent between the two schemes we denote this ability threshold, below which individuals prefer IC and above which individuals prefer TS, by a^I and it satisfies

$$p\left(a^I\right)=\frac{w_L+T^{TS}-T^{IC}}{\delta\,(w_H-w_L)}. \tag{18}$$

Individuals with $a>\widehat{a}^{IC}$ study regardless of the scheme in place and they prefer IC when they are required to contribute less: i.e., if and only if $T^{IC}+p(a)\,k<T^{TS}$. If there exists an ability level above $\widehat{a}^{IC}$ such that the individual is indifferent between the two schemes we denote this ability threshold by a^{II} and it satisfies

$$p(a^{II})=\frac{T^{TS}-T^{IC}}{k}. \tag{19}$$

From equation (17),

$$p\left(\widehat{a}^{IC}\right)=\frac{w_L}{\delta\,(w_H-w_L)-k}.$$

If $p(\widehat{a}^{IC})>\left(T^{TS}-T^{IC}\right)/k$, there does not exist an ability threshold a^{II} above $\widehat{a}^{IC}$. Individuals with ability $\widehat{a}^{IC}$ prefer TS and this is also the case for all individuals with $a>\widehat{a}^{IC}$. Some individuals with ability $a<\widehat{a}^{IC}$ prefer TS and there exists a threshold $a^I\in\left[\widehat{a}^{IC},\widehat{a}^{TS}\right]$ above which individuals prefer TS and below which individuals prefer IC.

If, on the other hand, $p(\widehat{a}^{IC})<\left(T^{TS}-T^{IC}\right)/k$ then individuals with ability $\widehat{a}^{IC}$ prefer IC. Some individuals with $a>\widehat{a}^{IC}$ prefer IC and there exists a threshold $a^{II}>\widehat{a}^{IC}$ below which individuals prefer IC and above which individuals prefer TS. All individuals with $a<\widehat{a}^{IC}$ prefer IC. To check this it suffices to show that the condition for the existence of a threshold a^I in the range $\left[\widehat{a}^{TS}, \widehat{a}^{IC}\right]$ is not satisfied - i.e., that $p\left(a^I\right) > p(\widehat{a}^{IC})$:

$$p(a^I) = \frac{w_L + T^{TS} - T^{IC}}{\delta\left(w_H - w_L\right)} > \frac{w_L}{\delta\left(w_H - w_L\right) - k} = p(\widehat{a}^{IC})$$

if and only if

$$w_L\delta\left(w_H - w_L\right) - w_L k + \left(T^{TS} - T^{IC}\right)\delta\left(w_H - w_L\right) - \left(T^{TS} - T^{IC}\right)k > \delta\left(w_H - w_L\right)w_L,$$

which can be simplified to $p(\widehat{a}^{IC}) < \left(T^{TS} - T^{IC}\right)/k$.■

Those who do not study under any scheme prefer the income-contingent loan because they pay less (if participation is less than 50% under both schemes, the income-contingent loan is the trivial outcome from voting). Among those who study with the tax-subsidy scheme but not with the income-contingent loan two things can happen: either some (those with relatively lower ability) prefer the income-contingent loan or all of them do so. The first case occurs when the decisive threshold ability is $a^I \in \left[\widehat{a}^{IC}, \widehat{a}^{TS}\right]$: individuals with ability $a \in \left[\widehat{a}^{IC}, a^I\right]$ prefer not to study with the income-contingent loan rather than study with the tax-subsidy: their probability of success is sufficiently low that they prefer not to forego earnings in the first period and pay a relatively lower contribution T^{IC} in the second. The second case occurs when $p(\widehat{a}^{IC})k + T^{IC} < T^{TS}$ (i.e., the expected total payment with the income-contingent loan is smaller than the payment with the tax-subsidy scheme for the individuals who are indifferent between studying or not with the income-contingent loan scheme): individuals with ability $\widehat{a}^{IC}$ prefer the income-contingent loan, and so do all individuals with lower ability, even if they would have studied with the tax-subsidy scheme. In this case the relevant threshold is $a^{II} > \widehat{a}^{IC}$ and only a subset of those who study regardless of the scheme in place prefer the tax-subsidy: namely, those individuas with relatively higher ability, who are more likely to be successful and expect to repay more with the income-contingent loan. The key difference is that, while in the first case some of those who support the tax-subsidy would not access higher education if offered income-contingent loans instead, in the second case all those who support the tax-subsidy study under both schemes and simply prefer to pay less.

5.2 Risk aversion

As mentioned above, with risk averse individuals it is not possible to determine in general which scheme induces more participation. In the simulations discussed above, however, the tax-subsidy induces more participation than the income-contingent loan for most reasonable degrees of risk aversion. We concentrate hereafter on situations of this type: i.e., $\widetilde{a}^{TS}(b) < \widetilde{a}^{IC}(b)$. In the region $\left[0, \widetilde{a}^{TS}(b)\right]$ individuals do not study with any of the two schemes, and they prefer the risk-sharing income-contingent loan because they pay less:

$$u\left(b + (1+\delta) w_L - T^{IC}\right) > u\left(b + (1+\delta) w_L - T^{TS}\right).$$

In the region $\left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ individuals study with the tax-subsidy scheme but do not study with the risk-sharing income-contingent loan, and they prefer IC when

$$u\left(b + (1+\delta) w_L - T^{IC}\right) > (1 - p(a))\, u\left(b + \delta w_L - T^{TS}\right) + p(a)\, u\left(b + \delta w_H - T^{TS}\right).$$

If for a given wealth b there exits an ability level in the range $\left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ such that the individual is indifferent between the two schemes, we denote this ability threshold, below which individuals prefer IC and above which individuals prefer TS, by $\widetilde{a}^{I}(b)$ and it satisfies

$$p\left(\widetilde{a}^{I}(b)\right) = \frac{u\left(b + (1+\delta) w_L - T^{IC}\right) - u\left(b + \delta w_L - T^{TS}\right)}{\left(u\left(b + \delta w_H - T^{TS}\right) - u\left(b + \delta w_L - T^{TS}\right)\right)}. \tag{20}$$

Let $G^{\Delta}(a,b)$ be the utility differential between studying with TS and not studying with IC:

$$G^{\Delta}(a,b) = (1 - p(a))\, u\left(b + \delta w_L - T^{TS}\right) + p(a)\, u\left(b + \delta w_H - T^{TS}\right) - u\left(b + (1+\delta) w_L - T^{IC}\right). \tag{21}$$

$G^{\Delta}(a,b)$ is increasing in a. If we evaluate it at $\widetilde{a}^{IC}(b)$ we obtain two possibilities:

1. If $G^{\Delta}(\widetilde{a}^{IC}(b), b) > 0$ then $\widetilde{a}^{I}(b) < \widetilde{a}^{IC}(b)$ and every individual with wealth b and ability above $\widetilde{a}^{IC}(b)$ prefers TS (expected utility of education is larger under TS for $\widetilde{a}^{IC}(b)$ and hence it is so for all $a > \widetilde{a}^{IC}(b)$). Then the decisive individual is $\widetilde{a}^{I}(b)$.

2. If $G^{\Delta}(\widetilde{a}^{IC}(b), b) < 0$ then $\widetilde{a}^{I}(b) > \widetilde{a}^{IC}(b)$. Everyone in the region $\left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ prefers IC and some individuals above $\widetilde{a}^{IC}(b)$ also prefer IC. It can be shown that there is a second threshold $\widetilde{a}^{II}(b) > \widetilde{a}^{IC}(b)$ that becomes the relevant one.

The outcome that ultimately emerges, and whether the individuals with ability $\widetilde{a}^{I}(b)$ or $\widetilde{a}^{II}(b)$ are the decisive ones, depends on the particular combination of parameters. To explore their role, and in particular the effect of the degree of risk aversion, we report some examples below. When $\widetilde{a}^{I}(b)$ is the decisive threshold, support for the tax-subsidy scheme comes from all individuals who study irrespective of the financing scheme and some individuals who study under the tax-subsidy but would not do so if offered income-contingent loans. When $\widetilde{a}^{II}(b)$ is the decisive threshold, support for the tax-subsidy scheme comes exclusively from some but not all of the individuals who study irrespective of the scheme: those individuals with relatively higher ability and wealth. Note that, contrary to the benchmark case of risk neutrality explored above, the decisive ability thresholds $\widetilde{a}^{I}(b)$ and $\widetilde{a}^{II}(b)$ are decreasing in wealth: this is due to the fact that absolute risk aversion decreases with wealth.

In situations where participation in higher education with TS is below 50% the outcome of the choice between the two stylized schemes that we consider is trivial: the income-contingent loan would be preferred since the majority of individuals do not study and they prefer to pay less for the education of others. We concentrate next mostly on examples where the combination of parameters adopted yields higher education participation in excess of 50%.[4]

5.2.1 Example 1: the majority supports *TS* with $\widetilde{a}^{I}(b)$ decisive

With the benchmark parameter values used before and for $\sigma = 0.75$ we obtain that a majority supports TS with $\widetilde{a}^{I}(b)$ being the decisive ability threshold. In this example, we represent the thresholds $\widetilde{a}^{TS}(b)$ and $\widetilde{a}^{IC}(b)$, together with $\widetilde{a}^{I}(b) \in \left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ (see Figure 6). $\widetilde{a}^{IC}(b)$ and $\widetilde{a}^{TS}(b)$ and both are below 0.5, for all b: more than half of the

[4] The OECD Education at a Glance 2010 Chart A2.5 suggests participation in higher education in OECD countries ranges from below 30% to above 70%.

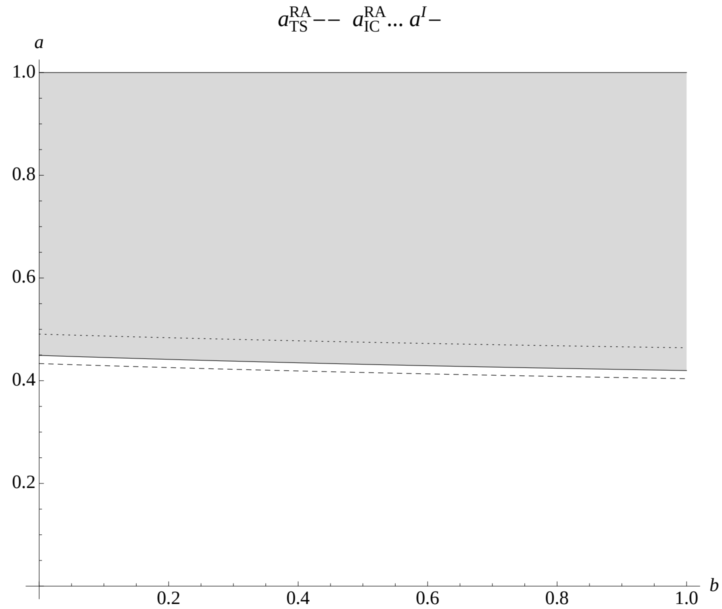

Figure 6: Majority for TS with $\widetilde{a}^{I}(b)$ decisive

population studies under any of the two schemes and, thus, those who never study do not have the majority of the vote. The threshold $\widetilde{a}^{I}(b) \in \left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ determines the support for each scheme for all b: all those below $\widetilde{a}^{I}(b)$ support IC (the shaded area, above $\widetilde{a}^{I}(b)$, which represents more than 50% of the population, supports TS). The support for TS comes from all those who study regarless of the scheme, and some but not all those who study with TS but would not do so with IC (the less able and less wealthy in this group, with relatively higher probability of failure and higher absolute risk aversion, prefer not to study and pay T^{IC}).

5.2.2 Example 2: the majority supports *IC* with $\widetilde{a}^{I}(b)$ decisive

For the same benchmark parameter values employed above but for a degree of risk aversion $\sigma = 1.5$ we obtain that a majority supports IC with $\widetilde{a}^{I}(b) \in \left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$ as the decisive ability threshold for all b. Increasing the degree of risk aversion to $\sigma = 3$ we obtain the same qualitative result with an even larger support for IC. The intuitive explanation is that as risk aversion increases participation levels decrease for both schemes (and hence support from non-students for IC becomes larger). In addition, with a larger degree of

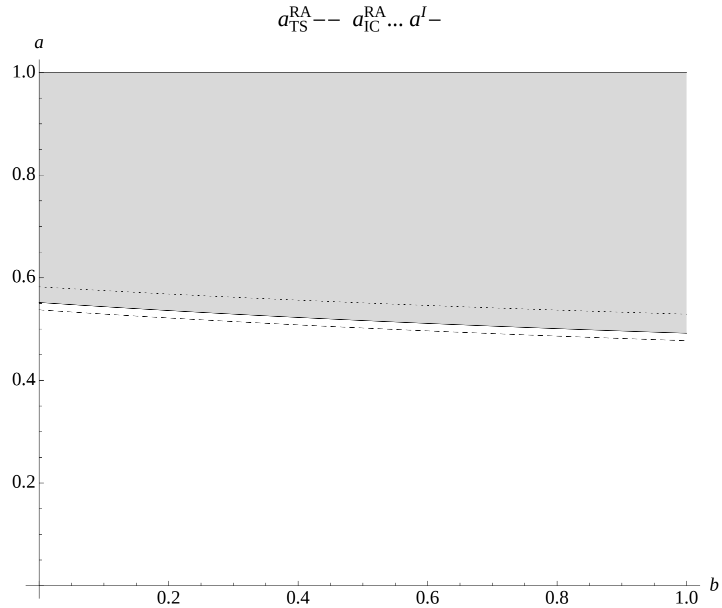

Figure 7: Majority for IC with $\widetilde{a}^I(b)$ decisive

risk aversion the IC scheme, which provides more insurance, becomes relatively more attractive. We again represent, in Figure 7, the thresholds $\widetilde{a}^{TS}(b)$ and $\widetilde{a}^{IC}(b)$, together with $\widetilde{a}^I(b) \in \left[\widetilde{a}^{TS}(b), \widetilde{a}^{IC}(b)\right]$. All those below $\widetilde{a}^I(b)$ support IC (the shaded area, which represents in this case less than 50% of the population, supports TS). The support for IC comes from those who never study, and some - the relatively less able and less wealthy - who would study with TS and do not with IC.

5.2.3 Example 3: the majority supports IC with $\widetilde{a}^{II}(b)$ decisive

If from the benchmark parameter values we increase δ to 3, to capture a larger weight of future earnings relative to present foregone earnings and cost of education, participation becomes relatively more attractive. In the case of $\sigma = 3$ we obtain that a majority supports IC but the decisive individuals are characterized by $\widetilde{a}^{II}(b) > \widetilde{a}^{IC}(b)$ for all wealth values b.[5] All those below $\widetilde{a}^{II}(b)$ support IC (the shaded area, above $\widetilde{a}^{II}(b)$, which represents

[5]If from the set of parameter values used in example 2, where $\sigma = 1.5$, we just increase δ to 3 (not reported graphically here to save space) we obtain that $\widetilde{a}^I(b)$ is the relevant threshold for less wealthy individuals whereas $\widetilde{a}^{II}(b)$ is the relevant threshold for wealthier individuals. Less wealthy individuals have a higher absolute risk aversion and a higher proportion of them tends to support the IC scheme, which provides more insurance.

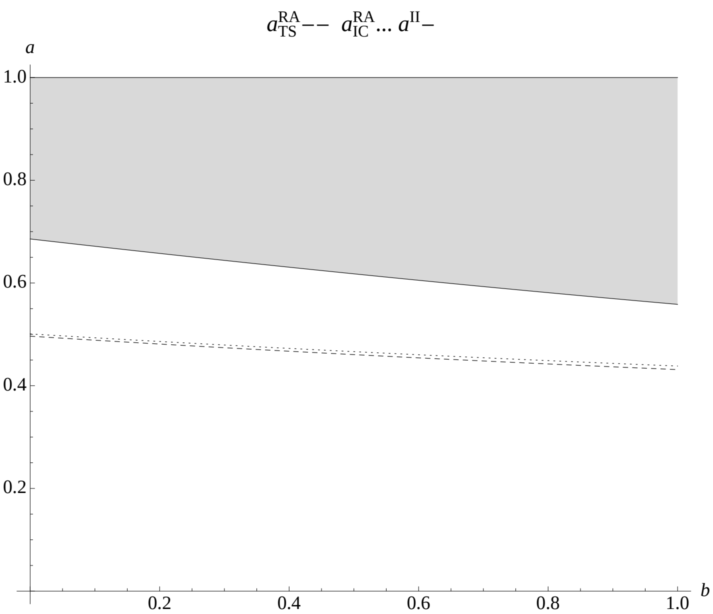

Figure 8: Majority for IC with $\widetilde{a}^{II}(b)$ decisive

in this case less than 50% of the population, supports TS). The composition of the group that supports IC differs from example 2. Those who prefer IC now include those who never study, all those who would study with TS but do not study with IC, and some of those who study regardless of the scheme in place. The support for TS comes from a subset of students who participate regardless of the scheme in place and prefer to pay less: namely, those with higher ability and wealth, who have a higher probability of success and and a lower absolute risk aversion. These individuals expect to pay more with, and value less the insurance features of, the income-contingent loan scheme.

6 Conclusions

We consider individuals who differ in two characteristics – ability to benefit from education and inherited wealth – and analyze higher education participation under two alternative financing schemes – tax subsidy and risk-sharing income-contingent loans –, paying particular attention to the welfare achieved by individuals with different ability and wealth under each. Wealthier individuals are more likely to undertake higher education despite the fact that they do not pay in advance for their education: the presence of foregone earnings and the assumption of decreasing relative risk aversion play crucial roles in this result.

We then study which financing scheme arises when individuals are allowed to vote between them. We do so both for the benchmark case of risk neutrality and for risk aversion. We identify ability thresholds that allow to determine the magnitude of the support for the alternative financing schemes. Those individuals with ability below the threshold ability support the income-contingent loan scheme whereas those with higher ability support the tax-subsidy scheme. In order to shed more light we perform numerical simulations. For a set of benchmark parameter values, a change in the degree of risk aversion switches the majority support from the tax-subsidy scheme to the income-contingent loan. The composition of the group that supports the alternative schemes may also change depending on the parameter values. We obtain cases in which the support for tax-subsidy comes from those who always study, and some (those with relatively higher ability and wealth) who study with tax-subsidy and not with income-contingent loans. The higher probability of success of higher ability individuals induces them to support the tax-subsidy instead of the income-contingent loan scheme because they expect to contribute more under the latter; the lower absolute risk aversion of wealthier individuals reduces their demand for schemes that provide insurance, and hence their support for income-contingent loans. We also obtain cases in which the support for the tax-subsidy scheme comes exclusively from some (those with relatively higher ability and wealth) who always study. In this case all those who do not study, all those who would study with tax-subsidy but not with income-contingent loans and some (those with relatively lower ability and wealth) who study with both schemes support income-contingent loans. In the numerical simulations we show that such a case arises when the degree of risk aversion is particularly large making the income-contingent loans, which provide insurance, relatively more attractive.

The way in which we model the alternative financing schemes is rather inflexible: in particular, the taxes the individuals are required to pay to contribute to the cost of higher education are lump-sum, and are calculated from the budget constraint. As a result individuals do not vote on the tax (or subsidy) rate, as is the case in other contributions in the literature, but on the overall financing scheme. This approach provides relatively clearcut and intuitive insights. It would nevertheless be worth exploring alternative taxation rules and we plan to do so in future research.

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