Oxford Economic Papers Advance Access published November 24, 2012

Oxford Economic Papers (2012), 1 of 25
doi:10.1093/oep/gps042

Political economics of higher education finance

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We study voting over higher education finance in an economy with risk averse households who are heterogeneous in income. We compare four different systems and analyse voters' preferences among them: a traditional subsidy scheme, a pure loan scheme, income contingent loans and graduate taxes. Using numerical simulations, we find that the poor prefer the subsidy scheme over the other systems, even though they pay part of the taxes. We also find that majorities for income contingent loans or graduate taxes become more likely as risk aversion rises or the income distribution gets more equal.

JEL classifications: H52, H42, D72.

1. Introduction

In this paper, we study household preferences over different systems of higher education finance. Traditionally, most western democracies have subsidized higher education costs, with the subsidies financed by general tax revenue. But this 'traditional tax-subsidy scheme' (TS for short) has been criticized on several grounds. First, since subsidies are financed by general taxes, but children from rich families are more likely to go to college, this financing scheme may lead to 'reverse' redistribution from poor to rich.[1] Second, even with subsidies, private education choices may not be efficient. For instance, poor but able students might not be capable of affording higher education if the subsidy is too low.[2] García-Peñalosa and Wälde (2000) show that, with risk neutral students and credit constraints, it is impossible to attain efficiency and equity at the same time with the TS system.

[1] See Johnson (2006) for a recent reference.

[2] Fernandez and Rogerson (1995) argue that rich households may keep subsidies low in order to prevent the poor from obtaining education and at the same time extract resources from the poor through general income taxation.

Recently, therefore, several countries have reformed higher education finance or are considering doing so. While some countries are moving towards greater reliance on user fees, proposals are usually coupled with a form of loan scheme. Among these schemes are what are called 'pure loan schemes' (PL), where the government makes loans available to students who are credit constrained. These loans then have to be paid back at (or below) market rates. While this system eliminates credit constraints, it has the disadvantage that it does not provide insurance against the risk of failure. Typically, around 25% of college students do not complete graduation. Hence, studying is an uncertain gamble, and individuals who wish to go to college will demand insurance against the risk of failure. If such insurance is not available in private markets, there is a role for insurance provided through the financing system.

Systems that do provide this type of insurance are income contingent loans (IC) or graduate taxes (GT).[3] Under IC, students receive loans which have to be repaid only after graduation, with repayment schedules typically depending on income. Loans to unsuccessful students are covered by general tax revenue. Under the GT system, again, only successful graduates repay their loans, but defunct loans are now financed only by the graduates. Different forms of IC systems have been introduced in Sweden, Australia, New Zealand, and the UK (see Chapman, 2006, for an overview). Many other countries are now discussing such schemes.

Chapman (2006) cites the regressivity of traditional subsidy financing as one of the reasons that led to the adoption of income contingent loans in Australia, New Zealand, and the UK. That politicians are concerned with equity is rather obvious, yet very little is known about the actual political forces underlying reforms of higher education finance. In order to fill this gap, we study voting on the schemes just described: TS, PL, IC, and GT. We assume risk averse households who differ by income. Individuals in their first period may study or work as low-skilled workers. In the second period, successful graduates work as high-skilled, whereas unsuccessful students work as low-skilled workers. Wages are endogenously determined by the number of students and non-students. Within each system, taxes and subsidies are determined by majority voting. This framework yields a number of interesting results. Since low-skilled wages rise with the number of students, the poor in general do not prefer the system where they pay the lowest taxes. In particular, the poor prefer the TS system over either GT or PL, even though in the latter systems they do not pay any taxes. This runs counter to the logic of the regressivity of the traditional subsidy system. Another question we address is which societies are most likely to move from a TS scheme to either GT or IC. By varying parameters, we find that majorities for IC or GT

[3] Chapman (2006) uses the terminology ICL (income contingent loan) with risk sharing for what we call IC system, and ICL with risk pooling for what we term GT. In his definition, under graduate taxes, there is no connection between total taxes and the costs of education. We follow the definition by García-Peñalosa and Wälde (2000) here.

become more likely as risk aversion rises, or when the income distribution becomes either less skewed, or median and average income both fall for given skewness. Interestingly, these changes in the income distribution make IC or GT more attractive, while making PL less attractive against TS. We believe that these results are important, since any reform of higher education finance must find support from a sufficient number of voters.

The paper is related to two strands of literature. One strand studies equity and efficiency of different higher education systems.[4] García-Peñalosa and Wälde (2000), for instance, argue that the TS system cannot achieve efficiency and equity at the same time. Del Rey and Racionero (2010) advocate an IC system which covers tuition and living costs to achieve efficiency. We use the same type of model as García-Peñalosa and Wälde (2000) and Del Rey and Racionero (2010), but, whereas both assume exogenous wages, we allow wages to be endogenously determined. Also, Del Rey and Racionero (2010) focus exclusively on efficiency whereas García-Peñalosa and Wälde (2000) look at efficiency and equity. We also analyse redistributional effects, but we go beyond the analysis of García-Peñalosa and Wälde (2000) in that we compare the systems with endogenously determined equilibrium subsidies and taxes and explicitly analyse household preferences over these systems.

There is also a relatively large literature on the political economy of education, much of which focuses on primary and secondary education, however. For example, Epple and Romano (1996) and Stiglitz (1974) study the provision of public education with private alternatives. Epple and Romano (1996) argue that rich and poor voters may prefer low public education provision while middle class voters want high provision. Fernandez and Rogerson (1995) study subsidies for education and show how the rich and middle class may vote for relatively low subsidies to keep the poor from studying. This results in reverse redistribution. A similar finding is obtained by Anderberg and Balestrino (2008), who apply the Epple-Romano logic to subsidies to higher education with credit constraints.[5] De Fraja (2001) studies voting on higher education subsidies and finds that it may result in a (partial) ends-against-the-middle equilibrium as in Epple and Romano (1996): some low ability-low income households vote with the rich for low subsidies.

We make two main contributions to the literature. First, most of the literature on the political economy of higher education finance has analysed voting on subsidies to higher education. Our paper is the first to incorporate the choice among different financing systems into a political economy model.[6] Second, most of the

[4] See, e.g., García-Peñalosa and Wälde (2000), Greenaway and Haynes (2003), Barr (2004), Chapman (2006), and Del Rey and Racionero (2010).

[5] Creedy and Francois (1990) also study voting on higher education expenditures. They assume that subsidising higher education benefits non-students through an aggregate externality.

[6] See also Del Rey and Racionero (2012) who study voting between a TS system and an IC scheme. They assume fixed wages, and in addition, they model exogenous lump-sum taxes for both schemes. Then, non-students vote for the IC scheme since tax payments are smaller. Instead, all students vote for the TS system. This is in contrast to our results, where non-students favour the TS system and students the IC

literature has analysed models with fixed wages, (see, e.g., Fernandez and Rogerson, 1995; De Fraja, 2001; and Anderberg and Balestrino, 2008). Hence, these models find that non-students vote against subsidies for higher education, since they pay taxes to finance these subsidies without benefiting from them. Applied to different systems of financing higher education, non-students would always prefer the system with lowest taxes, that is a pure fee-financing (or among the systems we study, pure loan) system. Instead, we follow Johnson (1984) and model wages that are endogenously determined by the supply of workers of differing skills. This implies that non-students may actually benefit from subsidies to higher education, which draw many individuals into higher education and lead to high wages for the low skilled.[7]

Our paper proceeds as follows. The next section presents the model, and Section 3 describes the equilibrium. Section 4 presents results from a numerical simulation, with varying parameters. The last section concludes.

2. The model

2.1 The economy

Our model economy contains an infinite number of heterogeneous households containing one parent and one child, and we assume that all decisions are taken by the parent. We normalize the size of each generation to one. Households differ in their initial wealth ω_i, which is distributed with cumulative distribution function $G(\omega_i)$ and density $g(\omega_i)$. We assume that higher education costs are a fixed amount $e > 0$ for all households. Because of imperfect credit markets households cannot borrow against future income. Therefore, without financial aid households who are credit constrained will be excluded from obtaining higher education.

Individuals live for two periods. Parents are assumed to be altruistic towards their children and maximize a well-behaved utility function

$$U_i = u(c_i^J + \delta c_i^O), \tag{1}$$

with $u' > 0 > u''$, where c_i^J is consumption of household i when the child is young and c_i^O consumption when the child is old (and parents have died), and δ is the discount factor. For simplicity, we assume that individuals care about their life-time consumption.[8]

scheme (in absence of PL) mainly because of variations in enrolment rates and the corresponding general equilibrium effects on wages.

[7] Only Creedy and Francois (1990) assume 'quasi' endogenous wages in that they model an enrolment-dependent positive externality on both high- and low-skilled wages. Similar to our model, they find that non-students may prefer positive subsidies to students.

[8] In other words, the intertemporal elasticity of substitution is infinite (see also García-Peñalosa and Wälde, 2000). This assumption can be relaxed. In fact, we have also simulated some examples where the elasticity of intertemporal substitution is equal to the inverse of the coefficient of relative risk aversion ρ, but the determination of voting equilibria becomes more complicated.

When their children are young, parents choose whether to let them study or work. Young workers work in a low-skilled job and earn a wage w_L. When old, the unskilled again work for wage w_L. The 'young' period consists of that period during which students obtain their education (say, 16 to 25 years), which is shorter than the working life period (say, 25 to 65). Therefore, we will assume that the young who work earn wages for a fraction $\gamma < 1$ of an entire period.

Individuals who study do not work during the first period. Successful students earn a high-skilled wage w_H in the second period, and we assume that every student is successful with probability p. With probability $(1-p)$ a student fails and works in a low-skilled job, earning a wage w_L.

Since utility is concave in consumption, households are strictly risk averse. This implies that financing higher education has two functions: a redistributive function and an insurance function against the risk of failure. Throughout the analysis, we assume decreasing absolute risk aversion.

Total production is given by the linearly homogeneous production function $y_t = AF(H_t, L_t)$, where H_t is the number (mass) of high skilled and L_t the number of low-skilled workers in period t. The parameter A reflects technology. The production function is assumed to be homogeneous of degree one with $F_H, F_L > 0$, $F_{HH}, F_{LL} < 0$, where subscripts denote partial derivatives. Homogeneity of degree one implies that the partial derivatives F_H and F_L are homogeneous of degree zero, which implies that $F_{HL} = -\frac{H}{L}F_{HH} > 0$.[9]

Since we focus on one generation out of an endless overlapping generations model, the high skilled and low skilled consist of young individuals of generation t, as well as the old of generation $t-1$. There are

$$H_t = pN_{t-1}$$

high skilled in period t, where N_{t-1} denotes the successful students from the previous generation. There are

$$L_t = (1-p)N_{t-1} + (1-N_{t-1}) + (1-N_t) = 1 - H_t + 1 - N_t$$

low skilled in period t, i.e., those of the current period who do not study, plus those who either have not studied or not studied successfully in the previous period. We assume profit maximising firms and perfectly competitive labour markets. Therefore, workers are paid their marginal product in each period, and the wages for high skilled and low skilled are given by:

$$w_H = AF_H \tag{2}$$

$$w_L = AF_L. \tag{3}$$

Since $F_{HL} > 0$, increasing the number of high skilled will reduce the high skilled wage and increase the low-skilled wage (since the number of low-skilled falls).[10]

[9] Homogeneity of degree zero implies that $HF_{HH} + LF_{HL} = HF_{HL} + LF_{LL} = 0$. See, e.g., Simon and Blume (1994, p.487).

Likewise, increasing the number of low skilled will decrease the low-skilled wage and increase the high-skilled wage. This is one important channel through which education finance affects household preferences.

A large literature has analysed changes in the US wage structure. Following Katz and Murphy (1992), several studies have found that because of imperfect substitutability between skilled (college-educated) and unskilled (non-college educated) labour, the skill premium in the US and other countries can be explained by the relative supply of skilled over non-skilled labour, in addition to demand factors and technological change. See, e.g., the surveys by Katz and Autor (1999) and Acemoglu and Autor (2011) who report elasticities of substitution between skilled and unskilled of 1.4 to two. The skill premium (relative college/high school wage) in the US increased in the 1960s, then decreased in the 70s and has been increasing since the 1980s. The fall and subsequent rise of the skill premium seems compatible with a sharp rise and subsequent slowdown in the relative supply of college to high school workers.[11] For Germany, Dustmann *et al.* (2009) document the evolution of inequality from the 1970s onwards. They show that the skill premia between middle and low skilled and between high and low skilled first fell and then rose starting in the late 1980s/early 90s. This is compatible with a fall in the relative supply of low-skilled workers in the 1970s, which then decelerated in the 1990s.[12] Studies on the effects of immigration on wages have also found imperfect substitutability among skill groups, with elasticities of substitution that are somewhat larger in some studies, e.g. Manacorda *et al.* (2012) and Ottaviano and Peri (2012) who find values of around three to five. In summary, we use a 'canonical model' whose basic setup is supported by a large number of empirical studies.

2.2 Financing schemes

We analyse four different financing schemes for higher education: a pure loan scheme (*PL*), a traditional tax-subsidy scheme (*TS*), a graduate tax scheme (*GT*) and income contingent loans (*IC*).

2.2.1 *Pure loan scheme* Consider first the PL scheme. Here, all students are eligible for a loan to cover the direct education costs e. This implies that credit constraints are never binding. Letting $EU(\omega_i)$ denote the expected utility of studying and $U(\omega_i)$ the (certain) utility of not studying, the endowment of the household who is just indifferent between letting its child study or not, $\hat{\omega}^{PL}$, is implicitly defined by

[10] See, e.g., Johnson (1984) for a discussion of the preferences of differently skilled workers for higher education subsidies.

[11] Again, other factors such as changes in demand and (skill-biased) technological change also played a role; see, e.g., Acemoglu and Autor (2011) for a survey.

[12] In fact, Dustmann *et al.* (2009) estimate an elasticity of substitution of around four between skilled and unskilled workers. A simple supply/demand model can explain around 93% of the evolution of relative wages in Germany from 1975-2004.

$$\Delta(\omega^{PL}) \equiv EU^{PL}(\hat{\omega}^{PL}) - U^{PL}(\hat{\omega}^{PL}) = 0, \tag{4}$$

where

$$EU^{PL}(\hat{\omega}^{PL}) = pu(\hat{\omega}^{PL} - e + \delta w_H) + (1-p)u(\hat{\omega}^{PL} - e + \delta w_L),$$
$$U^{PL}(\hat{\omega}^{PL}) = u(\hat{\omega}^{PL} + (\gamma + \delta)w_L).$$

We assume that the loan scheme is 'pure' in that the interest to be paid equals the market interest rate. Students pay their education costs e (they receive a loan of e in the first period and repay the loan plus interest, e/δ in the second period) and obtain a wage w_H if successful and w_L if unsuccessful in the second period.[13] Non-students obtain the wage w_L in both periods (where again first period length is a fraction γ of the second). Since all loans are repaid in period 2, government financing occurs only on paper, that is, government subsidies prepay for the loans of credit constrained students, but the government's intertemporal budget constraint always balances. Therefore, we do not explicitly model subsidies or tax payments, since in fact each student pays for her own education costs.

Since we assume decreasing absolute risk aversion, all households with endowment larger than $\hat{\omega}^{PL}$ will let their children study and all others won't.[14] The number of students under PL is then $N^{PL} = 1 - G(\hat{\omega}^{PL})$.

2.2.2 *Traditional tax-subsidy scheme* In the *TS* scheme, the fraction s of the costs of studying is covered by the government. These public expenditures are financed by a proportional tax levied on the endowments of all households. In contrast to graduate tax or income contingent loan schemes, the TS scheme is financed by taxes on the current working generation.[15] In purely fiscal terms, this system redistributes from non-students to students, since non-students pay taxes but do not directly benefit from subsidies towards higher education. However, they may benefit indirectly through higher wages (Johnson, 1984).

Households whose child goes to college obtain the expected utility

$$\begin{aligned} EU_i^{TS} &= pu((1-t^{TS})\omega_i - (1-s^{TS})e + \delta w_H) \\ &\quad + (1-p)u((1-t^{TS})\omega_i - (1-s^{TS})e + \delta w_L), \end{aligned} \tag{5}$$

where s is the subsidy rate and t the income tax rate, and the superscript TS denotes the financing scheme.

Households whose children do not pursue higher education achieve utility

[13] Implicitly, we assume that even unsuccessful students will be able to repay their loans. In the benchmark simulations, this poses no problem since the unskilled wage always exceeds the loans to be repaid including accrued interest.

[14] It can be shown that under decreasing absolute risk aversion, Δ is increasing in ω (see García-Peñalosa and Wälde, 2000, p.713).

[15] García-Peñalosa and Wälde (2000) analyse a similar set-up of education finance with lump-sum taxes but argue that a tax on current income seems like a more natural scheme. See also De Fraja (2001).

$$U_i^{TS} = u((1 - t^{TS})\omega_i + (\gamma + \delta)w_L). \tag{6}$$

To ensure a balanced budget, total tax revenue must cover subsidies to all students:

$$\left(t^{TS} - \frac{(t^{TS})^2}{2}\right)\omega = s^{TS} e N^{TS}, \tag{7}$$

where N^{TS} is the fraction (or number, since total population is set to one) of students and $\omega = \int_0^\infty \omega_i g(\omega_i) d\omega_i$ denotes average income. We assume that raising taxes causes a quadratic deadweight cost (perhaps because of incentive effects on labour supply). The reason for this assumption is that without such a cost, under GT all households would choose full insurance.[16]

Households decide whether or not to let their child study by comparing EU_i^{TS} and U_i^{TS}. Then, the number of students will be determined by the endowment level $\hat{\omega}^{TS}$, where the expected utility of studying equals the utility level for a non-student, if this endowment is larger than the net costs of studying. This endowment is implicitly defined by:

$$EU_i^{TS}(\hat{\omega}^{TS}) = U_i^{TS}(\hat{\omega}^{TS}). \tag{8}$$

If, on the other hand, the household with income $\hat{\omega}_i^{TS}$ is credit constrained, the equilibrium number of students is given by all those with income above $\bar{\omega}^{TS}$, which is the income level that just covers net education costs:

$$\bar{\omega}^{TS} = \frac{(1 - s^{TS})}{(1 - t^{TS})}\, e. \tag{9}$$

The equilibrium number of students is then given by:

$$N^{TS} = 1 - G(\tilde{\omega}^{TS}) \quad \text{with} \quad \tilde{\omega}^{TS} = \max\{\hat{\omega}^{TS}, \bar{\omega}^{TS}\}. \tag{10}$$

2.2.3 *Graduate tax scheme* Under the *GT* scheme, every student takes out a loan from the government in period 1. In addition, government subsidizes part of the education costs and finances these subsidies by issuing public debt. The debt is repaid in period 2 by a tax on successful graduates. Hence, this system is entirely self-financing and does not require any funding from general taxation.[17]

Consequently, the GT system redistributes from successful to unsuccessful graduates (García-Peñalosa and Wälde, 2000). In so doing, it provides insurance against the risk of failure to graduate.

[16] This shortcut modeling of the deadweight cost follows several other papers in political economy, e.g., Perotti (1993) and Bolton and Roland (1997).

[17] This definition of a graduate tax follows García-Peñalosa and Wälde (2000). On the other hand, Del Rey and Racionero (2010), following the terminology of Chapman (2006), call this type income-contingent loans with risk-pooling. In the generally known graduate tax system, there is no specific link between tax revenues and the costs of higher education. We keep the definition from García-Peñalosa and Wälde (2000) for better comparability.

The expected utility level of a household whose child studies under *GT* is

$$EU_i^{GT} = pu(\omega_i - e + \delta(1 - t^{GT})w_H) + (1 - p)u(\omega_i - (1 - s^{GT})e + \delta w_L), \tag{11}$$

whereas households whose child does not study realize utility

$$U_i^{GT} = u(\omega_i + (\gamma + \delta)w_L). \tag{12}$$

Since graduates finance the entire loans through their tax revenue—i.e. the loans they take out plus those taken out by the unsuccessful students—only the unsuccessful students are in fact subsidized.

Since the expenses for loans distributed in the first period will not be covered until graduation, i.e., the identification of lucky and unlucky students in period 2, government finances educational grants through public debt. The government budget constraint is:

$$\delta\left(t^{GT} - \frac{(t^{GT})^2}{2}\right)w_H p N^{GT} = (1 - p)N^{GT} s^{GT} e, \tag{13}$$

where the left side of eq. (13) reflects discounted tax revenue. As can be seen, only successful students pN are taxed to finance the education expenditures granted in effect only to the unsuccessful students.

The determination of the number of students proceeds like in the *TS* scheme. It is given by $N^{GT} = 1 - G(\tilde{\omega}^{GT})$ with $\tilde{\omega}^{GT} = \max\{\hat{\omega}^{GT}, \bar{\omega}^{GT}\}$, where again $\hat{\omega}^{GT}$ denotes the household who is indifferent between letting its child study or not and $\bar{\omega}^{GT} = (1 - s^{GT})e$ is the household whose income just suffices to pay (net of subsidy) education costs.

2.2.4 *Income contingent loans* Under the *IC* system, every student is entitled to a loan from the government in period 1, but only lucky students have to pay back their loans in period 2. The loans of unsuccessful students – who number $(1 - p)\ N$– are borne by the entire population via a general tax.[18] The expected utility level for a household whose child studies is

$$\begin{aligned} EU_i^{IC} = {} & pu(\omega_i - e + \delta(1 - t^{IC})w_H) \\ & + (1 - p)u(\omega_i - (1 - s^{IC})e + \delta(1 - t^{IC})w_L), \end{aligned} \tag{14}$$

and if the child does not study, household utility is

$$U_i^{IC} = u(\omega_i + (\gamma + \delta(1 - t^{IC}))w_L). \tag{15}$$

The government budget constraint in the IC system is:

[18] Chapman (2006) and Del Rey and Racionero (2010) call this type of student support income contingent loans with risk sharing.

$$\delta\left(t^{IC} - \frac{(t^{IC})^2}{2}\right)(pN^{IC}w_H + (1-p)N^{IC}w_L + (1-N^{IC})w_L) \\ = (1-p)N^{IC}s^{IC}e. \tag{16}$$

The left hand side is tax revenue, which comes from three sources: lucky students pN, unlucky students $(1 - p)\ N$ and non-students $(1 - N)$. The right hand side shows public expenditure for education, which consists of the loans to the unlucky which are not covered.

Again, the equilibrium number of students is given by $N^{IC} = 1 - G(\tilde{\omega}^{IC})$ with $\tilde{\omega}^{IC} = \max\{\hat{\omega}^{IC}, \bar{\omega}^{IC}\}$, where these thresholds are defined as before.

3. Equilibrium

We assume that our game has the following structure: at the first stage, households decide about the financing scheme, at the second stage the equilibrium subsidy is determined within each system by majority voting. And finally, households decide whether to let their child study or not at stage 3. As usual, this game is solved by backward induction.

3.1 Education decision

Let us first look at the last stage. Having observed the equilibrium subsidy rates for every scheme (the subsidy level under PL is zero by definition) and the resulting number of students determined by the political voting process in stage 2, households decide about the education of their children. As described before, students will be all children of households whose expected utility of studying exceeds the utility of not studying and who are not credit constrained. All those who either do not want to study or cannot study because of credit constraints will work (as low skilled) in both periods.

Since there is a continuum of households, we assume that they treat the number of students as given, but the equilibrium number of students results from the joint decisions of all households.

3.2 Equilibrium subsidy rates

At stage 2, the subsidy level is determined within a given education finance scheme by simple majority voting. Each household votes for its preferred subsidy rate within a given financing system.

A household with endowment level ω_i will vote for its optimal subsidy (and corresponding tax rate), which maximizes utility, subject to the relevant budget constraint. A majority voting equilibrium must satisfy the condition that there is no majority favouring a subsidy different from the equilibrium subsidy.

Each household will in general have two different optimal tax rates, one where the child studies, and one where she does not. When the child does not study, there are two effects on household utility: the direct effect, which occurs if the household has to pay taxes in the corresponding regime (as under TS and IC), and the indirect effect on the low-skilled wage. This effect depends on how increasing taxes and subsidies changes the number of students versus non-students and hence, skilled and unskilled wages.

If the child studies, there is also a direct effect of a higher tax on household utility, and additionally the effect of the higher subsidy received by students. Further, the wage effect is split in two: with probability p, the child will succeed and receive the high-skilled wage, and with probability $1 - p$ she will not succeed and receive the low-skilled wage. The household will vote for whichever tax rate maximizes its utility. The voting equilibrium is then determined by the aggregation of households' preferences via majority voting.

In general, under the TS system, preferences satisfy neither single peakedness nor single crossing. Hence, a voting equilibrium might not exist. We follow the approach of Epple and Romano (1996) and compute equilibria numerically in the next section. It turns out that, for all parameter values we study, a majority voting equilibrium exists in each system. We leave a description of the voting equilibrium to the next section.

3.3 Equilibrium financing scheme

At the first stage, households vote for a financing scheme. In so doing, they take into account the resulting equilibrium subsidy rate and the equilibrium number of students. We assume pairwise voting over alternatives. The equilibrium system is then defined as that system which beats all others in pairwise voting, if such an alternative exists.

4. Numerical simulation

In this section, we simulate the model numerically. We calibrate our numerical example to broadly fit the levels of relevant endogenous variables from Germany. The case of Germany is chosen because recently several German states have introduced tuition fees (at moderate levels), a marked change from the previously free higher education. Some states, however, have subsequently repealed tuition fees.

4.1 Specification

We use a CRRA utility function:

$$u = \frac{1}{1-\rho} c^{1-\rho} \text{ for } \rho \neq 1, \tag{17}$$

where ρ is the coefficient of relative risk aversion. Hence, we have constant relative and decreasing absolute risk aversion. In the benchmark simulation, we set $\rho = 2$, which seems an empirically plausible value. We also set the discount rate to $\delta = 0.85$.[19] The production function is assumed to be of the CES type:

$$y = A(\alpha H^{\beta} + (1-\alpha)L^{\beta})^{\frac{1}{\beta}} \text{ for } \beta \neq 0, \tag{18}$$

where A describes technological knowledge and is set to $A = 200$, α is set to 0.5, and $\sigma = 1/(1-\beta)$ is the elasticity of substitution. In the benchmark, we use $\beta = 0.3$, which corresponds to an elasticity of substitution $\sigma = 1.429$.[20]

Note that the resulting wages for high and low skilled correspond to lifetime income. The factor $\gamma < 1$ represents the fraction of the period of study to the working life of students, and in the benchmark simulation, we set $\gamma = 0.3$. The costs of education are measured in 1,000 euros and are set to $e = 50$.[21]

The financial endowment is distributed according to a lognormal-distribution, $\ln \omega_i \sim \mathcal{N}(\mu, \nu)$ with $\mu = 3.8$ and $\nu = 0.8$. This results in average endowment $\omega = 61.559$ and median endowment $\omega^m = 44.701$, with income measured in thousand euros. This distribution is a combination of the data for income distribution and wealth distribution.[22] The reason for this choice is that parents might finance their children's education out of current income or out of accumulated savings. Since we do not distinguish between the two, we take a combination of wealth and current income to be our measure of parental support.

Finally, the success probability is set to $p = 0.77$, which corresponds to the proportion of beginning students who graduate with a university degree.[23]

Using these functional forms and parameters, we solve the model numerically for the equilibrium number of students within each system and then determine households' optimal policy parameters for each system. We then study how equilibrium policy parameters are determined. Results are presented in the next subsection.

4.2 Baseline results

We first characterize the equilibria for all four schemes, and then consider the choice between regimes in the next subsection. Table 1 shows the equilibrium values for the four systems, TS, GT, IC, and PL, under our benchmark parameters. Note that for this specification, credit constraints are never binding in equilibrium in any financing scheme.

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[19] In Appendix 1 we show how this value of δ can be derived from discounting the payment streams of students and non-students over their entire lifespans.

[20] This value is at the lower end of the range of 1.4-2 reported for the elasticity of substitution by Katz and Autor (1999) and Acemoglu and Autor (2011). In the online Appendix, we report results of varying σ *inter alia* to two.

[21] The value for e comes from *OECD Education at a Glance 2008*, where Table B1.1a. shows annual expenditures on all tertiary education per student for Germany in 2005 of \$12.446 (weighted with PPP) multiplied by four years duration for higher education.

[22] We take the data from *Die wirtschaftliche und soziale Lage der Studierenden in der Bundesrepublik Deutschland 2006 - 18.Sozialerhebung des Deutschen Studentenwerks* and *Deutsches Institut für Wirtschaftsforschung*.

[23] See again *OECD Education at a Glance 2008*, Table A4.1.

Table 1 Equilibrium values for baseline example

	TS	GT	IC	PL
N	0.47	0.37	0.44	0.31
s	0.4779	0.5849	1.1042	–
t	0.2008	0.2846	0.0691	–
w_H	157.29	183.07	162.25	205.69
w_L	68.45	61.89	66.99	57.69
$(w_H - w_L)/w_L$	1.30	1.96	1.42	2.57

4.2.1 *Pure loan scheme* The results for the PL system are shown in the last column of Table 1. Computing the value of the endowment of the household who is indifferent between studying or not studying, we find $\hat{\omega}^{PL} = 66.845$, which translates into a number of students of $N^{PL} = 0.31$. Thus, 31% of all households choose to go to college. Previewing the results from the other systems in Table 1, we find that the number of students under PL is lower than under the other systems. This is not surprising, given that there are no subsidies and no insurance against failure in this system. As a result, the skill premium is rather large: the high-skilled wage is $w_H = 205.69$ and the low-skilled wage $w_L = 57.69$, which gives a skill premium, $(w_H - w_L)/w_L$, of 257%.

4.2.2 *Traditional tax-subsidy scheme* We next turn to the TS system. Here and for the other systems, we proceed as follows. Using the government budget constraint, we first compute the income of the marginal household—who is just indifferent between studying or not—for discretely varying tax rates. We also compute the income of the household who would just be able to finance higher education. We then calculate the number of students by taking the distribution of all households with income higher than the maximum of these two values.[24] Next, we interpolate the functions $N(t)$ and $\tilde{\omega}(t)$ relating the endogenous variables to the tax rate, which are shown in Fig. 1.[25] We then substitute back these functions into the utility functions and determine households' optimal tax rates. The figures show that increasing the tax rate (and subsidy rate) increases the number of students. This makes intuitive sense, since subsidies increase the utility of studying relative to not studying. This implies that the endowment of the marginal household falls and the number of students rises with the tax rate.

As a result, the skill premium falls with the tax rate: Fig. 2 shows that the high-skilled wage falls and the low-skilled wage rises with the tax rate.

Let us then analyse the determination of equilibrium taxes or subsidies. As is often the case in voting problems of this type, the equilibrium tax rate (if it exists)

[24] Note that for our benchmark example, under TS the credit constraint does not become binding unless the tax rate exceeds 97%.

[25] In the numerical computations, we vary the tax rate in steps of 0.001.

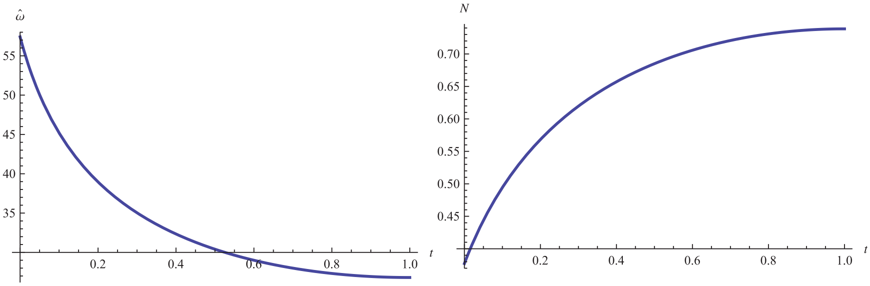

Fig. 1 Marginal student and number of students under TS.

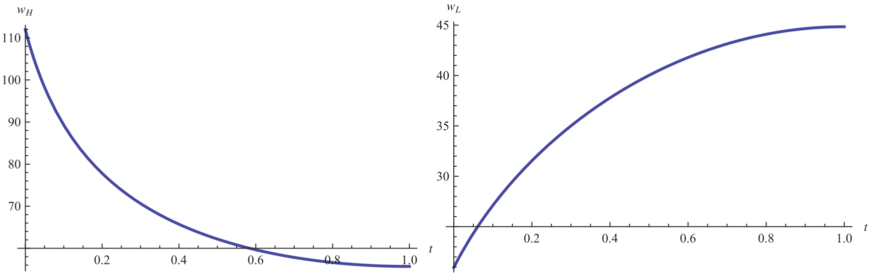

Fig. 2 Skilled and unskilled wages under TS.

does not necessarily correspond to the optimal tax rate of the household with median endowment, since preferences satisfy neither single peakedness nor single crossing. Indeed, voting under the TS system may give rise to an equilibrium similar to the 'ends against the middle' (EATM) equilibrium introduced by Epple and Romano (1996). Intuitively, this could occur for the following reason: a household's choice of tax rate depends on whether, at a particular tax rate, the household wants its child to study or not. There are some households, who, at their preferred tax rate, do not want their child to study, and they consequently vote for a tax rate, say $t_N(\omega_i)$, which is decreasing in income. This is intuitive, since the benefit of increased unskilled wages accrues to all households, while the financing costs increase with income. At some endowment, say, $\underline{\omega}$, the household is just indifferent between studying or not, at its preferred tax rate. Richer households then vote for a tax rate, say, $t_S(\omega_i)$, at which they prefer to study. Again, these tax rates are declining in income. This is due to the fact that financing costs increase with income (and in addition, marginal utility is decreasing in income). But, at each income level, $t_S(\omega_i) > t_N(\omega_i)$: the optimal tax rate is higher if the child studies, because of redistribution from non-students to students. Hence, since the optimal tax rate discretely jumps upwards at $\underline{\omega}$, optimal tax rates are not monotonic in income, and the median voter theorem may not hold. Figure 3 shows households' optimal tax rates computed for our numerical example.

If an equilibrium exists, the median voter might then not be the median income household. In fact, we find that the voter who is just indifferent between studying or not has endowment $\underline{\omega} = 48.697$, and this voter has an optimal tax rate conditional on studying or not of $t_N(\underline{\omega}) = 0.1642$ and $t_S(\underline{\omega}) = 0.2041$. The median income household's optimal tax rate is $t(\omega_m) = t_N(\omega_m) = 0.1976$ with $t_N(\underline{\omega}) < t_N(\omega_m) < t_S(\underline{\omega})$. Hence, more than 50% of households (those with endowment lower than ω_m and those with endowment in the interval $[\underline{\omega}, \bar{\omega}]$) prefer a tax rate above $t_N(\omega_m)$ (see Fig. 3), and, therefore, the median income household's optimal tax rate cannot be the equilibrium tax rate. The equilibrium tax rate is computed by finding two households with endowments ω' and $\omega'' > \omega'$ such that

$$t' = t_N(\omega') = t_S(\omega'') \quad \text{and } G(\omega') + G(\omega'') - G(\underline{\omega}) = \frac{1}{2}. \tag{19}$$

In words, households ω' and ω'' have the same preferred tax rate (where ω' prefers its child not to study and ω'' does prefer its child to study), and there are 50% of households (those with endowment lower than ω' and those with endowments in $[\underline{\omega},\ \omega'']$) who prefer a tax rate higher than t'.[26]

The corresponding subsidy rate is 47.8% and the tax rate is 20.1%. This results in a number of students $N^{TS} = 0.47$, which is actually the highest of any of the systems. The skill premium is correspondingly low: the skilled wage is $w_H = 157.29$, the unskilled wage $w_L = 68.45$, and the skill premium is 130%.

4.2.3 *Graduate tax scheme* We now turn to the GT system, using the same procedure as described above. It turns out that credit constraints are not binding for any positive tax rate. Here, the functions $N(t)$ and $\hat{\omega}(t)$ are not monotonically increasing as for TS, but inversely U-shaped or U-shaped as shown in Fig. 4. The reason can be seen as follows: let $\Delta^{GT}(\hat{\omega}^{GT}, t) \equiv EU^{GT}(\hat{\omega}^{GT}, t) - U^{GT}(\hat{\omega}^{GT}, t)$ be the utility difference between studying or not studying for the marginal household under GT. Appendix 2 shows that Δ^{GT} (and, hence, $\hat{\omega}^{GT}$) rises with t if $(u'_{ss} - (1-t)u'_{sn}) > 0$, which will be the case once the tax rate is high enough. Intuitively, when the tax rate is close to zero, there is no insurance so the marginal utility of the unsuccessful student is larger than the marginal utility of the successful, which implies that the income of the marginal household falls with t. When t is close to one, however, a further increase in t has a zero effect on the utility of the unsuccessful and the income of the marginal household rises with t.

Here, the pivotal voter under GT is the household with median endowment. The preferred tax rate conditional on not studying is identical for all households at $t_N(\omega_i) = 0.2846$ (which is the tax rate that maximizes the low-skilled wage). For all households with income above $\underline{\omega}^{GT}$, they prefer the tax rate $t_S(\omega_i)$ which is

[26] This condition is necessary but not sufficient for an equilibrium. Therefore, one has to check that there is no other tax rate which is preferred to t' by a majority of voters (Epple and Romano, 1996). In our simulation, we do find that the tax rate t' cannot be beaten by any other tax rate. For our sensitivity analyses in Section 4.4, we generally find that the median income household is decisive.

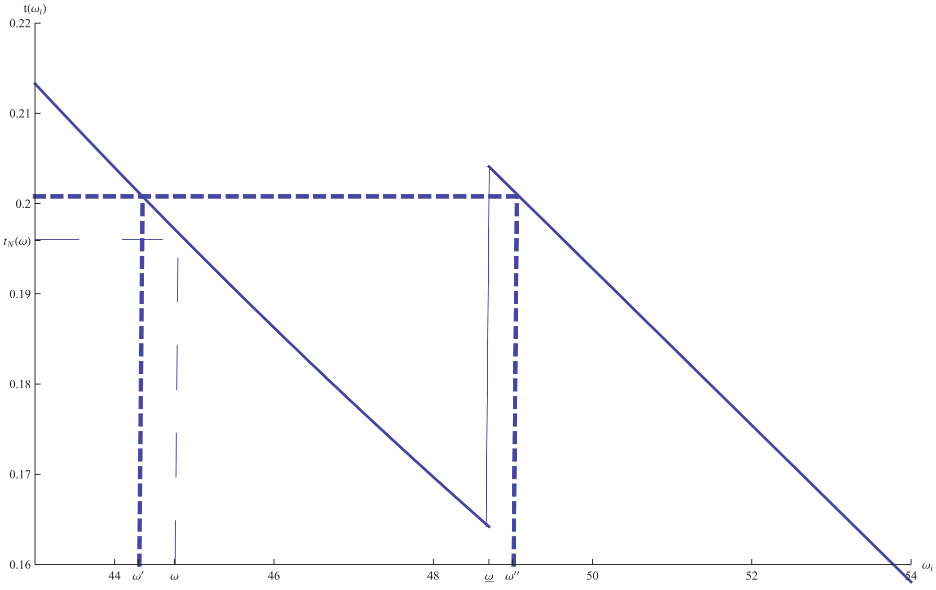

Fig. 3 Optimal tax rates under TS.

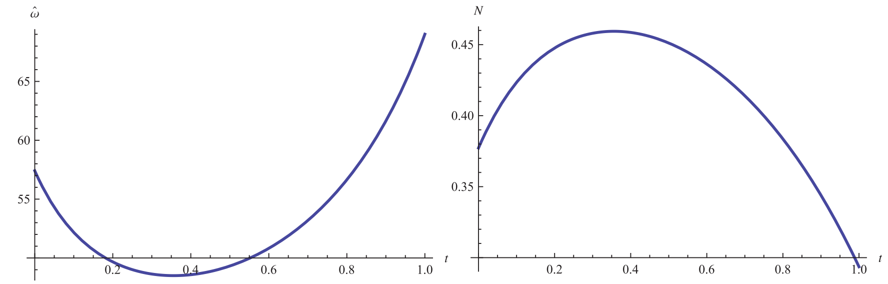

Fig. 4 Marginal student and number of students under GT.

decreasing in income. This follows because with decreasing risk aversion richer households demand less insurance against the risk of failure, and hence, the optimal subsidy rate falls with income. Hence, optimal tax rates are monotonically decreasing in income and we find that the median income household is decisive.[27]

The equilibrium values for GT are shown again in Table 1. The equilibrium tax rate is 0.2846 and the subsidy rate is 0.5849. As can be seen, the median income household prefers a tax rate where its child does not study. Incidentally, this is the tax rate which maximizes the number of students under the GT system and, hence, the low-skilled wage. The equilibrium number of students, $N^{GT} = 0.37$ is lower than

[27] Again, we check for the possibility that some other tax rate may be majority preferred to the optimum of the median income household and find this is not the case.

under TS, which implies a higher skill premium. We find that the skilled wage is $w_H = 183.07$ and the low-skilled wage $w_L = 61.89$, which gives a skill premium of about 196%.

4.2.4 *Income contingent loans* Finally, we turn to the IC system. Here, too, credit constraints are not binding for any positive tax rate. As in the GT system, both functions $N(t)$ and $\hat{\omega}(t)$ are (inversely) U-shaped, for a similar reason (see Fig. 1 in the online Appendix). Again, the pivotal voter is the household with median endowment. As under GT, the optimal tax rate conditional on not studying is identical for all households. Preferred tax rates $t_S(\omega_i)$ for those who prefer $t_S(\omega_i)$ to $t_N(\omega_i)$ are strictly lower than $t_N(\omega_i)$ and decreasing in income. Again, the median income household is decisive.

Table 1 shows the equilibrium values for IC. We find a relatively low tax rate of 7% and a subsidy rate of 110%. This is possible because the tax base includes all students and non-students, whereas under GT the tax base includes only the successful students. The number of students, $N^{IC} = 0.44$, exceeds that under GT. This can be explained by the fact that redistribution from non-students to students makes studying more attractive, despite the fact that unsuccessful students have to pay taxes under IC. However, the high subsidy rate and low tax rate more than compensate for this. We find skilled wages $w_H = 162.25$, unskilled wages of $w_L = 66.99$ and a skill premium of 142%.

4.3 Comparison of regimes

We now proceed to the comparison of the four financing systems by pairwise majority voting.

We start with the choice between TS and GT. Figure 5 plots the differences in indirect utility between GT and TS. We find that the utility difference is increasing in wealth, and that the household with endowment of 37.544 is just indifferent between GT and TS. This household's child does not study under either system. In sum, 58.63% of the voting population prefer GT over TS. Thus a majority supports GT. Interestingly, poorer households who do not study under either system prefer TS over GT, even though they do not pay taxes under the GT system. However, the general equilibrium effects imply that TS makes studying attractive, which pushes up unskilled wages. Hence, poor non-students prefer to subsidize studying through the TS system (see also Johnson, 1984). Since there are more students under TS than under GT, some households will study under TS but not under GT. It is interesting to note that these households prefer GT over TS. That is, they prefer not studying under GT to studying under TS. While studying under TS is attractive to these households, this is no longer true under GT because of the high graduate taxes and the incomplete insurance. However, because these households pay high taxes under TS and none under GT, they prefer the latter system. Finally, the rich households who study under both systems, have to relinquish the implicit subsidy from the non-students under GT. However, they still prefer the GT system since

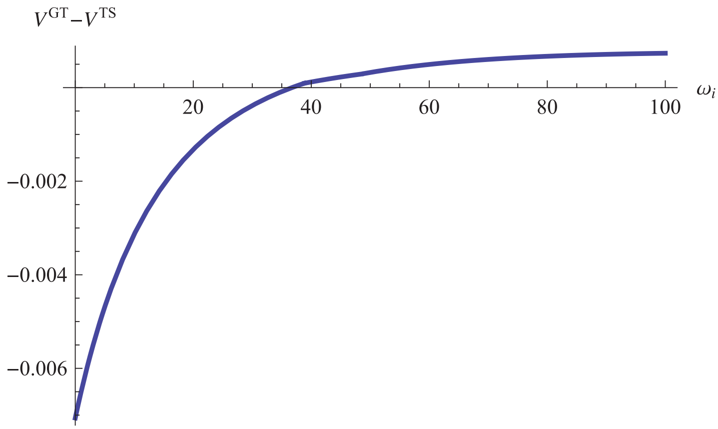

Fig. 5 Comparison between GT and TS.

skilled wages are higher, and in addition the GT system provides insurance against the risk of failure.[28]

Next, we look at household preferences between IC and TS, depicted in Fig. 6. The results here parallel those of the GT-TS comparison: TS yields higher unskilled wages. For the poor non-students, this is beneficial, even though they have to pay taxes under both the TS and IC system. For middle-income households who do not study under either system, however, IC becomes preferable because here they have to pay lower taxes.[29] For the rich students, again, there is the positive wage effect and the insurance effect under IC. In sum, the majority for the IC system, 72.17%, is, somewhat larger than the majority for GT over TS.

These results cast some doubt on redistributional arguments for the introduction of graduate taxes or income contingent loans. In fact, if wages are endogenous and subsidies chosen by majority voting, our results do not support the usual reverse redistribution argument. Instead, the poor prefer the TS system against either GT or IC.

The utility difference between IC and GT is shown in Fig. 7. We find that all households with income below 118.61 prefer IC. This makes for a majority for IC over GT of 88.87%. At first sight, wealthy students might be thought to prefer IC, since there the non-students have to pay taxes. Also, the IC system provides a larger subsidy at a lower tax rate than GT. Nonetheless, rich students prefer GT because it yields higher skilled wages. Conversely, the poor non-students prefer IC even though they have to pay taxes. Yet the unskilled wage is higher under IC, so the poor actually prefer this system to the GT system.[30]

[28] With some probability, these students will receive the low-skilled wage.

[29] There is a small interval of households whose child studies under TS but not under IC. They prefer not studying under IC to studying under TS, because under TS high-skilled wages are low and the tax rate relatively high.

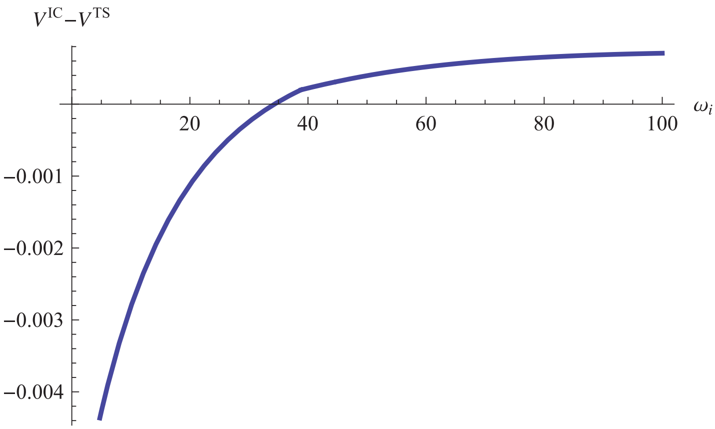

Fig. 6 Comparison between IC and TS.

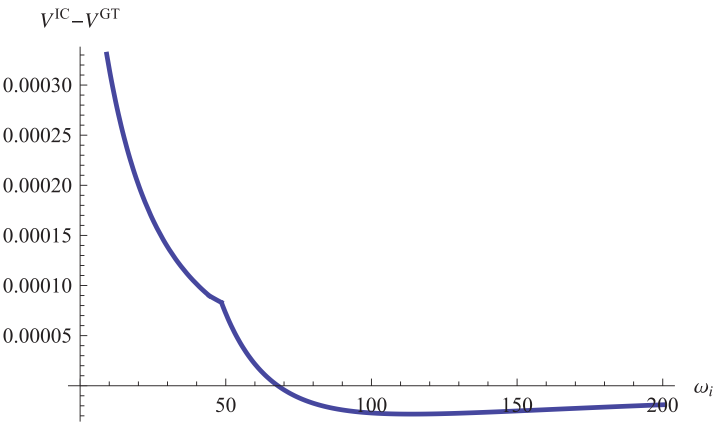

Fig. 7 Comparison between IC and GT.

The comparison between GT and IC also shows the importance of general equilibrium effects. For instance, García-Peñalosa and Wälde (2000) show that for large enough subsidy rates, a GT system would be preferable to an IC system on the grounds that it implies more insurance against risk, even though the expected income of students is higher under IC. Our example shows, however, that if subsidies are endogenously determined in the political process, the subsidy under IC can be larger than under GT. This tends to increase insurance. On the other

[30] Again, some households study under IC but not under GT, and they prefer studying under IC to not studying under GT, even though under IC they have to pay taxes. However, the large subsidy and small tax under IC make this system attractive for these households.

hand, the tax on the non-successful students tends to increase the difference in income between successful and unsuccessful students. In the example, we find that IC leads to higher expected income for students but a higher variance of income. Hence, in fact there is somewhat less insurance than under GT. This insurance aspect of GT would be especially valuable for students from middle-income families with relatively large risk aversion (since absolute risk aversion is decreasing in income).

At last we analyse the preferences over the PL system against GT, IC, and TS.[31] As can be seen in Fig. 8, only households with a high financial endowment vote for PL over GT. The same is true for the vote of PL against IC, where the utility differential looks similar (see Fig. 2 in the online Appendix). There are large majorities against PL of 81.84% for GT and 83.02% for IC. For poorer students the insurance function of GT and IC outweighs the taxes they have to pay. Very rich students on the other hand, have a sufficiently low degree of risk aversion that they benefit from the absence of subsidies and the high-skilled wages under PL. For the poor non-students, PL is not attractive even though under this system they do not have to subsidize students. The same, of course, is true under GT, so non-students prefer the system with higher unskilled wage, which is GT. They also prefer IC over PL, however, even though they have to pay taxes, because here the low-skilled wage under IC is even higher than under GT, and in addition the tax rate under IC is low. The majority for TS over PL is somewhat lower at 70.21%. The utility difference between PL and TS follows a similar pattern as that between PL and GT (Fig. 3 in the online Appendix). While non-students benefit from the high unskilled wage under TS, the middle class students benefit from redistribution from non-students and rich students under TS, even though they receive lower high-skilled wages if successful. Rich students have a preference for PL, since they have to bear the highest taxes under TS and because skilled wages are highest under PL. This finding again shows that the TS system may not be regressive, as argued by Johnson (1984) and others: if subsidies were abolished and students had to pay their own way, the rich, not the poor, would stand to gain.

In summary, in the benchmark example, IC beats all other systems and would be chosen in a pairwise majority vote among the four systems. The PL system loses against all others. In the next subsection, we explore how varying parameters changes our results.

4.4 Sensitivity analysis

In this subsection, we study the effects of varying parameters on the equilibrium of our model. Here, we present variations of the coefficient of relative risk aversion, the elasticity of substitution and the parameters of the income distribution. Risk aversion is obviously important since the systems insure against the risk of failure

[31] Here, as before, there are some households whose child would study under GT, TS, or IC but does not study under PL.

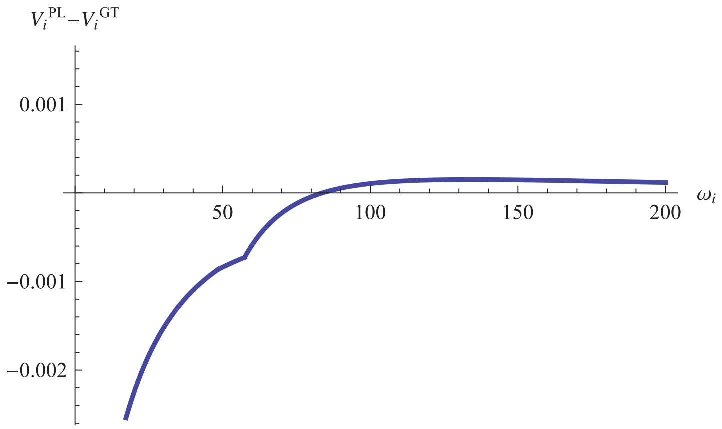

Fig. 8 Comparison between PL and GT.

to different degrees. The elasticity of substitution is important for how wages react to an increase in the high-skilled population. The income distribution plays a decisive role in political-economic models of redistribution with linear income taxes (see Borck, 2007, for a survey).

First, we increase ρ from two to 2.5. This increased risk aversion will make studying less attractive, other things equal. In the PL system, the number of students consequently falls from 31% in the baseline case to 26%. Consequently, skilled wages rise and unskilled wages fall. However, in the other systems, there will be a response through changed subsidies. Indeed, the subsidy rate increases in all systems, reflecting the increased demand for insurance. Tax rates rise as well. As a result, the equilibrium numbers of students change by relatively little (compare the first column of the upper panel of Table 2 with Table 1). The effects on the voting equilibrium are mostly relatively small as well. Support for PL against all systems decreases somewhat.

Increased risk aversion would tend to increase the demand for insurance, and one would tend to think that this increases support for those systems that provide more of it. In fact, the majority for GT over TS increases from 59% to 61% and that for IC over TS from 72% to 75%. However, the majority of IC over GT increases from 89% to 92%. This despite the fact, as mentioned above, that the variance of incomes for students is larger under IC than under GT. However, the increased risk aversion actually reduces the difference in those variances between IC and GT. In fact, as can be seen from Table 2, the skilled wage rises under GT with increasing ρ whereas it falls under IC. Therefore, the majority of IC over GT actually rises.

Next, we look at the effect of varying the parameters of the income distribution. We first decrease μ to 3.7. This leaves the skewness unchanged, but decreases both mean and median income. As the table shows, the effect on the numbers of students and wages does not seem huge. However, there is a clear political effect: since the median voter gets poorer, she votes for a higher tax rate under TS. Since the average

Table 2 Sensitivity analysis

System	N	w_H	w_L	s	t	$(w_H - w_L)/w_L$
$\rho = 2.5$						
TS	0.47	155.75	68.92	0.5582	0.2436	1.26
GT	0.36	185.34	61.42	0.6615	0.3257	2.02
IC	0.45	161.70	67.15	1.1576	0.0729	1.41
PL	0.26	228.26	54.42	–	–	3.19
$\mu = 3.7$						
TS	0.46	163.58	66.62	0.4175	0.1812	1.46
GT	0.37	183.54	61.79	0.6017	0.2935	1.97
IC	0.45	162.14	67.02	1.1147	0.0699	1.42
PL	0.30	210.29	56.96	–	–	2.69
$\nu = 0.9$						
TS	0.46	153.02	69.79	0.5295	0.2140	1.13
GT	0.37	182.92	61.99	0.5792	0.2815	1.95
IC	0.44	162.27	66.99	1.1025	0.0690	1.42
PL	0.31	203.68	58.02	–	–	2.51

tax base has fallen, however, the subsidy rate under TS rises only very slightly. This makes TS less attractive. Consequently, we find that the majorities for GT and IC over TS increase to 60% and 75%. Interestingly, the majority of TS over PL increases from 70% to 73%. The reason for this difference is that the marginal voter between TS and PL is a household whose child studies. Since the high-skilled wage under TS increases when μ falls, this household actually now prefers TS to PL. Hence, more voters vote for TS over PL, whereas IC or GT are favoured by more voters over TS.

This exercise suggests that varying the income distribution affects TS most, and the effect comes through (i) varying mean income, with constant median to mean income ratio, and (ii) varying the mean to median income ratio.[32] In order to look at the second effect, we increase ν to 0.9. This does not affect median endowment, but mean income rises, so the median to mean income ratio falls. Again, the results do not change dramatically in terms of the number of students and wages under the several systems. Again, however, there is an interesting political effect: since the tax base rises with higher ν, the median voter now benefits more from redistribution and votes for a higher tax rate under TS. Since the average tax base has increased, this strongly increases the subsidy rate. The result is to increase support for TS. We find that the majority for GT over TS shrinks to 52% and the majority of IC over TS shrinks to 61%. Increasing ν even further eventually leads to a majority for TS over GT and IC. Thus, a reform of higher education finance to a graduate tax or

[32] One might think that this effect is the result of our assumption that initial endowments are heterogeneous while post-education wages are not. However, we find similar results if we assume that second period wages have some ‘inherited’ component which depends on first-period endowments. In this case, under GT and IC, taxes on second-period wages redistribute from rich to poor, similarly to TS.

income contingent loans is more likely, the lower *per capita* income or the more equal the income distribution is.

We have also analysed how results change with a change of the elasticity of substitution. Results are available in the online Appendix.

5. Conclusion

We have studied the political determination of higher education finance. In particular, our interest was to analyse what factors might contribute towards reforming higher education finance from a traditional tax-subsidy scheme to income contingent loan schemes or graduate taxes. Because we have allowed for endogenous wages and subsidies, general equilibrium feedback effects are present, which implies that comparative statics are mostly non-trivial. Nonetheless, under our assumptions, we find that majorities for GT or IC become larger when risk aversion rises, or when the income distribution becomes less skewed, or median income falls for given skewness. In principle, one could test whether societies with different degrees of inequality or risk have differing propensities to choose one or the other financing system.

There are some possible extensions of the model that come to mind. For one thing, we have assumed that the elasticity of intertemporal substitution is infinite. It may be desirable to relax this assumption. A straightforward way to do this would be to assume a separable intertemporal utility function with the elasticity of intertemporal substitution being the inverse of the coefficient of risk aversion. We have actually computed examples with this specification, but do not report them here, since the determination of voting equilibria gets even more complex. Another way forward would be to allow for heterogeneous abilities (see Del Rey and Racionero, 2010). Doing this would be relatively straightforward, but combining income and ability heterogeneity would again complicate the determination of voting equilibria. Another interesting extension would be to allow for the possibility of moral hazard especially in the GT system. Individuals may not have the proper incentive to study successfully if they know that they will not have to repay their loans. This would reduce the incentives to vote for higher subsidies and would obviously affect the voting equilibrium.[33] Finally, an interesting question that we study in a companion paper is what happens if different countries choose different financing regimes, with students and possibly workers selecting into countries based on their preferences (Borck *et al.*, 2012).

Supplementary material

Supplementary material (Appendix) is available online at the OUP website.

[33] See Nerlove (1975). Chapman (2006) argues that the moral hazard problem is less pronounced with income contingent loans (what he calls ICL with risk sharing).

Acknowledgements

We would like to thank two referees, as well as Pio Baake, Jo Thori Lind, Silke Übelmesser, Klaus Wälde, and seminar participants at Augsburg, IEB Barcelona, Linz, Munich, Passau, DFG workshops in Dresden and Mannheim, the CESifo Public Sector area conference in Munich, and the Public Economic Theory conference in Seoul for helpful comments.

Funding

Deutsche Forschungsgemeinschaft (BO 3201/1-2).

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