An investigation of education finance reform: Income contingent loans and graduate taxes in the Netherlands

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Graduate taxes and income contingent loans in the Netherlands

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Abstract

In this paper we analyse the consequences of replacing government subsidies with a graduate tax (GT) or income contingent loan (ICL) system for the financing of higher education. Both these systems are directed towards solving capital and insurance market failures. We constructed an empirically based simulation model to analyse loans, GT's and ICL systems of education finance. We considered various financing regimes that differ in: i) the extent to which non-repayment or default risks are pooled or shifted towards society; and ii) the level of education subsidies. We show that the switch to a GT or ICL system can significantly reduce the income risks that graduates would experience under an artificially constructed loan system. A reduction in government outlays of about 2.5 billion euro. would result if education subsidies are dropped to zero. The tax rate in a GT would then have to be about 6% on average. In an ICL system with full risk pooling the repayment rate would be higher, ranging from 10%-6%, depending on the size of the default/solidarity premium on the interest rate. If default risks are shifted to society the repayment rate may be lower, but this goes at a cost of a smaller reduction in government outlays. Under a risk-shifting regime, the government encounters diminishing savings on outlays because reducing ex ante subsidies on education subsidies, increases the costs of default (ex post subsidies). Replacing ex ante subsidies with ex post subsidies makes the resulting distribution of incomes more equal because only those with low life-time incomes benefit from ex post subsidies. We discuss behavioural responses and policy implications.

Key words: education finance, graduate taxes, income contingent loans, education subsidies, government expenditures on education.
JEL-codes: H24, H52, H82, I22, I28.

1 Introduction

> "[...] Existing loan or loan guarantee programs are too restricted in their terms, length of repayment period, and size of the loan, to offer many lower- and middle-class young people an opportunity to borrow against future earnings to the extent necessary to achieve adequate levels of demand even for the educational services of virtually free public institutions." (Nerlove, 1972, p. S185).

In this paper we analyse the consequences of replacing education subsidies on higher education with an equity participation scheme of financing higher education. We analyse various financing schemes - graduate taxes (GT) and income contingent loans (ICL) - in order to channel private resources into higher education without harming accessibility. Our focus is fourfold. First, we study the financial consequences for students/graduates of these new financing schemes. To that end we try to quantify the (re)payment conditions. Second, we analyse the insurance characteristics of the equity participation schemes. Third, we address the potential gains in terms of saved government revenue of these policy switches. Fourth, we discuss the qualitative consequences for the distribution of incomes.

We think that the subject is relevant for the following reasons. First of all, most governments in Western countries spend a lot of resources on higher education. Nevertheless, government budgets for education are under pressure for various reasons, such as the ageing of the population and the EMU-criteria for deficits and debt. At the same time, enrolment in higher education has been steadily increasing in recent decades. This has caused a crisis in the funding of higher education, see for example Kane (1997), Barr (1998) and Barr and Crawford (1998). Policy interest in alternative ways of financing education has increased as governments seek ways to control outlays. In particular, policymakers may look for ways to increase private contributions since subsidising education while enrolment rates remain increasing does not resolve funding problems. Indeed, the only way to circumvent pressures on government budgets is to increase private contributions to higher education, given that there are limitations on the amount of tax revenues that can be spend on subsidies for higher education. However, a major concern with raising private contributions is that accessibility to higher education needs to be warranted.

In addition, it is argued that current higher education finance is inequitable.[1] The unfortunate by-product of subsidies on education is that they imply reverse redistribution. The incidence of the costs is born by the average taxpayer, whereas the benefits accrue to the most talented part of the nation. To put it in Arrow's (1971) terms, subsidies for higher education are 'input' regressive, since only the students with the highest abilities within a cohort benefit from

[1] This is a long standing debate, see e.g. Friedman (1962), Nerlove (1972, 1975), or Schultz (1972) for early contributions.

these subsidies because they learn most. As a consequence, socio-economic outcomes are more regressive as well. The reason is that initial differences in abilities become more pronounced because the highest ability students can increase their ability to earn income through education. Additionally, the larger part of students enrolled in higher education already belong to the most wealthy families. The Social and Cultural Planning Office in the Netherlands has shown that the 50% wealthiest families receive 80% of education expenditures on higher education (SCP, 1994).

Finally, one may argue whether giving subsidies on a large scale, as current policy practice shows, is really an optimal policy. Clearly, some arguments justify education positive education subsidies, see also the box. However, not all arguments are equally valid. Probably the most important reason for education subsidies is the failing of capital and insurance markets. These market failures are the roots of inequality of opportunity. I.e., not all students can obtain an education at the same financial conditions. Failing capital and insurance markets hamper access for students from lower socio-economic backgrounds. Disadvantaged students suffer more from liquidity constraints because they cannot finance education themselves. And, because they are less wealthy, require larger returns on their investments in human capital because they are typically more risk averse. Both capital and insurance market failures result in under-investment in human capital from a social perspective.

However, education subsidies do not tackle the real problems with capital and insurance market imperfections. In principle, an equity participation model where the government buys shares in graduates' human capital in exchange for funds (to cover costs of living and tuition) while enrolled in education is sufficient to overcome credit and insurance market failures. Students obtain funds independently from background conditions so that liquidity constraints are avoided. Income insurance by means of pooling income risks solves the under-investment problem due to risk aversion. An equity participation scheme does therefore not require external subsidies, see also Jacobs and Van Wijnbergen (2002).

An equity participation scheme has two potential disadvantages, however. First, the insurance of income risks may cause problems with adverse selection and moral hazard. This is the case if the system attracts too many high risk - low return graduates and the low risk high return graduates do not want to participate. One may then opt for a debt-remittance scheme whereby the government shares in the income risks as suggested by Kane (1997). This is the case in Australia. Then, education subsidies enter in *ex post* fashion (after graduation), but the incidence is much more equal than *ex ante* subsidies (while studying) because only the graduates with very low life-time incomes receive income protection rather than all graduates. Second, the equity participation model potentially distorts education choices and labour supply decisions because income insurance and redistribution of incomes cannot be completely separated. One could also say that redistribution causes a moral hazard problem because it reduces labour supply and distorts education choices. In order to mitigate the adverse consequences of redistribution of incomes, the government may again limit the repayment burden on graduates, e.g. through an

Economic reasons to subsidise education

- **Positive externalities**. Education fosters the production and dissemination of knowledge and technology which in turn contributes to economic growth. Due to non-rivalness and non-excludability of knowledge under-investment in human capital may result, see e.g. Nelsson and Phelps (1966), Lucas (1988), and Romer (1990). Education should then be subsidised education to restore social efficiency. Education may also cause *negative* externalities. If education is a *signalling* device only reflecting differences in abilities, taking up education as such is not productive (Arrow,1971; Spence,1973; and Stiglitz, 1975). Further, Murphy et al. (1991) suggest that particular types of education may result in *rent-seeking* activities (e.g. lawyers), which harms economic efficiency and cause negative externalities. These arguments weaken the case for subsidising education. Empirical support for the presence of positive education externalities cannot be found, see also Heckman and Klenow (1997), Acemoglu and Angrist (2000), Heckman (2000), Ciccone and Peri (2002), Krueger and Lindahl (2002), among others. Education subsidies are therefore difficult to justify on the basis of perceived externalities.
- **Subsidies to correct tax distortions**. (Progressive) taxation comes along with distortions on learning decisions. It is generally optimal to restore incentives to learn by means of education subsidies that eliminate the tax-wedge on learning, see also Bovenberg and Jacobs (2001) and Van Ewijk and Tang (2000a). If, however, some returns of education are non-taxed (immaterial returns) the case for subsidising education on the basis of fiscal distortions is diminished. Bovenberg and Jacobs (2001) and Jacobs and De Mooij (2001) show that - even in the absence of consumption motives - current education subsidies are likely to be much higher than necessary to eliminate the distortions from the tax system on learning decisions.
- **Merit goods**. Some types of education may contribute to immaterial aspects of welfare, such as culture, citizenship, etc. There will be under-investment because society may value these subjects while private agents are not willing to pay for it. The government may want to compensate private agents for low monetary returns of education types that are socially desirable. The public good value of education is not measurable, however, and is based on political judgements on the public value of education.
- **Myopia**. Some argue that students are irrational and not able to make the right decision to enrol in higher education while it is actually worthwhile to do so. Education subsidies may yield proper incentives to irrational students. But this seems to be a second-best instrument. First-best would be to provide students with better information so that the decision making process is based on right premises, rather than correcting the mistakes in decisions through subsidies. Furthermore, one can cast doubt on the irrationality of graduates. Webbink and Hartog (2000) find that students can predict their future salaries very well. If this is so, why would students be irrational and not choose to enrol in education?
- **Income redistribution**. Subsidies on higher education stimulate the supply of skilled workers relative to unskilled workers. This compresses wage differentials between skilled and unskilled workers, because skilled workers become less scarce relative to unskilled workers. A government that wants to redistribute incomes may want to subsidise education, see Tinbergen (1975) and Teulings (2000). However, the benefits of more equality need to be balanced against the unequal incidence of education expenditures. Dur and Teulings (2001) calculate that the unequal incidence of education subsidies roughly cancels out against the effects on relative wages through general equilibrium repercussions. Therefore, it is doubtful whether education subsidies can be used for redistributional purposes.

- **Capital markets imperfections**. Imperfections originate from the fact that human capital cannot serve as collateral due to its illiquid nature (non-slavery), see also Friedman (1962). Moreover, information asymmetries (moral hazard and adverse selection) between borrower and bank results in credit rationing, see Stiglitz and Weiss (1981). Capital market imperfections may give under-investment in human capital. (Income dependent) grants are can be used to alleviate problems with imperfect capital markets. Empirical evidence on the importance of capital market imperfections is mixed. For example Shea (2000) and and Plug and Vijverberg (2001) find empirical evidence for the importance of capital market imperfections, at least for the poor. Cameron and Taber (2000), on the other hand, suggest that capital market imperfections are not important at all.
- **Uninsurable risks**. If risks of investments in human capital cannot be insured, risk averse students require a risk premium on their investments and there is under-investment in human capital, see Levhari and Weiss (1974). The insurance market fails because trade in claims on human capital is legally impossible (non-slavery). Under-investment only results if income risks are not correlated. In that case there are private risks, but no social risks and the risks can be pooled. Some risks of education, such as employment conditions and technological changes, cannot be pooled because these risks cannot be diversified at the national level. Also here, information problems associated with insurance arise (moral hazard and adverse selection). Rothshield and Stiglitz (1976) show that insurance markets may not even exist if there is asymmetric information between the insurer and the insured. Subsidies on education may restore disincentives to accumulate human capital if it is impossible to insure income risks. Judd (2000) argues that there is a 'human capital premium puzzle' because the returns on human capital are way above the real risk free rate on government bonds and similar to real returns on equity. This suggests that there may be social under-investment due to the riskiness of human capital.

opting out provision, see also Nerlove (1972).

A subsidy is a second-best means to resolve the *capital market imperfection*. Giving grants that are independent of financial needs, is not an efficient policy. Students without funding problems, because they have sufficiently *high* (parental) incomes, or can obtain finance themselves in the capital market, also receive education subsidies, see Oosterbeek (1998). More targeted education subsidies may partially resolve this issue. But, this is not free either. Income dependent grants distort incentives for parents to save for their children's education, see Edlin (1993) and Feldstein (1995). Further, subsidies may result in enrolment of too many 'marginal students', i.e., students with insufficient academic abilities.

Education subsidies are also a second-best means to resolve the *insurance market imperfection*. Subsidies are an highly ineffective instrument to combat risk aversion, because subsidies do not reduce the spread in future earnings. Subsidies should therefore be very large in order to induce risk averse graduates (with sufficiently high returns) to enrol in education, see also Jacobs and Van Wijnbergen (2002). Second, also the graduates that do not need income protection (because they have sufficiently *safe* incomes) receive education subsidies.

Furthermore, since in principle no additional subsidies are needed for an equity participation scheme, some other general advantages of an equity participation scheme over subsidies exist. First, subsidies cause welfare losses because the government has to rely on distortionary taxation to finance subsidies. Second, education subsidies redistribute incomes from poor to rich.

Many authors have advocated education finance based on loans with insurance elements like an ICL system or an equity participation scheme such as a GT, see e.g. Friedman (1962), Nerlove (1972, 1975), Barr (1991, 1993), Chapman (1997), Oosterbeek (1994, 1998) and Van Wijnbergen (1998). The advantages compared to education subsidies are summarised as follows:

- Students receive funds on the basis of their needs without distorting savings decisions of parents;
- Student are confronted more with the real costs of education so that 'marginal students' do not enrol;
- Government resources are allocated more efficiently because resources are not transferred to students that have no funding problems or do not encounter problems in repaying their debts;
- Deadweight losses of financing education subsidies are avoided;
- Redistribution of incomes in the wrong direction is avoided. All redistributions go from either the lucky graduates or the average tax payer to unlucky graduates;
- Equality of opportunity is warranted since everyone can obtain funds to finance education at the same conditions independently from background conditions;
- Risk aversion is largely avoided because graduates do not need to repay anything when they are not able to do so.

As we noted before there are two disadvantages of ICL and GT's to be taken into account:

- Asymmetric information between students and the government may cause problems with moral hazard and adverse selection.
- Any pooling system of income risks also entails redistribution which implies that there are potential efficiency losses since labour supply of graduates and education choices are distorted.

We analyse the financial consequences of a switch to an GT/ICL system that (partially) replaces education subsidies. We derive the repayment conditions for individual students, the distributional consequences and the effects on public expenditures. The general motivation is that education subsidies are inefficient in resolving capital and insurance market imperfections and that the financing system of higher education can be more efficient. I.e., whatever the level of education subsidies, accessibility of education can be warranted at lower public costs. Clearly, there is also an equity gain if the regime switch is accompanied by an increase in private contributions or if ex ante subsidies are replaced by ex post subsidies. We take into account the disadvantages on labour supply behaviour. We can only qualitatively analyse the role of moral hazard and adverse selection effects. Lacking empirical evidence on these matters impedes a thorough quantitative assessment.

At the outset we remark that this analysis does not discuss differentiation of educational costs. I.e., we do not allow for differentiation in repayment conditions according to field of study. There can be advantages of tuition fee differentiation, however, see Nerlove (1972) and CPB

(2002) for a more elaborate discussion on these matters.

We compute the repayment conditions and the insurance aspects of these financing schemes. To that end we estimate the life-time earning capacity of graduates. Only by knowing the earning capacity of graduates we can assess to what extent graduates are able to bear some of the costs of higher education. Additionally, we construct risk classes in incomes so as to incorporate the uncertainties of future wages. These risk classes are derived from estimated standard deviations of the wage profiles. This allows us to assess the insurance aspects of the proposed education finance regimes.

This paper is related to some studies that attempt to quantify the consequences of increases in private contributions to higher education. First, there is a policy report by Rinnooy Kan, Moerland and Kapteyn (1988) (RMK). The purpose of that policy analysis was to investigate the consequences of replacing the (income dependent) grants by annuity type of loans provided by banks in the private sector. In this proposal, banks are compensated for the costs of default, the so called social risk, in order to make such a policy shift attractive to the private sector. The main focus of this analysis was to estimate the amount of compensation that private banks would receive. They found that the fraction of debt that would not be repaid was about 6%. This policy proposal was never implemented. Strange enough, this well documented study disappeared from policy discussions on education finance reform.

Although we follow largely the same lines as RMK, our analysis differs in some important aspects. First of all, we analyse the consequences of raising private contributions that are possibly much larger than studied by RMK. This has important consequences for the risks of default, and thereby on repayment conditions. Second, RMK only analyse increases in private contributions with the annuity type of loan system that we currently have and do not consider ICL's or GT's. They do investigate the option however to increase the repayment period to 25 years, and they find that the fraction of debt that is not repaid falls about 50%. Further, they raise the option to include a solidarity premium on interest rates for loans so as to increase the insurance characteristics of the loan system. We investigate the consequences of such a solidarity premium.

Second, Barr and Falkingham (1994) analyse the consequences of an ICL/GT system in the UK on the basis of a numerical model (LIFEMOD) with heterogeneous agents. Their main contribution is to show the various ways *how* increases in private contributions can be achieved. They find that an ICL/GT system protects individuals from high repayment burdens and about 90% of total borrowing is repaid under an ICL compared with 80% under a mortgage type of loan scheme. The drawback of their analysis is that they only consider loans of limited size (1000 UK pounds). Consequently, we do not gain insight in the tax burdens that individuals face if they paid full (or partly subsidised) tuition. Repayment behaviour changes when larger loans are needed to finance education.

Third, experiences with the Australian Higher Education Contribution Scheme (HECS) provide information on the consequences of increasing private contributions. Chapman (1997), and CPB (2001a) extensively discuss the effects of HECS. In HECS graduates pay around 23% of the direct costs of education. Students have to option to pay (differentiated) tuition fees up-front or to defer fees. In the latter case graduates repay a (increasing) fraction of their incomes while working. The government, i.e., the average tax payer bears the costs of default. The introduction of HECS had no important effects upon enrolment even for students with disadvantaged backgrounds. Furthermore, almost all outstanding debts were repaid, so that costs of default were minor.

The setup of this paper is as follows. We start with a discussion of ICL and GT schemes of education finance in sections 2 and 3. Sections 4 and 5 are devoted to the derivation of the present value of the earnings of graduates and to the costs of education, respectively. In section 6 we describe our measures for income uncertainty. In section 7 we discuss some consequences of an GT/ICL for redistribution and its associated dead weight losses. In sections 8, 9, and 10 we discuss the consequences of introducing a pure loan system, a GT and an ICL system, respectively. In section 11 we discuss some economic aspects of ICL's or GT's. In section 12 we conclude. An appendix at the end contains a description of the data used in the paper and the empirical analysis underlying the simulation model.

2 Defining graduate taxes and income contingent loans

To start our discussion we introduce some background definitions. There seems to be a lot of confusion on what an ICL system really is, and the same holds for a GT system. To avoid this confusion we precisely define what is and what is not an ICL or GT system. As becomes clear later on, the GT can be seen as a special case of an ICL system. There are two essential elements in both systems, as explained in the introduction: the loan or equity element and the insurance element to insure income risks.

The basic idea of an ICL is that students borrow the funds from the government to cover the costs of tuition and (partly) the costs of living while enrolled in education. Costs education are deferred to the stage in life where graduates start to earn income. When graduates start to work they repay a (potentially differentiated) fraction of earned incomes to cover the costs of their loan including interest. This repayment rate may differ according to the length of the study, costs of the study, et cetera.

For a proper working of any GT or ICL the repayment rate should be differentiated according to length of enrolment. Clearly, also students that do not graduate earn a positive return on the years enrolled in education, see also Groot and Oosterbeek (1994).[1] Making repayment obligations dependent on whether graduates receive their diploma or not will for sure give problems with moral hazard. E.g. students may actually do the entire curriculum needed to graduate, but never collect their diplomas. In our analysis, we do not consider differentiation of repayment rates according to enrolment duration, because all graduates are assumed to be enrolled for the same time. The costs of drop-outs are taken into account in indirect fashion because graduates are assumed to be enrolled for a longer time than the nominal duration of their education.

Some of the graduates may not repay the complete principal and interest, so that default occurs. The crucial difference with an ordinary loan is that the risks of non-repayment are bounded for student. This is the insurance element. There are in general two ways of protecting students against default: *risk pooling* among students and *risk shifting* to society.

First, risk pooling is an *insurance* system, where *risks of default are shared among graduates*. The interest rate on the loans contains a premium to cover the costs of 'default' of those who are not able to repay. Therefore, students who succeed in repaying their loan are paying the costs of nonrepayment of those who fail. Consequently, there is redistribution from the lucky students to the unlucky students after graduation. Individuals who cannot repay their loan because they have insufficient incomes are not obliged to repay the loan. Second, under risk shifting, the *default risks are borne by society* as a whole as in the Australian HECS system. In that case there is in principle no redistribution from the lucky to the unlucky students, except for the fact that the

[1] Groot and Oosterbeek (1994) interpret the positive returns to education of drop-outs as evidence against the screening hypothesis.

lucky students contribute via their tax payments to the government budget from which the costs of default are funded. Note that now tax financed education subsidies are still entering the education system, but in an *ex post* fashion. These subsidies are not given when students are studying (*ex ante*), but only after graduation when they are not able to repay their debts.

Under a GT system every graduate receives an amount of resources, equity. Graduates retain a (potentially differentiated) fraction of their incomes and pay a fraction of their life-time incomes to the government as dividends: the graduate tax. Repayments under a GT may (far) exceed initial funds (including interest). Therefore, contributions by graduates with high incomes under a GT system are relatively larger than under an ICL scheme and there is more insurance and redistribution. From the individual perspective, there is therefore no link between the amount of equity received and the total repayments. This is not the case with an ICL system.

In our opinion, the crucial difference between a GT and an ICL system is related to the amount of insurance and/or income protection. The GT offers relatively more insurance (or redistribution) than the ICL. In an ICL system, the graduates with high enough incomes stop their repayments when they have repaid their debts including interest and default premiums. This is not so under a graduate tax.

A semantic confusion may also arise to what extent an ICL or GT may be called *equity participation* models. Friedman and Kuznetz (1945) were the first to express the problem of financing education with explicit reference to equity:

> "Investment in professional training will not necessarily be pushed to the margin because earning power is seldom explicitly treated as an asset to be capitalized and sold to others by the issuance of "stock". [...] if individuals sold "stock" in themselves, i.e., obligated themselves to pay a fixed proportion of future earnings, investors could "diversify" their holdings and balance capital appreciations against capital losses." Friedman and Kuznets (1945, p.90).[2]

With an equity contract there is no limit on the dividends that graduates pay out to the government similar to stocks. Since there is an upward limit on contributions to an ICL system, as with ordinary loan contracts, only systems of a graduate tax can be called equity participation models. However, an ICL is not exactly like an ordinary loan, because it also has equity elements when income risks are pooled, solidarity premiums are included and default risks are not shifted to society. One can say that an ICL is a hybrid contract: a combination of an ordinary debt

[2] Later Friedman restated this in similar words:

> "[...] The device to meet the corresponding problem for other risky investments is equity investment plus limited liability on the part of shareholders. The counterpart for education would be to "buy" a share in an individual's earning prospects; to advance him the funds needed to finance his training on condition that he agree to pay the lender a specified fraction of his future earnings. In this way, a lender would get back more than his initial investment from relatively successful individuals, which would compensate for the failure to recoup his original investment from the unsuccessful." Friedman (1962, p.103).

contract and an equity contract. Consequently, the Australian HECS is, strictly speaking, not an equity participation model, first of all because default risks are borne by society rather than shared amongst graduates. Second, repayment obligations in HECS are limited and there is no insurance/solidarity aspect involved.

Confusion may also arise about other characteristics of the education finance regimes. First, throughout we only consider so called *fully funded* schemes of education finance. That is, we assume that the education finance scheme does not imply income redistribution between age-cohorts. The government provides funds to students by issuing government debt. With the repayments of the graduates the government repays it's debt in full. This is analogue to a fully funded pension system. Occasionally, proponents of a graduate system have suggested a 'pay-as-you-work' system where the currently working graduates finance costs of the currently studying. In our opinion this intergenerational link is *not* essential for a GT system. However, this way of financing education generally implies income redistribution from the older to the younger generations if the real interest rate is higher than the growth rate of students enrolling in higher education. Only in case the real interest rate is equal to the growth rate of enrolment in education, this system is intergenerationally neutral. We do not see convincing arguments to incorporate elements of obligatory intergenerational redistribution in the system of education finance.

Second, most proposals of an ICL system seem to be based on *voluntary* participation by students, whereas most proposals of GT's seem to be based on *obligatory* participation. However, one can easily implement voluntary GT's and obligatory ICL's, so this is not a vital difference. We shall initially assume that participation in both an ICL system and the GT system is voluntary. Later we discuss the economic motivations (notably adverse selection) to make the system of education finance obligatory.

Third, the size of the loan or the amount of equity, may be chosen by graduates themselves or may be determined by the government. In our analysis we initially assume that the size of the amount of resources available to graduates is set by the government for every student at the current levels of support for students, i.e., the level that is determined by the size of the basic grant, the average level of the income dependent grant, travelling subsidies (OV-kaart) and the institutional costs of education. However, we also present some analyses where the size of funds made available to students is increased or decreased. Later we also discuss the economic reasons for restricting the amount of funds made available to students.

3 A mathematical model

In order to clarify the important mechanisms at work we now set up a model of education finance that serves as the basis of the analysis in this paper. This allows us to highlight the consequences of the financing regimes.

3.1 Income contingent loans

Let the principal for graduate n of the loan in an ICL be denoted D_n (in thousands of euro). Students repay a constant fraction of income when working. In this study, we take into account that medical and technical studies have longer duration, so that D_n is larger for those who have longer education tracks. We also differentiate between higher vocational and university education. However, within each education type we assume that D_n is equal for all graduates. This assumption corresponds to the flat tuition fees that we currently have in higher education in the Netherlands. For the theoretical exposition, we assume that D is equal for all graduates.[1]

In an ICL, the principal including interest is repaid in income contingent fashion. When working, graduates pay a constant fraction τ of their income w, for the repayment of interest and principal. A flat repayment rate implies that repayments of all graduates are treated the same whatever the type of education they pursued. The important difference between the two is that potentially not only cross-subsidies are introduced between graduates of different subjects (as with flat tuition fees), but also cross subsidies from high to low return studies if interest rates contain a default/solidarity premium.

The repayment R_T in year T equals τw_T.[2] Repayments start in year t and continue to year T^*. r is the real interest rate. When the present value of repayments in year T, $\tau W_T \equiv \sum_{a=t}^{T} \frac{\tau w_a}{(1+r)^{a-t}}$, exceeds a level of $1+\delta$ times the value of the loan, repayments are stopped. This is the opting out provision that limits the amount of insurance and redistributions which may be introduced to avoid moral hazard or adverse selection effects, see also Nerlove (1972). An opting out provision implies that there is a maximum on the contributions by graduates.

Hence, in mathematical terms the repayment scheme can be expressed as follows:

$$\begin{aligned} R_T &= \tau w_T, \quad \tau W_T < (1+\delta)D \\ R_T &= 0, \quad \tau W_T \geq (1+\delta)D. \end{aligned} \tag{3.1}$$

[1] There are clear economic arguments to differentiate tuition costs, and therefore the repayment rates, between the various subjects, see for example Nerlove (1972). Egalitarian motives seem to be at the heart of the arguments against differentiation of tuition costs. We do not want to get involved here in a discussion on the advantages and disadvantages of differentiation of tuition costs.

[2] The repayment rate τ may depend on actual income earned $\tau = \tau(w)$. If repayment rate increases with income we have that $d\tau/dw > 0$. This is the case in the Australian system. In the remainder we assume that the repayment rate is flat.

These equations state formally that the graduate makes a repayment as long as the present value of repayments is below the present value of debts including the opting out parameter δ. One could also allow for a lower bound on income below which graduates do not have repay anything. We abstract from the possibility that graduates repay their debt quicker than necessary.

We can say that δ is a measure for the default or insurance premium for the certainty that students do not have to repay debts when they cannot do so because their incomes are too low. This can be seen as follows. The repayment scheme can be written in (almost) equivalent form as:[3]

$$\begin{aligned} R_T = &\quad \tau w_T, \quad \sum_{a=t}^{T} \frac{\tau w_a}{(1+\delta)(1+r)^{a-t}} \equiv \sum_{a=t}^{T} \frac{\tau w_a}{(1+r+\rho)^{a-t}} < D \\ R_T = &\quad 0, \quad \sum_{a=t}^{T} \frac{\tau w_a}{(1+\delta)(1+r)^{a-t}} \equiv \sum_{a=t}^{T} \frac{\tau w_a}{(1+r+\rho)^{a-t}} \geq D, \end{aligned} \tag{3.2}$$

where ρ is the so called default premium on loans. The default premium on top of the interest rate makes the effective interest rate higher, so that it takes longer to repay the loan. The graduates who do repay fully, pay more than loan plus interest, so that costs of default can be covered. Consequently, including a default premium in an ICL is economically the *inverse* of an opting-out provision. The lower is δ the quicker high income earning graduates leave the system and the less insurance/redistribution takes place so that ρ is effectively lower.

As mentioned already in the introduction, income redistribution and insurance of default risks cannot be separated. The reason is that ex ante insurance requires ex post redistribution of incomes from lucky to unlucky graduates. This inevitably also causes redistribution from high ability graduates to low ability graduates, but also redistribution from graduates that pursued high earning types of education (e.g. law and economics) to graduates that have chosen low earning subjects (e.g. arts, languages).

ρ can also be interpreted as a 'solidarity' premium. Apart from the risks of default that are covered by ρ, there is also income redistribution. Rinnooy Kan et al. (1988) suggest to investigate the consequences of such a solidarity premium on loans by students. This can be done by analyzing the effects of increases in ρ for repayment rates, social risks and so on.

In the numerical calculations later on we use this last representation of the repayment scheme with a default premium ρ, since ρ has a more intuitive economic interpretation than δ. For the theoretical exposition, however, the formulation in terms of δ is more easy. We note that there is a strictly positive relation between δ and ρ

As a theoretical benchmark we can construct a *pure loan system* if $\delta = 0$ ($\rho = 0$) and if the repayment rate τ_n can be *varied* for each student the system. Then only the principal (including interest) is repaid. This is an artificial construct, however, since in reality repayment rates τ cannot be made contingent on individual incomes. This construct allows us to estimate the repayment burden (as a fraction of life-time incomes) on graduates when private contributions

[3] Note that differences in repayments in these systems emerge because the timing matters.

are increased and have to be self financed. The insurance element is completely absent because there is *no* redistribution from the graduates that succeed to repay their loan, to the graduates who do not succeed to do so. Nor is there an aggregate loss of default if the government can vary the repayment schedule, i.e., the tax rate, for each student, provided that life-time earnings are always higher than outstanding loans.

The notable difference with the annuity-type of loan system, which we currently have in the Netherlands, is that the repayment schedule is different. In the annuity system repayments are a constant amount during a fixed period of time (15 years). In our repayment schedule the repayments are a constant fraction of income (τ) during a fixed period of time.

We have an *ICL system with full risk-shifting* if $\delta = 0$ ($\rho = 0$) and the repayment rate τ is set at some arbitrary level and is equal for all students. Then, only the principal (including interest) is repaid. If the students cannot repay the costs of their education the system makes a loss that is borne by society. Suppose that we have N students and they borrow amounts D, but differ in their wage incomes w_a^n. The students that are not able to repay their loan in full are indexed $1 \ldots \bar{N}$. The present value of the loss of the system $\mathscr{L}$ is then given by:

$$\begin{aligned} \mathscr{L} &= \left(\tau \sum_{n=1}^{\bar{N}} W^n - \bar{N}D\right) + \left(\tau \sum_{n=\bar{N}}^{N} W^n - (N-\bar{N})D\right) \\ &= \tau \sum_{n=1}^{\bar{N}} W^n - \bar{N}D, \end{aligned} \tag{3.3}$$

where $W^n \equiv \sum_{a=t}^{T^*} \frac{w_a^n}{(1+r)^{a-t}}$ is the discounted value of life-time earnings of graduate n. The first term in the first line measures the total costs of default for those who are not able to repay in full. The second term gives the contributions for the graduates who do repay in full. This term is equal to zero.

For given repayment rate τ and earnings W^n, savings on government expenditures diminish if private contributions are increased. On the one hand increasing private contributions increases the average level of debts D since students are confronted more with the costs. However, this also implies that the loss of the system $\mathscr{L}$ increases since more students are not able to repay their debts in full, i.e., $\bar{N}$ increases.[4] (The first term in in the first line becomes larger). Although there is always a gain by raising private contributions, this gain is lowered at higher levels of private funding because lowering *ex ante* subsidies (higher D) increases *ex post* subsidies (lower L) on education.

Replacing ex ante subsidies with ex post subsidies makes the resulting distribution of incomes more equal. Ex ante subsidies are given to all students, whether they have high incomes or not during their working lives. However, only graduates who are not able to repay their debts see their debt remitted so only the 'poor' graduates benefit from ex post subsidies.

If δ (ρ) is in an intermediate range, $\delta > 0$ ($\rho > 0$), we speak of an *ICL system with (partial) risk pooling.* Repayments for graduates who have paid $1+\delta$ times the value of debt during their

[4] We assume that there are no positive or adverse selection effects that changes the number of students N.

working lives are stopped. If, after the repayment period some graduates have not repaid $1+\delta$ times their debt, the outstanding debt is remitted. As those who succeed to repay their loan, pay more than principal plus interest, funds are raised so as to cover for the costs of those graduates whose outstanding debts are remitted.

For a full risk pooling system, both the opting out parameter δ (ρ) and the tax rate τ must simultaneously keep the books of the ICL system balanced. This is the case if total repayments of those who are able to repay debts, plus the repayments of those who eventually fail, equal the value of total outstanding debts:

$$(1+\delta)(N-\bar{N})D+\tau\sum_{n=1}^{\bar{N}}W^n = ND. \tag{3.4}$$

In order to illustrate the relation between the opting out parameter and the tax-rate we normalise debt at unity, $D = 1$. The repayment rate then satisfies:

$$\tau = \frac{1-\delta\left(\frac{N}{\bar{N}}-1\right)}{\frac{1}{\bar{N}}\sum_{n=1}^{\bar{N}}W^n}. \tag{3.5}$$

The repayment rate is lower if there are more graduates repaying their debts, i.e., when $N/\bar{N}$ is higher. The repayment rate is higher if the average incomes of the defaulters decrease, i.e., when the denominator is lower. The effect of a increase in the opting out parameter δ is that the graduates pay relatively more of their incomes to repay their debt. Therefore, the tax rate must decrease. However, a decrease in δ has the additional composition effect that there are more costs of default because the number of defaulters also decreases for given N. Repayment obligations are more strict. Therefore, the repayment rate increases because of this composition effect. Finally, the average incomes of the remaining defaulters are higher, if more agents default, so that the repayment rate must decrease on that account.

A combination of risk pooling and risk shifting occurs where $\delta > 0$ ($\rho > 0$) and the tax rate parameter τ are set such that the books of the system do not balance and part of the default losses are borne by society. In that case the total loss is given by:

$$\mathscr{L} = ND-(1+\delta)(N-\bar{N})D-\tau\sum_{n=1}^{\bar{N}}W^n, \tag{3.6}$$

where the first term is the present value of outstanding debts, the second term gives the repayments of those who do not default, and the last term denotes the repayments of those who cannot repay in full. Similarly to the system with full risk-shifting, in a system with partial risk-shifting raising private contributions will only yield savings on government outlays at diminishing rate because reducing ex ante subsidies (higher D) increase ex post subsidies (lower L). Notwithstanding that ex post subsidies are more equitable since these are only given to graduates with low incomes.

3.2 Graduate taxes

Similarly as in an ICL, let the amount of equity be denoted D (in thousands of euro). Students repay a constant fraction of income when working. In an GT, graduates pay a constant fraction τ of their income w. The government may balance the books of the graduate tax by choosing τ so that no costs of default occur. The repayment scheme is now somewhat simpler than an ICL, i.e., R_T in year T equals τw_T for all T. Repayments are never stopped. Hence, in mathematical terms the repayment scheme can be expressed as follows:

$$R_T = \tau w_T. \tag{3.7}$$

Clearly, exactly a graduate tax repayment scheme results if we let δ (ρ) go to infinity in the ICL scheme. In that case, graduates have to repay a fraction of their incomes during their whole lives because they never reach the threshold when the repayments are stopped. Therefore, the graduate tax is a special case of the income contingent loan system where the solidarity premium is very high. A graduate tax entails more insurance/redistribution than an income contingent loan where the default/solidarity premium is bounded.

In case of a *GT with full risk pooling*, the tax rate in a graduate tax system τ is determined simply so as to equate the total repayments to the total costs of government debts that were created to proceed the graduates with equity D, i.e., $\mathscr{L} = 0$ and

$$\tau \sum_{n=1}^{N} W^n = ND. \tag{3.8}$$

So that the graduate tax rate equals:

$$\tau = \frac{ND}{\sum_{n=1}^{N} W^n}. \tag{3.9}$$

From the last equation follows that the larger is the average value of life time income of a graduate - the denominator -, the lower is the graduate tax needed to balance the books.

If τ is not set so as to balance the books of the system, there is always a combination of risk pooling and risk shifting, i.e., a *GT with (partial) risk shifting*. Similarly as before, we derive that the social loss is given by:

$$\mathscr{L} = ND - \tau \sum_{n=1}^{N} W^n. \tag{3.10}$$

For given repayment rate and life-time earnings, increasing private contributions yield diminishing savings on government expenditures, because they increase the total loss of the graduate tax system if D gets higher.

4 Earning capacities of graduates

To analyse various policy options to raise individual contributions to higher education, we need to determine the earning capacity of graduated students. The reason for doing so is that we want to compute tax and repayment rates for various financing models. Therefore, we need to relate the costs of education to the life-time incomes of graduates later on. We measure earning capacity by the present value of life-time labour earnings (*PV*). Only by knowing how much students earn after graduation we can assess the consequences of various systems of education finance.

We base our calculations of life-time earnings on empirically estimated earnings profiles of graduates. We estimated standard OLS regressions of 4-th order polynomial age-earnings profiles with fixed effects for every education type, separately for men, women, higher vocational, and university training. Based on our estimated coefficients we are able to simulate an age earnings profile for a male or female worker with a particular type and subject of education. We use the estimated coefficients to predict the yearly incomes of graduates as follows:

$$\ln w_e = \ln(\widehat{wage}_e) = \widehat{const} + \sum_{j=1}^{8-1} \hat{\alpha}_j dum_j + \sum_{z=1}^{Z} \hat{\beta}_z e^z, \qquad (4.1)$$

where a hat denotes an estimate. $\hat{\alpha}_j$ is the estimated fixed effect for education type j and $\hat{\beta}_z$ is the estimated coefficient for the z-th power of experience. As such, we obtain predicted wages for an individual with experience e. We then transformed the predicted wages at experience e to predicted wages at age a using the relations between experience and age.[1]

In figures 4.1, 4.2, 4.3, and 4.4 we plot the estimated wage profiles for the various education categories. Estimated coefficients are such that the familiar age-earnings profiles follow. Profiles are consistent with the literature, see e.g. Becker (1993), Murphy and Welch (1992). I.e., profiles are roughly concave: earnings increase over time at decreasing rates. Details of the estimations and the data that are used can be found in the appendix at the end.

There are differences between the different types of education, between men and women, and between higher vocational and university education. First, between the various types of education we can see a pattern. From the constants in our estimations follows that economics law and technical education types have higher earnings for both men and women. Then follow the other subjects with cultural and languages and arts studies at the bottom. Second, the differences between men and women are quite striking. Men have systematically steeper earnings profiles. Women experience that their wage increases level off earlier over the life-cycle. Third, the shapes of the wage profiles differ importantly between higher vocational and university training, because the latter are much steeper. Average wages are therefore lower for higher vocational compared to university education.

[1] E.g. $a = e + 22$ if graduates have higher vocational education. Similar transformations apply to university educated graduates: $a = e + 24$ for β-types of education, $a = e + 25$ for medical types of education and $a = e + 23$ for other types of education.

Figure 4.1 Wage profiles women higher vocational studies

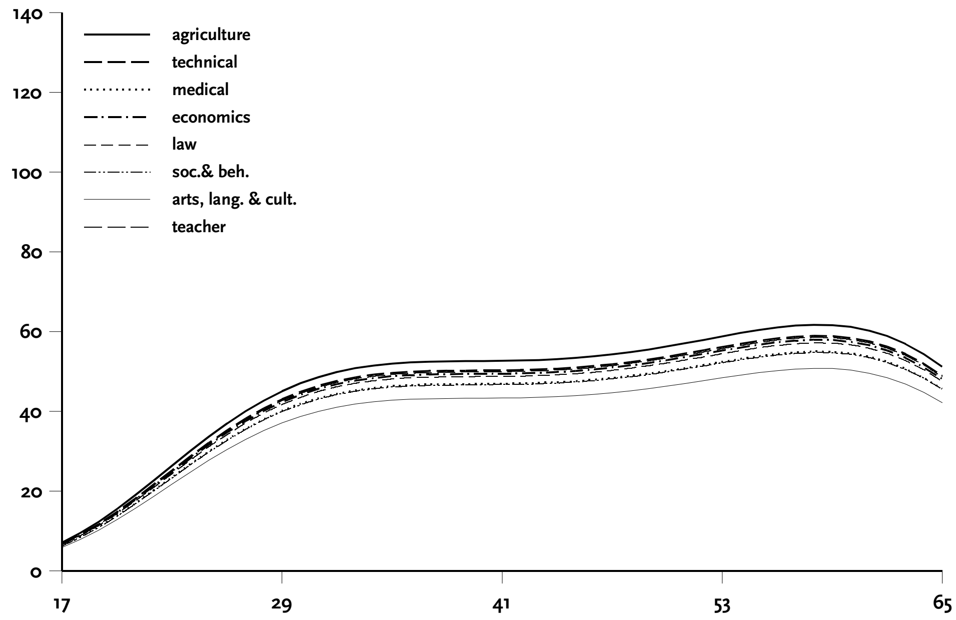


Figure 4.2 Wage profiles men higher vocational studies

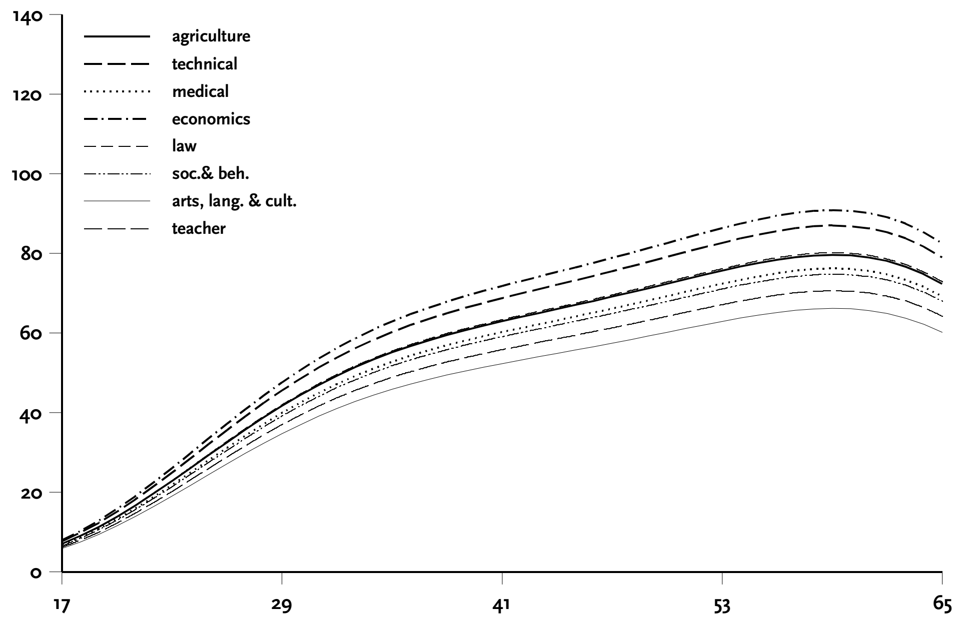


Figure 4.3 Wage profiles women university studies

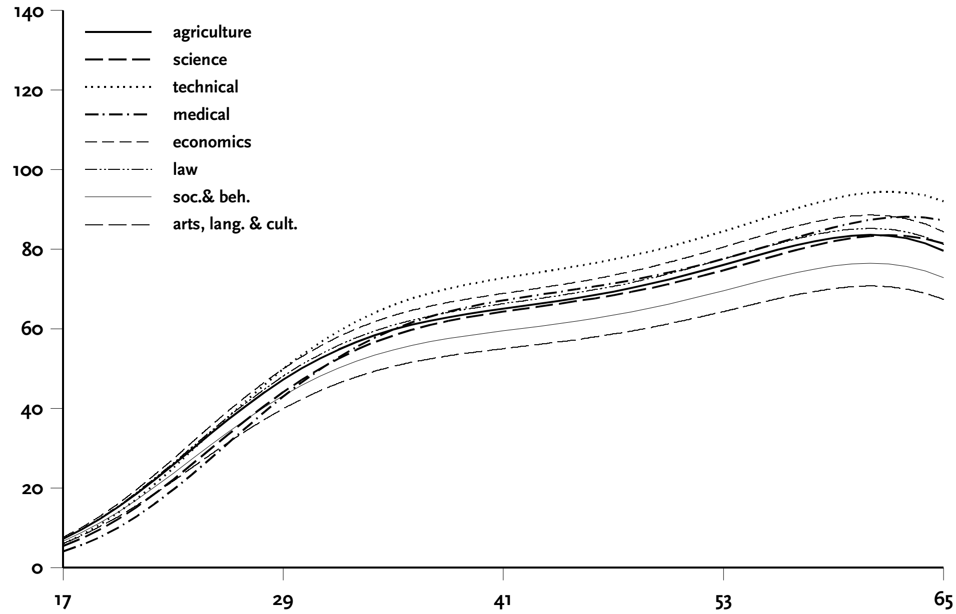
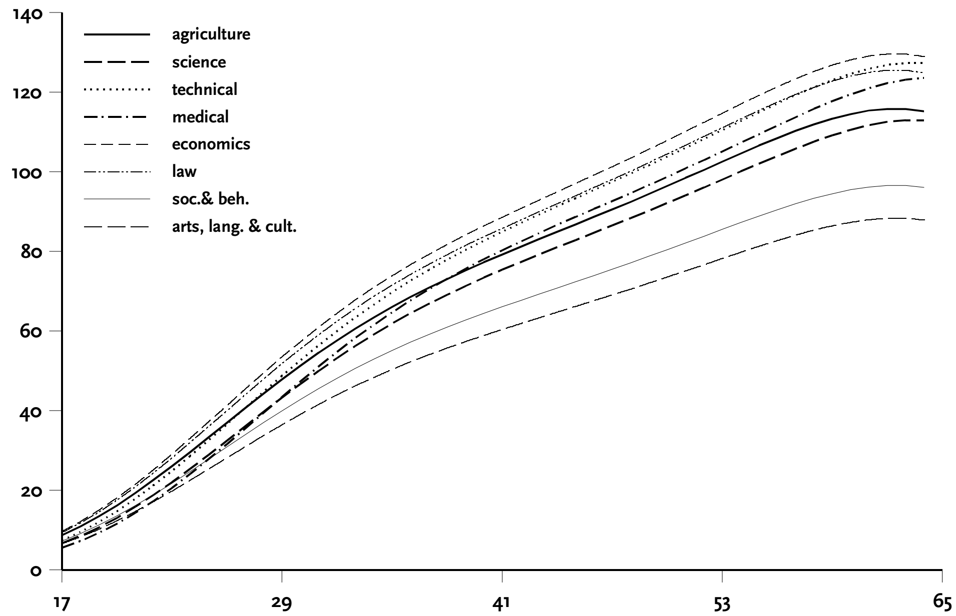


Figure 4.4 Wage profiles men university studies



So far we assumed that graduates worked full-time over the entire life-cycle. In reality this is not the case. We therefore have to correct the estimated life-time earnings for these labour supply effects. Since some graduates do not work full-time or do not participate, their present value of life-time earnings falls.

We adjust the PV of earnings evaluated at age a for labour supply effects by simply correcting earnings in each year with a factor $\Lambda_{i,s,j,a}$ in year a. We define this correction factor as follows:

$$\Lambda_{i,s,j,a} \equiv L_{i,s,j} L_{i,s,a} pr_{i,s,a} Ipr_a. \tag{4.2}$$

If a graduate participates in the labour market, $L_{i,s,j}$ denotes an index of labour supply of a worker with education level i, gender s and education type j. If $L_{i,s,j} = 1$ people work full-time. Similarly, $L_{i,s,a}$ denotes an index of labour supply of a worker with education level i of gender s as of age a.[2] Not all graduates participate in the labour market however. We correct for this by multiplying with $pr_{i,s,a}$ which denotes the participation rate in the labour force (lies between 0 and 1) of a worker with education type i, which is only disaggregated in higher vocational and university education as of age a. Ipr_a is the *index* of labour force participation as of age a. We use this index (1997 = 1) to correct for projected growth in participation rates in the next 20 years. The last index is also only dependent on age and not differentiated between the various types and levels of education. Tables of the data that were used and more details can be found in the appendix.[3]

We make two important assumptions with respect to the index of labour force participation. First, if agents are younger than 25 years old, we assume that the index takes the value of a 26 year old agent. The reason is that in our numerical calculations later on we assume that higher vocational graduates enter the labour force at age 22, and university graduates at 23 years of age. Applying official statistics at these ages is inappropriate since statistics on labour force participation rates suggest very low participation rates at these ages, but this is exactly because many young people are still in college, i.e., not all graduates leave higher education at 22 or 23 years of age.

The second assumption is that the participation index remains constant after age 55 at the level of age 55. Clearly, by all measures labour force attachment of the older workers falls sharply after 55 years of age. This does not imply that incomes of these workers incomes decrease in the same way as their labour supply and participation rates. The reason is that older workers participate in retire early schemes, disability benefits, take up their pensions, etc. Incomes remain therefore fairly high - presumably at levels comparable to a worker of 55 years old. We assume that incomes until the age of 65 are in principle subject to the GT or that repayment

[2] We can only use the averages over each group (age/or education type) because of data restrictions. This procedure is valid if life-cycle effects in hours worked are independent from the education type j.

[3] In a previous version of this paper we also corrected for mortality, but this correction did not affect any of our results because mortality rates are simply too low to have any significant effects.

obligations under an ICL system continue even when some kind of social benefit is collected.[4]

We further assume that participation decisions do not affect the slopes of the age-earnings profiles. This is correct if age-earnings profiles are not affected by labour supply decisions. However, these profiles are expected to differ as a consequence labour supply decisions. The earnings profiles have been 'corrected' for life-cycle labour supply effects as a result of the experience terms (age). The profiles are not corrected for differences in hourly labour supply and participation rates. We cannot easily correct the wage profiles for labour supply and participation decisions because labour supply and participation rates are endogenous regressors in an estimation with the wage as dependent variable. In general it is only possible to correct for this by estimating of a more structural model where this endogeneity is taken into account. This is beyond the scope of this research.

A number of assumptions must be made before turning to the calculations of the *PV* of life-time earnings. Given the fact that our estimates are based on a cross-section of wages we have to be careful in transforming the cross-sectional profiles into time-series profiles. The most important reason why cross-sections differ from time-series is the fact that there is wage growth due to technological progress (amongst other things), see also Becker (1993).[5] There is a stable increase in real wages over time of about 2% per annum. A calculation of the *PV* solely based on the cross-sectional estimates neglects this exogenous wage growth and will therefore under estimate the true *PV*.

In the remainder we present calculations based on various assumptions on the growth of wages. For the base calculations we use a rate of growth $g = .02$. This is approximately the real long-run wage growth.[6] Skill biased technological progress, for example due to the ICT-revolution, may further increase real wage growth for higher educated workers so that higher wage growth is a possibility to investigate. We consider cases of $g = .01$ and $g = .03$ as robustness checks.

A similar problem arises concerning the real discount factor that is used in the *PV* calculations. As is well known, the discount factor influences the outcomes to considerable extent. One may use a real risk free discount rate of $r = .04$ according to the official guidelines for government investments in the Netherlands. However, the real long-run return on government bonds in the 20th century is about 2-3% per year, see also table 4.1. In recent years,

4 In principle, also pension incomes may be subject to the GT/ICL schemes, because pension incomes are dependent on earned labour incomes.

5 Becker (1993) also mentions business cycles, trends in supply of educated workers, and occupation or life-cycle employment changes (p.231).

6 Annual wage growth in the post-war years was 3%, but this caused a steady increase in the labour income share. We do not expect that wage growth will increase at this pace. Statistics Netherlands (1998) gives a gross hourly wage rate for the private sector equal to 0.5 euro in 1950 and 10.0 euro in 1993. The consumer price indices in these years were 19 and 109 respectively (base year = 1990).

real returns have increased way beyond the centuries' average to about 4% or more, depending on the various sources. The question is whether a real interest rate equal to 4% is appropriate in light of the relatively low long-run real return on government bonds. For our base-line calculations we use a value equal to $r = .03$. However, we also present robustness checks for lower and higher real discount rates.

Table 4.1 Real returns on government bonds

Fase, 1997 (1952-1973)	.000
Fase, 1997 (1974-1995)	.033
Fase, 1997 (1952-1995)	.016
Eicholtz et al., 2000 (1960-1980)	-.017
Eicholtz et al., 2000 (1980-2000)	.059
Eicholtz et al., 2000 (1900-2000)	.013
Van Ewijk et al., 2002 (1900-2000)	.033
Van Ewijk et al., 2002 (1951-2000)	.026
Van Ewijk et al., 2002 (1981-2000)	.048

Furthermore, we possibly need to apply a risk-premium on top of the risk-free discount rate. The reason is that the government buys 'shares' in graduates' human capital. Since the returns on these shares are not risk-free due to macroeconomic shocks, the average tax-payer is confronted with uncertainty in revenues from the education financing system. In principle this uncertainty government revenues needs to be valued, see also Van Ewijk and Tang (2000b). If all individual income risks can be diversified (pooled) at the national level, there is no macroeconomic uncertainty so that the required risk-premium is zero. However, the presence of macroeconomic shocks that cannot be diversified at the national level requires a positive risk-premium. We present robustness calculations with a positive risk-premium.

On the other hand one may argue that there is a negative covariance between tax revenues (or government expenditures) and education. I.e., the variability in tax revenues or government expenditures is reduced when people become more educated, see also Gould et al. (2000). The reason is that higher educated are typically less dependent on social benefits, have shorter spells of unemployment, and so on. This implies that a shift in tax revenues from low-skilled workers, towards investments in high skilled workers reduces the average risk of total tax revenues. Therefore, one may question the appropriateness of using a risk-premium in our calculations to value the uncertainties associated with the revenues from the financing scheme.

For our base-case scenario we do not use a risk-premium on the real interest rate. I.e., we assume that the two effects described above cancel out (i.e., systematic risks due to macroeconomic shocks and less variation in tax revenues or government expenditures). We also present calculations for the case in which we apply risk premia of $\pi = .01$ and $\pi = .02$. An obvious candidate for the value of the discount rate is the real return on equity. However, the equity-premium on equity is around 6% or more for the post-war period, see also Fase (1997) or Eicholtz et al. (2000). In our opinion, this is way too high for a number of reasons. First, the government is able to smooth intergenerational risks associated with macroeconomic shocks, which the private sector cannot. Second, non-diversifiable risks on the stock market are arguably much larger for stocks than for labour incomes in view of the relatively stable labour income share. A real risk-premium equal to $\pi = .02$ seems therefore reasonable as an upper bound.

We assume further that inflation does not erode real wages and thereby the present value of life-time earnings. That is, we assume that nominal wages are indexed to inflation. Since we estimated the age-earnings profiles on the basis of a cross-section of wages we do not need to correct further for the effects of inflation if we assume that the CPI's for every age cohort are the same.

Finally we assume that each graduate enters the labour market directly after graduation and remains in the labour market until 65 years. We also present some calculations in which the retirement age is increased to 70 years.

Given the assumptions made so far, we compute the expected *PV* of earnings of workers with education level i, of gender s, with education type j evaluated at age t. This is done according to the following formula:

$$PV_{t,i,s,j} = \sum_{a=a^*}^{a=65} \frac{w^*_{a,i,s,j}(1+g)^{a-t}}{(1+r+\pi)^{a-t}}, \tag{4.3}$$

where $w^*_{a,i,s,j} \equiv w_{a,i,s,j}\Lambda_{a,i,s,j}$. Note that a one percentage change in the growth rate g, or interest rate r (risk-premium π) has an almost identical effect on the *PV*.

Table 4.2 presents the computed *PV*'s of earnings as of age 25, i.e., $t = 25$, for the different types of education, gender and whether a higher vocational or university type of education is followed. For all assumptions used in this and all other calculations, we refer the reader to the list in the appendix. First, from table 4.2 can be seen that the different subjects earn different streams of incomes.[7] Clearly, economics, technical, and law education have the highest present value of life-time earnings for both higher vocational and university education. Behavioural, social, arts and cultural types of education are at the lowest end of the present value of earnings.

It is apparent that differences in the present values of education can be large, certainly for the behavioural, social, arts and cultural types of education compared to economics and law. The differences between higher vocational and university education are also large. University education pays off in terms of income generally hundreds of thousands euro more than higher vocational education. Men also seem to profit relatively more from doing a university education than women. Further, the differences of the *PV* of life-time earnings for men and women echo the estimation results that women have less steep earnings profiles in addition to lower

[7] Note that we do not make a social cost-benefit analysis here. This requires additional estimations on foregone earnings that should be taken into account. Furthermore, we potentially have to take into account of ability biases, the role of the tax system to evaluate the private returns, et cetera. This is left for future research.

Table 4.2	Present value of life-time earnings in thousands of euro			
	Men		Women	
	Higher vocational	University	Higher vocational	University
Agriculture	899	1209	446	676
Science		1121		612
Technical	1017	1296	415	863
Medical	792	1133	336	640
Economics	1053	1357	443	798
Law	868	1289	367	736
Behavioural & social	794	905	360	545
Arts	546		285	
Languages & culture		811		519
Teachers	770		365	

participation rates than men. Differences between men and women are quite large reflecting mainly labour force participation characteristics.

5 Costs of education

We need to compute the present value of the costs of education. As stated before, we assume that all costs of tuition are evenly shared among graduates. We do however distinguish between graduates from higher vocational/university education and graduates with longer durations of their education. Generally, students in low-cost education types cross-subsidise students in high-cost education types. This is also the case in the current system with flat tuition rates.

We confine the analysis solely to the direct costs for education and the grants that are currently given to students to compensate for costs of living and foregone earnings. We thus ignore the opportunity costs of education that students incur while learning. Our purpose here is to relate current government outlays to future incomes of students. It is therefore not necessary to derive opportunity costs for this calculation.

Further, we exclude costs of health care in university education, e.g. the medical hospitals, that render the medical studies expensive. We do the same for the expenditures on scientific research at universities, and arts at higher vocational schools, e.g. arts academies, conservatories, acting schools, etc. These types of education are heavily subsidised in addition to the standard government contributions. The reason for giving these subsidies are presumed consumption and production externalities. In this research we do not discuss the validity of subsidies to these subjects and assume that these subsidies are also given when students pay a substantial fraction of the costs of their education.

In order to relate the benefits of education to the costs of education we have to assign present values of costs to various education types. Because men and women are treated equally we only need to consider the present value of the government expenditures per type of education, per student. Costs of grants are evenly distributed among the various types of education, and among higher vocational and university students.

The government provides students with (income dependent) grants, education services that are below the cost price and pays for the student's travelling expenses, and some other relatively minor things. Table 5.1 summarises the costs per student per year for higher vocational studies and university education.

Table 5.1 Yearly costs of education in thousands of euro

	Cost[a]	Grant[b]	Tuition[c]
Higher vocational	4.5	3.384	1.0
University	3.9	3.554	1.1

Sources: Ministry of Education (2000, 2001).
a) Average institutional cost per student, based on average costs per student (Ministry of Education, 2001, pp. 61, 71).
b) Average outlays on basic grants, income dependent grants, travelling card (OV-kaart), partner and one-parent refunds, and some other minor expenses (Ministry of Education, 2000, p. 83).
c) Statutory tuition rates (Ministry of Education, 2000, pp. 63, 73).

We further estimate the average number of years that students are enrolled in higher education. Both university and higher vocational education have a nominal length of 4 years. In practice however students are enrolled for a longer time. We assume that students are enrolled 5 years in higher education. Data from Statistics Netherlands (2000c, p.19) indicate that these figures are a little too low for the cohorts that graduated in 1996/1997. However, the same figures show a clear trend that average duration of education is falling over time.

Apart from the opportunity costs of education, students have to pay up-front tuition fees. As such, students contribute to the financing of education. However, we use a benchmark in our calculations where all costs are deferred to later stages in life and tuition rates upon enrolment are zero. This is similar to the Australian system if students choose to defer tuition fees. Furthermore, we assume that all (income dependent) grants that are currently given to students are replaced by loans/equity.

No external subsidies in the form of grants or below cost pricing of education are given in the baseline scenario and all costs, both tuition and the grants, are paid for by the students themselves in the future. The reason for choosing this reference point is that it facilitates the comparisons of the current system of education finance and income contingent systems of education finance, where subsidies possibly enter in an ex post fashion, as was explained before.

We calculated different financing schedules for various levels of education subsidies s per student per year. The reason is that there is no need to abolish all education subsidies. In the introduction we presented a number of arguments in favour of education subsidies. We use 4 categories of education subsidies as given in table 5.2. The zero subsidy regime corresponds to the case where all current outlays on education (grants and institutional costs) are replaced by loans/equity. The low, middle and high subsidy scenarios correspond to 25%, 50% and 75% of current total outlays. In the current system where the contribution on the part of students is 12% and 13% of the direct outlays on education for higher vocational and university education respectively.[1]

For the various subsidy regimes we have computed the yearly savings in government expenditures on education. In the remainder of the analysis we do not consider various options to spend the free resources. The government may want to use the proceeds for lower taxes or higher government expenditures, or reduce government debt. A discussion on these matters is beyond the scope of this research.

Table 5.3 shows the savings in government expenditure per year for the various subsidy levels. Savings on government expenditures per year amount to 459 million euro if the subsidies are lowered to 6,355 euro, and increase to 3261 million euro if students have to pay for everything

[1] These figures are derived as follows. We take the sum of grants and institutional costs minus the own contributions by the students and divide this through the sum of grants and institutional costs. For the share of government expenditures in total costs at higher vocational education we get (4.5+3.884-1.0)/(4.5+3.884)=.88, and for university education we get (3.9+3.554-1.1)/(3.9+3.554)=.87, see also table 5.1.

Table 5.2 Education subsidies and level of funds (thousands of euro)

	Subsidy level s Higher vocational	University	Loan/equity D Higher vocational	University	Average s^a
Zero	0.000	0.000	8.421	8.569	0.000
Low (25%)	2.105	2.142	6.325	6.426	2.119
Middle (50%)	4.210	4.285	4.210	4.285	4.237
High (75%)	6.315	6.426	2.105	2.142	6.355
Current system (88%)	7.377	7.434	0.000	0.000	7.398

a) Average subsidy computed using the relative number of students in higher vocational and university education as weights.

and the government stops subsidising education.

Table 5.3 Savings on government outlays (mln euro)

Subsidy	Average level (x1000 euro)	Savings Higher vocational	University	Total
Current	7.398	0	0	0
High	6.355	239	213	459
Middle	4.237	771	607	1393
Low	2.119	1304	1000	2327
Zero	0	1837	1393	3261

Note: Number of students enrolled: Higher vocational 282,000, University 158,800. Average cost per student: higher vocational 8,420 euro university 8,569 euro.

We can derive the present value of costs (PVC) of a student with education type i and subject j analogously to the present value of future earnings:

$$PVC_{t,i,j} = \sum_{a=a_o}^{a=a^*} \frac{(c_{a,i,j} - s_i)(1+g)^{a-t}}{(1+r+\pi)^{a-t}}. \tag{5.1}$$

where the present value of costs is denoted in values as of age t. a_o denotes the year in which the education is started and a^* is the year in which the education is ended. In our calculations we set a_o for higher vocational studies at $a_o = 17$ years of age, and for university education at $a_o = 18$ years of age. As already discussed, we set $a^* = 22$ for higher vocational education, $a^* = 24$ for technical university education, $a^* = 25$ for medical university education and $a^* = 23$ for other university education. s is the subsidy on total costs of education, assumed to be equal across the board.

We assume that costs also increase at a rate of g% per year. The reason is that the main costs of education are wage payments to teachers, researchers, and so on. Also a risk-premium in the costs may be included. Main costs are wage costs in education that may be subject to similar risks as wages of educated workers, which is the reason for including a risk-premium in the calculations of the present value of earnings. Table 5.4 shows the present values of costs per type of education. (Note that all present values are based on discounting to age 25).

Table 5.4 Present value of costs of education in thousands of euro

	Higher vocational	University
Agriculture	45	45
Science		54
Technical	45	54
Medical	45	62
Economics	45	45
Law	45	45
Behavioural & social	45	45
Arts	45	
Languages & culture		45
Teachers	45	

6 Income uncertainty

The crux of the proposed education finance regimes is that they provide insurance (at least partly) to graduates against the possibility that they cannot pay back their loans. To analyse this uncertainty we have to know to what extent uncertainty influences the expected earnings when graduated. In order to proxy for the effects of uncertainty we employ the standard deviation of the residuals from the estimations to measure the spread of incomes around the estimated wage-profile. A larger standard deviation in the residuals implies that there is more unexplained variation in wages. Therefore, the standard deviation is a potentially suited measure for income uncertainty. However, deviations from mean incomes are of course also attributable to all factors we omitted in the estimations, such as labour market conditions, personal characteristics, etc. For our analysis this is not a problem because, in general, the financing schemes cannot be conditioned on the omitted characteristics such as individual abilities, or industries where people work, etc.[1] This is a relatively crude method to cope with uncertainty in earnings. Ideally one would like to employ panel data to determine income uncertainty and income mobility effects. With the data at hand this is not doable. Therefore, we cannot capture differences in earnings-profiles over the life-cycle for various risk-classes, since this requires measures of income mobility over time in the income distribution. One may correct for heterogeneity between different risk classes by employing, for example, quantile regressions to capture differences in life-time wage profiles. [2] However, a priori it is not clear whether this is a correct procedure in light of the unmeasured mobility effects.

Rinnooy Kan et al. (1988) compare the outcomes of an analysis based on panel data and on a cross-section - as we employ here. They conclude that both approaches yields quantitatively very similar results. So we do not expect to bias the results to a great extent with our method.

A log-normal income distribution is a widely used approximation to the real income distribution. Under the assumption that these residuals from our estimations are normally distributed with mean zero and standard deviation σ_ε around the mean income along the estimated income profiles we generate income classes depending on the distance from mean incomes. We divide our estimated profiles of each of our 32 profiles in quintiles. Each of which contains 20% of the students. The lowest quintile has the 20% of the students with the lowest incomes, the highest quintile contains the 20% of the students with the highest incomes. In

[1] Again, these deviations from the estimated age-earnings profiles are potentially endogenous. The reason is that the slopes of the earnings profiles are affected by occupational choices, abilities of graduates and so on. Only more sophisticated econometric techniques can correct for this. We do not do this. The reason is that our wage profiles will still on average reflect the wage profile of the graduates, which is the relevant variable in our calculations. And, as already noted in the text, repayment schedules cannot be made contingent on ability, occupation and so on.

[2] We did estimate quantile regressions for the five income categories used, but this only marginally affected our results.

order to define the mean incomes in each of these classes we make use of the properties of the standard normal distribution. The mean income of the k-th, k = 1,...,5 class of students is defined as – omitting education type and gender subscripts:

$$\ln w_{ak} \equiv \ln w_a + \sigma_\varepsilon \Phi^{-1}((2k-1)/10), \tag{6.1}$$

where $\ln w_{ak}$ is the mean of predicted income at age a in class k, $\ln w_a$ is mean predicted income, and Φ^{-1} is the inverse of the cumulative standard normal distribution with mean zero and unit variance.

The total number of categories of students has by now increased from 32 to 160. We therefore allow for heterogeneity *between* the sexes, higher vocational and university education, and the various education types and *within* all these categories due to uncertainty. In figures 6.1, 6.2, 6.3, and 6.4, we plotted estimated wage profiles for the various classes for the economics education category. We could also have taken any other education type, but this does not add to our understanding because the fixed effects would only shift the profiles of log(wages) linearly upwards or downwards so that the qualitative effects remain the same.

Figure 6.1 Wage profiles by different income classes women higher vocational

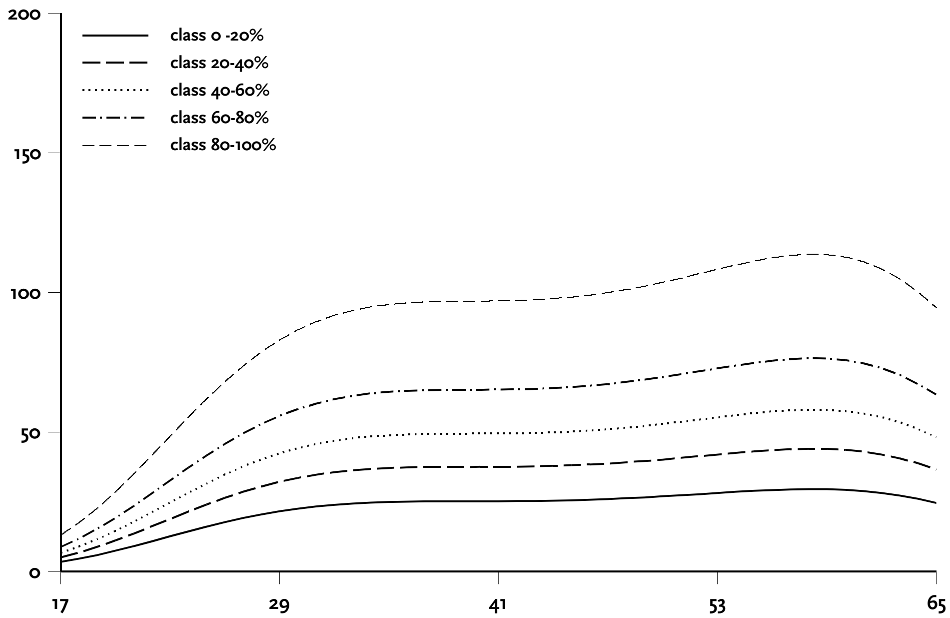


Figure 6.2 Wage profiles by different income classes men higher vocational

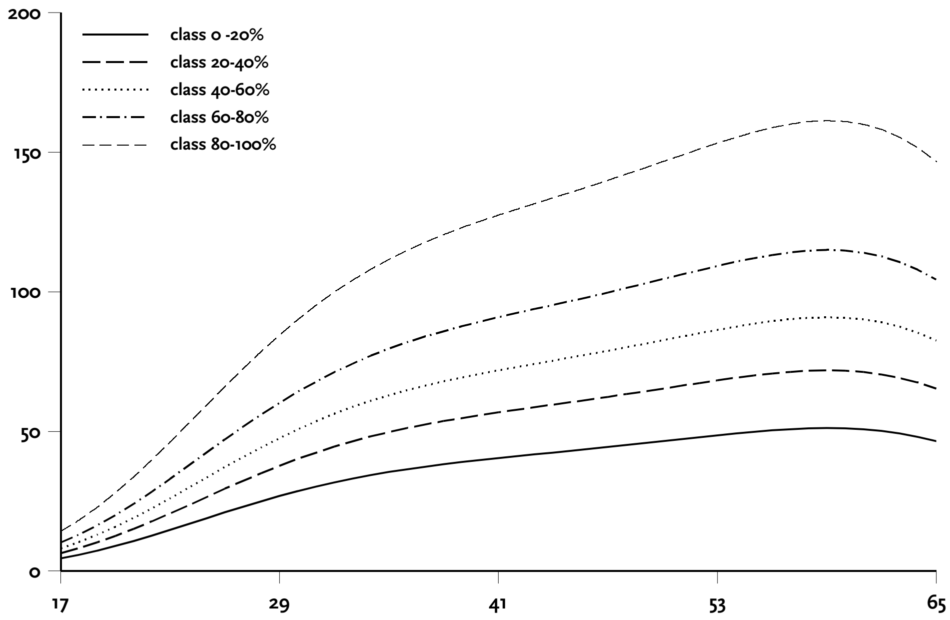


Figure 6.3 Wage profiles by different income classes women university

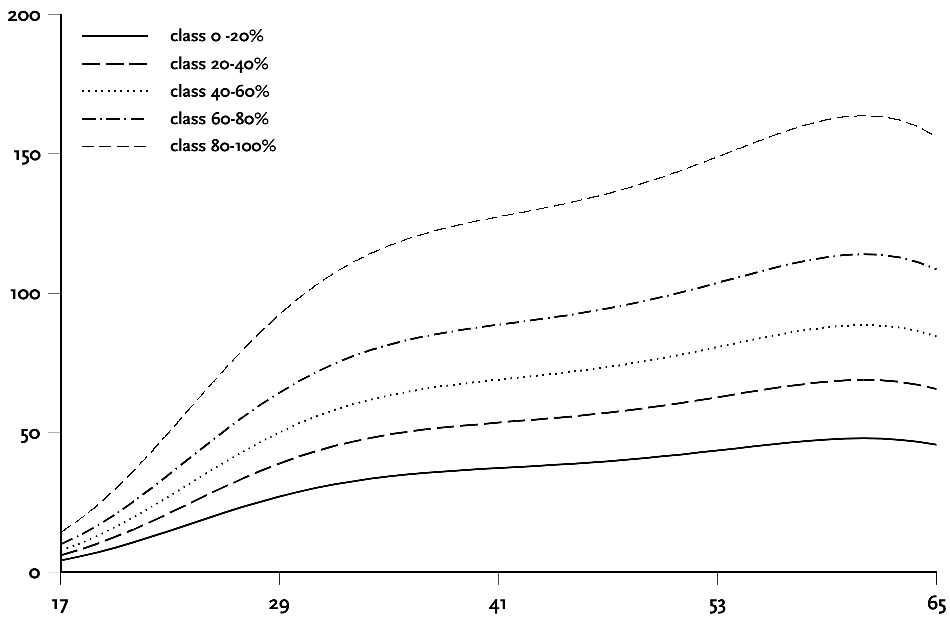
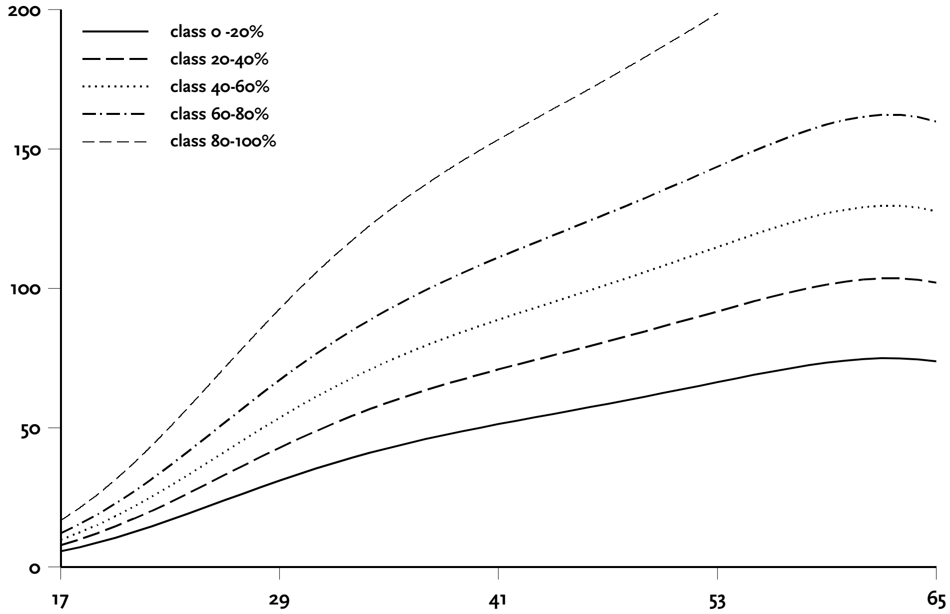


Figure 6.4 Wage profiles by different income classes men university



7 Redistribution and tax distortions

There is potentially redistribution from high earning graduates towards low earning graduates. Therefore, the distribution of the student body over the different subjects matters. To capture these effects, we employ the number of students enrolled in each education category. It happens to be the case that the high earning types of education for men, economics, law, and technical studies, are very popular. For women we find that medical, social and behavioural, economics, and law studies are the most popular. These numbers suggest that students tend to choose the financially most beneficial subjects. An exception is the teacher category that is relatively popular, but teachers do not have very high life-time earnings. Table 7.1 shows the number of students in the various education categories.

Table 7.1 Number of students enrolled in 1997/98.

	Men		Women	
	Higher vocational	University	Higher vocational	University
Agriculture	6100	2200	3200	1700
Science		8400		4400
Technical	44400	19100	7900	3900
Medical	5200	7700	20100	10800
Economics	29691[a]	17800	11603[a]	6300
Law	20209[a]	12100	24097[a]	13100
Behavioural & social	9200	10200	30100	19400
Arts	7900		9500	
Languages & culture		7700		14000
Teachers	16900		35900	

Source: Statistics Netherlands (1999, p.9, p.12)
a) Numbers of students enrolled in law and economics at the higher vocational level are calculated by weighting the total number of students in these areas with the corresponding ratios of law (economics) to total number of students in law and economics at the university level.

We take into account the potentially distortionary effect of both the GT (and ICL) on life-time labour supply, which comprises hours worked and participation effects. The graduate tax may also reduce post-initial schooling efforts which result in a smaller effective tax base. Similarly, student may increase tax avoidance activities by shifting income to the black circuit. All these effects reduce the base of the income tax and thereby the base from which repayments are funded. As a consequence, the government loses tax revenues.

We have to note here that, from a welfare perspective, not the whole increase in the tax burden can be viewed as a distortionary loss for two reasons. First, we do not consider rebating the savings in government outlays. If government savings were rebated through tax reductions, distortionary losses of increasing private contributions may vanish. The reason is that in the latter case there is only a shift in the tax burden from the average tax payer, i.e. non-graduates, towards graduates. It depends on the elasticities of labour supply of both groups whether there is an increase in welfare costs of taxation. If non-graduates have higher (lower) elasticities of labour supply than graduates there is a welfare gain (loss), since the tax system becomes more (less) efficient.

Second, the system has insurance elements that cannot be fully regarded as an increase in the average tax burden. If the repayment conditions were actuarially fair, i.e., for every graduate there is no increase in the expected tax burden, behaviour does not change. Tax distortions only arise as a consequence of inevitable redistribution. Therefore, one should interpret the welfare losses of taxes computed here as a conservative upper-bound.

We assume that the effective marginal rate (θ) without the graduate tax repayment equals 50%. This is the marginal rate in the second tax bracket in the old tax system and corresponds closely to the top bracket in the new tax system (52%). The marginal tax burden increases in the GT (and ICL) systems, since students contribute to their education through the tax system. For the computations of the revenue loss we assume an *average* tax rate equal to 40%. Bovenberg and Cnossen (1998) estimate the effective average rate on labour income equal to about 45%. Caminada et al. (1996) find a much lower average of about 35% rate when deductions for mortgage payments and pension premiums are taken into account. CPB (2001b) finds average tax wedges on income equal to about 40% for workers with modal incomes.

Empirical evidence suggests that (uncompensated) labour supply elasticities are small to negligible for men and small but positive for women, see e.g. Pencavel (1986), Killingsworth and Heckman (1986), Hanssen and Stuart (1985). However, taxable income may respond more elastically to the increased repayment rates. Gruber and Saez (2001) find that the average tax elasticity of labour income is .4. Feldstein (1999) finds very high elasticities of taxable income around 1.

As base-line values we take for men an uncompensated wage elasticity of labour supply $E = .1$ and for women $E = .5$. This gives an average elasticity of taxable income equal to .3, which is in line with Gruber and Saez (2001). Based on these elasticities we compute the life-time labour supply adjusted for the tax increase (Λ^*) as follows:

$$\Lambda^* \equiv \Lambda \left(1 - \frac{E\tau^o}{1-\theta}\right), \tag{7.1}$$

where we used $E \equiv \frac{\partial \Lambda}{\partial \theta}\frac{1-\theta}{\Lambda} = \frac{\partial \Lambda}{\partial \tau}\frac{1-\theta}{\Lambda}$. To calculate the change in the tax burden under a graduate tax regime, we used an (first-order) approximation, since the tax is endogenous. First, we derived τ^o which equals the graduate tax computed in the *absence* of a change in labour supply. Based on this increase in the tax-burden we adjusted life-time labour supply to calculate the new graduate tax adjusted for labour supply effects. As it turns out, labour supply effects are very modest, so that this approximation is fairly accurate. For the ICL scheme, we choose repayment rates in advance, i.e., $\tau^o = \tau$. Since the repayment rate is exogenous, the change in labour supply is precisely measured under an ICL scheme.

8 Loan system as a benchmark

We assume in all the calculations that follow, that the whole system as it currently operates remains in place with the difference that tuition fees are abolished and grants are replaced by loans. The major change is that the government finances the costs in advance and collects repayments from students after graduation through the tax system. We assume that there is in principle no differentiation in costs between the subjects, only as regards to the level of education (higher vocational and university) and to the length of education. So there is a cross subsidy from cheap to expensive subjects (this is also the case in the current system).

The government borrows the funds to provide students with the 'grants' and the institutional costs of education. It does so by means of the issue of government bonds and repays its debt with the repayments received from the students as they work. We assume further that the income of (full-time) working partners is not included in the repayment scheme, i.e., there is no income check on family income.

In our artificial benchmark of a loan system no individual default occurs, because the government simply varies the repayment conditions *for every student* exactly so as to cover principal plus interest. Our only purpose here is to calculate the life-time repayment burden with an ordinary loan and compare this with an GT/ICL later on. As noted before, this is a purely theoretical construct. Table 8.1 shows the average fractions of income per year that the students in each category have to repay under a loan system when subsidies are zero ($s = 0$ euro) and the yearly loan (D) given to students equals 8,420 euro for higher vocational students and 8,569 euro for university students.[1] This implies that yearly private costs increase. For higher vocational students this is 8,420 - 1.0 = 7,377 euro, and for university students the increase equals 8,569 - 1.1 = 7,434 euro.

First, we concentrate on the means - indicated by the bold numbers in the third category. For men with university education, the fraction of life-time income repaid varies from 3.5% for economics, law, technical, agricultural and medical studies to 5% for behavioural and social studies and arts and languages. For women we see that repayment burdens are higher than for men. At the university level the repayment rates are in the order of 6% for technical subjects, economics and law education, to more than 8% for behavioural and social studies and arts and languages. This is due to their lower life-time present value of incomes, and, more importantly, their lower labour supply.

Repayment burdens for men with higher vocational types of education are comparable, although slightly higher than men with university education, varying from 4-8%. For women at the higher vocational level repayments are substantial and higher compared to women with university education, ranging from 10-15%. This is mainly the consequence of lower labour supply figures at higher vocational education. Clearly, women with higher vocational education

[1] Tables for the other subsidy regimes are available upon request.

Table 8.1 Fractions of life-time incomes repaid under pure loan system

	quintile	University men	University women	Higher vocational men	Higher vocational women
Agriculture	1	6.4	12.3	8.8	19.7
	2	4.6	8.5	6.3	13.2
	3	**3.7**	**6.6**	**5.0**	**10.0**
	4	3.0	5.2	3.9	7.6
	5	2.1	3.6	2.8	5.1
Science	1	8.3	16.2		
	2	6.0	11.3		
	3	**4.8**	**8.8**		
	4	3.8	6.8		
	5	2.8	4.7		
Technical	1	7.2	11.5	7.8	21.1
	2	5.2	8.0	5.6	14.2
	3	**4.1**	**6.2**	**4.4**	**10.8**
	4	3.3	4.8	3.5	8.2
	5	2.4	3.4	2.5	5.5
Medical	1	9.5	18.0	10.0	26.1
	2	6.9	12.5	7.1	17.5
	3	**5.5**	**9.7**	**5.6**	**13.3**
	4	4.4	7.6	4.5	10.1
	5	3.2	5.3	3.2	6.8
Economics	1	5.7	10.4	7.5	19.8
	2	4.1	7.2	5.4	13.3
	3	**3.3**	**5.6**	**4.2**	**10.1**
	4	2.6	4.4	3.4	7.6
	5	1.9	3.0	2.4	5.1
Law	1	6.0	11.3	9.1	23.9
	2	4.4	7.8	6.5	16.0
	3	**3.5**	**6.1**	**5.1**	**12.2**
	4	2.8	4.7	4.1	9.2
	5	2.0	3.3	2.9	6.2
Behavioural & social	1	8.6	15.2	10.0	24.3
	2	6.2	10.6	7.1	16.3
	3	**5.0**	**8.2**	**5.6**	**12.4**
	4	4.0	6.4	4.4	9.4
	5	2.9	4.5	3.2	6.3
Arts, languages	1	9.6	16.0	14.5	30.7
	2	6.9	11.1	10.3	20.6
	3	**5.5**	**8.7**	**8.2**	**15.7**
	4	4.4	6.7	6.5	11.9
	5	3.2	4.7	4.6	8.0
Teacher	1			10.3	24.0
	2			7.3	16.1
	3			**5.8**	**12.2**
	4			4.6	9.3
	5			3.3	6.2

Note: Higher vocational students borrow 8,420 euro per year and university students borrow 8,569 euro per year. This is equal to total current educational expenditures per student, including tuition fees from students.

are the first to get into repayment problems under a loan regime.

The general picture is that economics, law, technical and behavioural subjects have the lowest repayment rates. Intermediate repayment rates are found in agriculture and languages at the university levels. High repayment burdens are found in sciences, health, arts and teacher education. This is due to the fact that in first group of studies present values of earnings are relatively higher, whereas in the last group the opposite holds.

Second, we concentrate on the difference in repayment burdens within the various education types. We see that there is substantial heterogeneity in fractions of income repaid within education groups. For men with university education, the repayments are roughly 75% higher if graduates belong to the first quintile compared to the mean - the third quintile. Repayment burdens fall to about half of the mean for the highest quintiles. For women and men at higher vocational education the lowest income quintile has repayments that are about two times higher than the mean in each category.

This picture is roughly the same for the various subjects, higher vocational and university education. We can see that especially women in lower income quintiles get into repayment problems, because they have to repay sometimes 20% or more of their incomes in order to repay their debts. The variations in earnings follow the general pattern of the standard deviation of the residuals in the estimations.

9 Graduate taxes

Under a GT system all students are treated equally and they have to repay a constant fraction of their incomes during their whole lives. According to the formula (3.9), we can compute the repayment rate to cover all outstanding debts, so that no aggregate default occurs and all risks are borne by the students themselves. This also entails redistribution from high income earners to low income earners.

Table 9.1 shows the graduate taxes required to cover all outstanding government debt. We first concentrate on the base line case in which no subsidies are given. In that case the repayment rate, or GT, equals 5.9%. When we compare this rate with the various rates we encountered in table 8.1, it becomes clear that there is a lot of redistribution involved. The reason is that with a graduate tax all elements in table 8.1 are equal to 5.9. Thus, there is a very strong compression in repayment obligations. As such our calculations show that income insurance is substantial. There is insurance/redistribution in particular from men to women, from high earning subjects to low earning subjects, and from university to higher vocational education.

We can at least conclude that pooling of risks is highly beneficial in order to reduce the uncertainties involved of doing a particular type of education. Moreover, on average the absolute increases in the tax rates for the high earning subjects are relatively modest compared with the decreases – in absolute terms – in tax rates for the subjects that are relatively less financially beneficial. This effect can be attributed mainly to the fact that there is a relatively large number of male students in the high earning subjects.

Table 9.1 Graduate taxes (%)

	$s = 0$	$s = 2.119$	$s = 4{,}237$	$s = 6{,}355$
Baseline	5.9	4.4	2.9	1.4
$g = .01$ ($\approx r = .04$)	7.6	5.7	3.8	1.9
$g = .03$ ($\approx r = .03$)	4.4	3.4	2.2	1.1
$\pi = .01$ / $r = .04$	7.6	5.7	3.7	1.9
$\pi = .02$ / $r = .05$	9.7	7.2	4.7	2.3
Retirement age = 70	5.3	4.0	2.6	1.3
Elasticity high	6.1	4.4	2.9	1.5
Elasticity zero	5.7	4.3	2.9	1.4
+25% funds	7.4	5.5	3.6	1.8
-25% funds	4.4	3.3	2.2	1.1
Nominal duration	4.0	2.8	1.6	0.4

The GT is reduced when the government increases subsidies. The reason is that graduates obtain fewer funds. With a low average subsidy of 2,119 euro the graduate tax equals about 4.4%, with subsidies in the middle it falls to 2.9% and with a high subsidy of 6,355 euro the tax rate is only 1.4%. However, government savings on education expenditures also decrease when subsidies are brought in line with current levels, see below.

In the rest of the table we have computed the consequences for the GT when the crucial parameters of the model are changed. First, we looked at a 1%-point lower rate of wage growth. This corresponds as well with a higher real interest rate of 1%-point.[1] Clearly, lower wage growth or higher real interest rates has important consequences for the GT, for is has to increase with more than 1%-point for every %-point reduction in the growth rate of wages.

Similarly, a positive value of the required risk premium of 2% increases the graduate tax to 9.7% in the base-line scenario. This also corresponds to an increase in the real interest rate of 2% per year. Clearly, unfavourable conditions with regards to the interest rate are importantly affecting the repayment conditions. In the case the real interest rate equals 2%, a graduate tax of about 4.5% is sufficient to let the graduates pay for all the costs of education.

The statutory retirement age may increase in years to in come. We calculated the consequences of increasing the retirement age to 70 years. Only modest decreases in repayment rates are found when retirement age increases. This is caused by the fact that revenues further away in the future are heavier discounted. Interestingly, repayment rates are not very sensitive with respect to labour supply elasticities. We calculated cases in which labour supply effects are absent, i.e., $E = 0$, for both men and women, and where labour supply is more elastic, that is, $E = .25$ for men and $E = 1$ for women. These are upper bounds that are found in the literature. Very modest increases are found when labour supply elasticities are set at levels that can be considered very high. Based on these figures we may say that moral hazard in labour supply after graduation is potentially not a very important factor that drives repayment conditions.

Under a graduate tax system, students may wish to have more funds than in the current system, because the capital market imperfection is tackled and students may suffer less from risk aversion. We compute the levels of the graduate tax in case the government increases the funds available to students. We compute the consequences of an increase of 25% in total funds, this corresponds to an increase in (average) grants from 2,884 euro per year to 4,989 euro per year for higher vocational students and from 3,554 euro to 5,719 euro per year for university students in the base-line scenario. In the other scenarios the increase in the *level* of funds is smaller because the initial size of equity/loan is smaller. This figure is picked somewhat arbitrarily and may be at the high end. On the other hand, the graduate tax may also reduce the amount of funds that students wish to have since total costs of education increase. We also analyse the effects of a decrease in the funds made available by the government with 25%.

The latter calculation approximately corresponds as well to the total elimination of drop-outs in higher education. The overall drop-out rate in higher education is 19% and university education has a drop-out rate of 28%, see Statistics Netherlands (1995, p.32). Accordingly, a decrease in average costs of education of about 25% results if all drop-outs are eliminated. The

[1] The approximation follows from the fact that, at low interest and growth rates on may write for the discount factor: $\frac{1+g}{1+r+\pi} \approx \frac{1}{1+r+\pi-g}$.

government may want to avoid moral hazard and adverse selection under a GT/ICL scheme. It can do so by means of selection procedures or allow universities to expel non functioning students, the so called ‘binding study advice’.

Linear effects on the levels of the repayment rates are found when the amounts borrowed are increased (decreased) with 25%. The corresponding GT also increases (decreases) with 25%. The reduction in average duration of the study to nominal length has similar effects as a reduction of the total costs with 25%. The latter findings imply that moral hazard effects while enrolling in education are important for the repayment conditions. If the government wishes to make the financing system more attractive, reducing drop outs and shortening enrolment duration is potentially effective to reduce the costs of education.

We also compute the consequences of a shorter average duration of enrolment in higher education. We compute the GT in case all students study for the nominal length of their education. In order to avoid moral hazard and adverse selection, the government may also want to set stricter norms with respect to the duration at which students are allowed to be enrolled in higher education.

All the consequences of changing parameters turn out to become more modest at higher education subsidies. All said, we have to be careful to draw conclusions about the exact size of the repayment rate, since it turns out to be sensitive to the assumptions made as regards the rate of wage growth, the interest rate and the required risk-premium, but not with regard to the labour supply effects.

Finally, we computed the loss in tax revenues per year as a consequence of increasing the effective tax burden. To that end, we first determined the total present value of lost life-time tax revenues per student. By making the steady state assumption, we convert the loss in tax revenues to an equivalent increase in costs per student per year. Finally, we computed the total yearly tax loss by summing all average revenue losses per student over the whole student population currently enrolled. In mathematical terms this can be expressed as:

$$q_j \equiv \frac{\sum_0^{N_i} L_{j,n}}{N_j \sum_{t=a_o}^{t=a^*} \left(\frac{1+g}{1+r}\right)^{a-t}}. \tag{9.1}$$

where q_j, N_i, $L_{i,n}$, a_o, a^* denote the yearly equivalent of the total tax loss per student of education level j, the number of students in education level j, the present value of the life-time revenue loss per student of education level j, the age at which education is started, and the age at which education is ended, respectively.[2] In table 9.2 we computed for the base-line values the yearly revenue losses for the different values of the graduate tax.

[2] Here, we make an approximation by assuming that students in medical and technical subjects are 5 years enrolled. We do not expect that this approximation has large effects on the estimated tax losses, since the fraction of students enrolled in these studies is relatively low compared with the total number of students. In any case, in this procedure tax losses will be over-estimated, because these medical and technical students typically have shorter working lives because they study for a longer time.

Table 9.2 Yearly equivalent of lost tax revenues and net savings (bln. euro)

	baseline	$E = 0$	E high
$s = 0$ euro	$\tau = 5.9\%$	$\tau = 5.7\%$	$\tau = 6.1\%$
Gross savings	3.2	3.2	3.2
Lost revenues	0.7	0	1.6
Net savings	2.5	3.2	1.6
$s = 2,119$ euro	$\tau = 4.4\%$	$\tau = 4.3\%$	$\tau = 4.4\%$
Gross savings	2.3	2.3	2.3
Lost revenues	0.5	0	1.1
Net savings	1.8	2.3	1.2
$s = 4,237$ euro	$\tau = 2.9\%$	$\tau = 2.9\%$	$\tau = 2.9\%$
Gross savings	1.4	1.4	1.4
Lost revenues	0.2	0	0.7
Net savings	1.2	1.4	0.7
$s = 6,355$ euro	$\tau = 1.5\%$	$\tau = 1.4\%$	$\tau = 1.5\%$
Gross savings	0.5	0.5	0.5
Lost Revenues	0.2	0	.4
Net savings	0.3	0.5	.1

From table 9.2 can be concluded that losses in tax revenues with a graduate tax can be substantial compared to the savings on government outlays. As noted before, the savings on government outlays may be rebated through general tax reductions so that welfare costs of taxation may disappear. In the current discussion, the government savings are simply taken out of the economy.

Potential revenue losses critically hinge on the presumed labour supply elasticities. For the most reasonable values of the labour supply elasticities (base-line scenario) we see that the loss of tax revenues is about 1/4 of the total reduction in government outlays. We calculate that net yearly savings on government outlays with a graduate tax are ranging from .3 to 2.5 bln euro if the subsidies on higher education are decreased from 6,355 euro on average per student to 0 euro per student. In the case where labour supply elasticities are zero, full gross savings are realised as net savings, since there are no revenue losses. However, if the labour supply elasticities are set at upper bounds found in the literature, net savings on government expenditures are very much reduced due to lower tax revenues.

10 An income contingent loan system

10.1 ICL with full risk pooling

In an ICL system with full risk pooling all costs of default are shared amongst graduates – as in the GT system. The only notable difference is that there is a limit on the amount that graduates repay after graduation. This limit is determined by the default premium ρ see also section 3. Under an ICL system, ρ determines how long graduates remain in the program. The lower is ρ, the quicker they have repaid their debts. For effective insurance to occur ρ must take some positive value. As the default premium increases an ICL with full risk pooling is in the limit equal to the graduate tax system. Then, redistributional aspects enter more and more in the default premium as in the GT. ρ should then be denoted more appropriately as a solidarity premium.

In table 10.1 we have computed the repayment rates for the various subsidy regimes and for varying the default/solidarity premiums ρ. We have used the baseline values of the other parameters. The values of the repayment rates are obtained by solving the budget constraint for τ of the system as given in equation (3.4). The risk premium and the repayment rate must simultaneously keep the books of the system balanced.

Table 10.1 Repayment rates τ (%) in ICL with full risk pooling.

	$\rho = .01$	$\rho = .02$	$\rho = .03$	$\rho = .04$	GT ($\rho = \infty$)
$s = 0$ euro	10.3	7.8	6.9	6.4	5.9
$s = 2,119$ euro	7.5	5.8	5.1	4.8	4.4
$s = 4,237$ euro	4.9	3.8	3.4	3.2	2.9
$s = 6,355$ euro	2.4	1.9	1.7	1.6	1.4

We see that the repayment rates increase relative to the repayment rates encountered under a graduate tax. The reason is that the high-earning graduates are leaving the system earlier so that the low-earning graduates have to pay more of their incomes to repay their debts. Again we can see that the spread in repayment rates in the various subsidy regimes is reduced, when we compare the repayment rates in table 10.1 with those encountered in table 9.1. However, at very low levels of ρ ($\rho = .01$), the effective insurance against the bad states of nature has importantly diminished compared to the graduate tax system. The reason is that high income earners contribute little to solidarity. Only women with higher vocational education benefit from the insurance characteristics, i.e., transfers from high income earners.

Furthermore, we see relatively large reductions in repayment rates when ρ is increased at low initial levels of the default premium. An increase in the default/solidarity premium implies that high earning graduates repay more and remain repaying for a longer period of their lives. This improves the insurance/redistributional characteristics of the system, so that repayment rates can be lower. The reductions in τ level off when ρ gets higher. The repayment rates converge to the values of the graduate tax when the default premium is increased to about 12%. The reduction in government expenditures for the various subsidy regimes are assumed to be equal to that of the graduate tax as no external losses of default are present.[1]

10.2 ICL with (partial) risk shifting

One may also design the ICL system where costs of default are (partly) shifted to society at large. In the Australian system, students never repay more than the principal (the real interest rate is zero). That implies that there is no ex post redistribution from lucky students to unlucky students. Subsidies on education now enter in an *ex post* fashion, however, rather than *ex ante*, since the costs of default are funded from government budget. Still there can be reductions in total government expenditures on education. The reason is that subsidies are also given to successful graduates, whereas in a risk-shifting arrangement only subsidies are given only to unsuccessful students. In that case, replacing ex ante subsidies for every student by ex post subsidies - only given to unlucky graduates - makes the education system more egalitarian, since the unlucky graduates have lower incomes than the average graduates.

We present calculations for various (exogenous) values of the default premium and the repayment rate. The problem here is to pick some reasonable values in order to illustrate the important mechanisms. The reason is that the number of possible ICL-schemes that one can think of is infinitely large. In the Australian system there is no risk-pooling so that $\rho = 0$. This is a natural lower bound. Rinnooy Kan et al. (1998) use a default-premium ρ equal to 1.3% to cover costs of default and early mortality. They do discuss also the possibility of a solidarity premium. As a benchmark we take $\rho = .02$. This figure implies that the effective interest rate for students increases to $r + \rho = .05$ in the base line case. We also present calculations for a default premium of $\rho = .04$ which is our upper bound and ρ gets more the character of a solidarity premium. We finally calculate the consequences if we let ρ go to infinity. These calculations then correspond to a graduate tax with partial risk-shifting.

For the repayment rates we take values $\tau = .02$, $\tau = .03$, and $\tau = .04$. These values are somewhat arbitrarily chosen, but probably represent the politically feasible range. Finally, we restrict our subsidy regimes to $s = 2,199$ euro, and $s = 4,237$ euro. The high and zero subsidy regimes ($s = 0$ euro and $s = 6,355$ euro) are probably not very interesting from a policy perspective. For these 24 combinations of repayment rates, solidarity premiums and education subsidies we present calculations below.

[1] This depends on the timing of tax revenues and the elasticities of labour supply over the life-cycle. Tax losses with an ICL are generally larger compared to a GT because tax smoothing over the life-cycle is optimal as the GT does, rather than concentrating it at the young ages in an ICL. However, tax losses may be smaller if the elasticity of labour supply is smaller at young ages, the period to which the tax burden is shifted. Given that repayment periods are generally very long, we are inclined to think that the difference is relatively minor.

In order to assess the behaviour of the ICL scheme we also present some additional statistics. First, we calculate the so called *debt-gap*. This is the fraction of total outstanding debt that has been repaid. The remaining fraction is the social loss as a fraction of outstanding debts. The latter is what Rinnooy Kan et al. (1988) dub the *social risk* of loans. Second, we calculate the fraction of students that are able to repay their debts in full. This is denoted the *debt-count*. Third, we computed the average number of years it takes to repay debt, for those who do pay back in full, see also Barr and Faulkingham (1993).

We also compute the average costs of default for graduates with higher vocational and university education. The costs of default are derived in similar fashion as the losses in tax revenues. First we calculated - for given repayment rate τ and default premium ρ - the net present value of default costs. Then we transformed the present value of default costs to the equivalent yearly rise in education expenditures per student that generates the same present value of default costs. In mathematical terms this can be expressed as:

$$d_i \equiv \frac{\sum_0^{N_i} DL_{i,n}}{N_i \sum_{t=a_o}^{t=a^*} \left(\frac{1+g}{1+r}\right)^{a-t}}, \tag{10.1}$$

where d_i, and DL_i denote the yearly equivalent increase in costs of education of education type i, and the default loss per student of education type i. The other variables are defined above. Here we make an approximation by assuming that students in medical and technical subjects are 5 years enrolled.[2]

Table 10.2 and table 10.3 present the results for the $s = 2,119$ euro and $4,237$ euro regimes where students pay 75% and 50% of total current costs respectively. For the low subsidy regime we see that the debt gap is substantial. Large fractions of outstanding debts are not repaid with the repayment rates and default premiums chosen here. Even with a repayment rate equal to 4% of total life-time income and a default premium of $\rho = .04$ about 11% of outstanding debt is not repaid. This is less so in the high subsidy regime, where the debt gap may be close to 100% or more if the repayment rate is 4% and the default premium is 2% or higher. Furthermore, we see that a substantial fraction of students in all scenario's does not repay in full. Of course, the number of students that repays falls if the default premium increases, since it takes longer to repay debts for given repayment rates. The average duration of of repayment is long, i.e., about 30 years or more.

If one regards the base-line parameters and tax and default rates as plausible, it is not surprising that the private sector is reluctant to provide students with substantial loans. The low debt gaps require substantial risk premia and repayment rates. The very low fractions of students that repays in full and the long periods of repayment make education loans very costly from an administrative point of view. As such, the role for government intervention seems vindicated.

[2] Again, we do not expect that this approximation has large effects on the estimated costs of default, since the fraction of students enrolled in these studies is relatively low compared with the total number of students.

Yearly costs of default decrease if the government increases subsidy rates. Students have to borrow less if the government is financing larger parts of the costs of education. Reducing *ex ante* subsidies on education by increasing private contributions yield marginally decreasing savings on government outlays because *ex post* subsidies on education increase. Given the repayment scheme (τ, ρ), lowering education subsidies ex ante, implies that more costs of default that are shifted to society at large, so that education subsidies ex post increase. From the figures on the government savings we can see that the reductions in government outlays are almost similar in both regimes for identical repayments schemes (τ, ρ). More generally, only by increasing the repayment rate or the default/solidarity premium, substantial savings on aggregate government outlays can be achieved. If the repayment rate or risk premium increases, we can see that costs of default decrease substantially. The reason is that students now have to repay a larger fraction of their incomes to repay their debts, so that less default occurs. Consequently, savings on government outlays are increasing. We see in the middle subsidy regime that aggregate costs of default eventually become negative. Due to high default/solidarity premiums, graduates repay more than they have borrowed.

Replacing ex ante with ex post subsidies has of course distributional effects. Whereas everyone benefits from ex ante subsidies, only the graduates with incomes insufficient to repay their debts benefit from the insurance aspects of the ICL. Consequently, replacing ex ante with ex post subsidies results in a more equal distribution of income across graduates. This is the insurance element in an GT/ICL system, that is absent in schemes with education subsidies. Moreover, we can say that, more generally, ex post subsidies are more equitable than ex ante subsidies.

If $\rho \to \infty$ results converge to that of a GT (with partial risk-shifting). In the low subsidy regime a repayment rate of 4% is too low to cover all outstanding debts since the debt-gap is 91%. From table 10.1 we can see that a tax of 4.4% is sufficient to get the debt gap at 100%. Similarly, for the high subsidy regime, we see that the debt gap is 118%, so that the repayment rate covers more than all outstanding debts. From table 10.1 follows that a repayment rate of 2.9% is sufficient to cover debts.

In table 10.4 we did some sensitivity analyses for the ICL scheme for different assumptions of the parameter values used in the base-line calculations. Here we use the middle subsidy regime. The low subsidy regime features qualitatively similar effects. Again, the results show large sensitivity with respect to the growth rate of wages and the (macro) risk-premium chosen. A 1% point change in the 'good' direction in either one these parameters ensures that the debt gap is about 100% or even higher. Similar effects are found if the amount borrowed is 25% lower (no drop-outs) or students are enrolled for the nominal duration of their study. However, a change in the 'wrong direction' makes the system vulnerable to non-repayment. This also holds for 25% more funds. The labour supply effects (elasticities and retirement ages) have again relatively modest effects. From the figures for government savings we see that it ranges from 0.5 to 1.6

Table 10.2 ICL with (partial) risk shifting ($s = 2,119$ euro)

ρ	τ	Gap (%)	Count (%)	Average years repay	Loss x 1000 euro H. voc.	Loss x 1000 euro Univ.	Gross savings (bln euro)	Revenue loss (bln euro)	Net savings (bln euro)
.00	.02	45	6	44	3.7	3.3	0.7	0.2	0.5
.02	.02	46	-	-	3.7	3.2	0.8	0.2	0.5
.04	.02	46	-	-	3.7	3.2	0.8	0.2	0.5
∞	.02	46	-	-	3.7	3.2	0.8	0.2	0.5
.00	.03	62	19	39	2.8	2.0	1.2	0.4	0.9
.02	.03	67	6	42	2.5	1.5	1.4	0.4	1.0
.04	.03	69	1	48	2.5	1.4	1.4	0.4	1.0
∞	.03	69	-	-	2.5	1.4	1.4	0.4	1.0
.00	.04	73	34	37	2.0	1.2	1.5	0.5	1.0
.02	.04	82	18	39	1.6	0.4	1.8	0.5	1.3
.04	.04	89	6	41	1.3	-0.2	2.0	0.5	1.5
∞	.04	91	-	-	1.2	-0.5	2.1	0.5	1.6

Table 10.3 ICL with (partial) risk shifting ($s = 4,237$ euro)

ρ	τ	Gap (%)	Count (%)	Average years repay	Loss x 1000 euro H. voc.	Loss x 1000 euro Univ.	Gross savings (bln euro)	Revenue loss (bln euro)	Net savings (bln euro)
.00	.02	62	19	39	1.8	1.4	0.7	0.2	0.5
.02	.02	67	6	42	1.7	1.0	0.8	0.2	0.5
.04	.02	69	1	48	1.4	0.9	0.8	0.2	0.6
∞	.02	69	-	-	1.4	0.9	0.8	0.2	0.6
.00	.03	78	42	36	1.1	0.6	1.0	0.4	0.6
.02	.03	89	20	36	0.8	-0.1	1.2	0.4	0.8
.04	.03	97	9	39	0.5	-0.6	1.4	0.4	1.0
∞	.03	103	-	-	0.3	-1.0	1.5	0.8	1.1
.00	.04	87	91	34	0.7	0.3	1.1	0.5	0.6
.02	.04	102	36	34	0.0	-0.6	1.5	0.5	1.0
.04	.04	116	18	33	-0.2	-1.5	1.8	0.5	1.2
∞	.04	137	-	-	-1.0	-2.8	2.1	0.5	1.6

billion euro. So the earlier conclusion that one needs to be careful with drawing inferences is also confirmed here.

Table 10.4 Sensitivity analysis ICL ($\rho = .02$, $s = 4,237$ euro, $\tau = .03$)

	Gap (%)	Count (%)	Average years repay	Loss x 1000 euro H.voc.	Loss x 1000 euro Univ.	Gross savings (bln eur)	Revenue loss (bln eur)	Net savings (bln. euro)
Baseline	89	20	36	0.8	-0.1	1.2	0.3	0.8
$g = .01$ ($\approx r = .04$)	75	10	37	1.4	0.6	0.9	0.3	0.6
$g = .03$($\approx r = .02$)	103	34	36	0.2	-0.7	1.5	0.5	1.0
$\pi = .02$ / $r = .05$	62	6	40	2.1	1.4	0.6	0.2	0.4
$\pi = .01$ / $r = .04$	75	11	38	1.4	0.6	0.9	0.3	0.6
Ret. age = 70	95	24	38	0.6	-0.4	1.3	0.4	0.9
Elasticity high	88	19	36	0.8	0.0	1.2	0.8	0.4
Elasticity low	90	20	36	0.7	-0.1	1.2	0.0	1.2
+25% funds	77	11	39	1.6	0.6	0.9	0.4	0.5
-25% funds	103	36	34	0.1	-0.5	1.5	0.4	1.1
Nominal duration	99	34	35	0.3	-0.4	1.4	0.4	1.0

11 Discussion

11.1 Enrolment effects

Although we have taken into account various possibilities that may affect behaviour it is possible that other effects are important. Decreasing the subsidy rates and increasing the repayment obligations through the tax after graduation may cause a drop in enrolment in higher education because students are confronted with lower returns on their investment in education. On the other hand, since there is effective insurance of repayment risks, enrolment is expected to increase. A priori, we cannot quantify the combined effect since both effects work in opposite direction.

Empirically, evidence on the effects of reducing future earnings on enrolment is mixed. Estimates for the Netherlands by Kodde (1986) suggest that enrolment is hardly price-responsive. Oosterbeek and Webbink (1995) find no effects in a similar study for the Netherlands. Empirical evidence for other countries - notably the US - suggests that increasing tuition rates could reduce enrolment in higher education. However, empirical evidence is mixed in the US as well.

Leslie and Brinkman (1987) and Hilmer (1998) find a substantial impact of lowering tuition prices upon enrolment. Kane's (1994, 1995) findings suggest that this effect is substantially lower. In table 11.1 we summarise the enrolment elasticities found in the literature. The elasticity is defined as the absolute change in enrolment in %-points (dq) with respect to an increase in tuition prices with 1% (dp/p), i.e., $e \equiv -dq/(dp/p)$. It is therefore more correctly denoted a quasi-elasticity. We computed the elasticities using information on the average prices of college/university education and the estimated effects upon enrolment in university or college.

Table 11.1 Enrolment (quasi) elasticities

	dq	dp	p	e
Kodde, 1986, NL	.5	272 euro	545 euro	.01
Oosterbeek and Webbink, 1995, NL	0	-	-	0
Kane, 1994, US	5	$1000	$1200	.06
Kane, 1995, US	3.5	$1000	$753	.03
Leslie and Brinkman, 1987 (various)	.6 - .8	$100	$3420	.21 - .27
Hilmer, 1998	1	$100	$3576	.36

Table 11.1 shows for the US studies that increases in the tuition rates with equal amounts resulted in roughly equal decreases in enrolment. However, the quasi-elasticities turn out to be very different since the mean levels of tuition - given in the third column - vary heavily. Kane's findings are about ten times lower than Leslie and Brinkman's findings. This suggests a highly non-linear relationship between tuition prices and enrolment: the higher is the tuition, the more enrolment is affected by increases in tuition.

The level of tuition fees in the Netherlands corresponds more to the Kane's (1994, 1995) analysis where effects on college enrolment are estimated. Hilmer (1998) and Leslie and Brinkman (1987) look at university enrolment. Based on the low elasticities of enrolment in the Netherlands, combined with the tuition levels in the Netherlands that are comparable to Kane's studies, we are inclined to think that the enrolment elasticity is somewhere between zero and .03. The latter corresponds to a drop in enrolment of 3% points if current tuition levels are doubled. Additional evidence based on subjective evaluation by students also suggests that effects upon enrolment are not very large, see also SEO (2000).

We present some suggestive calculations of the consequences for enrolment for the various subsidy regimes in table 11.2 based on elasticities in the interval (.01;.03). In the regimes where students are confronted with all costs, an average price increase of 687% occurs. Based on the presumed elasticities, a drop in enrolment occurs of 7%-points to 21%-points in the regime with the highest elasticity of enrolment. For the regimes $s = 2,119$ euro changes in enrolment are 5-15%-points whereas the $s = 4,237$ euro regime features drops in enrolment ranging from 3-9%-points. Increasing the private contributions for students to 25% of current total outlays gives small effects on enrolment. Clearly, potential effects on enrolment can be important. When considering a policy switch towards more private contributions in higher education, it would therefore be wise to increase private contributions only slowly and, at the same time, monitor the development of enrolment rates, especially among the disadvantaged groups.

Given that there are potential repercussions on enrolment, also savings on government outlays may be larger than presumed.

Table 11.2 Potential effects on enrolment

	dp/p (%)	dq (%)		
		$e = .01$	$e = .02$	$e = .03$
$s = 0$ euro	687	6.9	13.7	20.6
$s = 2,119$ euro	490	4.9	9.8	14.7
$s = 4,237$ euro	294	2.9	5.9	8.8
$s = 6,355$ euro	67	.7	1.3	2.0

Chapman (1997) shows that the introduction of the Australian HECS system did not produce negative effects on the enrolment of the lower income groups, see also CPB (2001a) for a more detailed discussion. Furthermore, in the Netherlands we have seen that enrolment has been steadily increasing in recent years despite lower grants and higher tuition rates. Other factors seem to be more relevant to explain this observation. Hereby one can think of increases in real incomes by parents and students (working while studying) which may have caused relaxations of credit constraints, an increased preference for education as a consumption good, or an anticipated future increase in real returns on education, see also Leslie and Brinkman (1987) for more arguments.

Whether a drop in enrolment is a social disadvantage or not depends on both positive and adverse selection effects. A positive selection effect occurs because enrolment of marginal students falls since they are confronted more heavily with the real costs of education. Adverse selection occurs if low-risk students do not want to participate anymore and if students choose more risky education types.

11.2 General equilibrium effects

If enrolment effects are important, then general equilibrium repercussions on wages and interest rates could be important as well. With respect to general equilibrium effects on the interest rate there is not an issue because the Netherlands is a small open economy in which the interest rate is determined on world capital markets.

Under perfect factor price equalisation, the relative wages of skilled viz a viz unskilled workers are determined on world factor markets, see also Topel (1999). Consequently, in a small-open economy with perfectly integrated capital and/or goods markets there are in principle no effects on relative wages. However, one can be sceptical about the strength of factor price equalisation from an empirical point of view. The work by for example Hartog et al. (1993) suggests that relative wage differences are importantly determined by (local) demand and supply factors.

Hence, changes in relative wages, and therefore wage profiles, might occur as a consequence of different enrolment decisions of students, see e.g. Katz and Murphy (1992), Heckman et al. (1998). This changes the income distribution and the incentives to acquire skills. More research with general equilibrium models as in Heckman et al. (1998) is needed to address this issue. However, we do not think that general equilibrium effects are very large in view of the low price elasticity of enrolment.

11.3 Adverse selection and moral hazard effects

With the *risk pooling* arrangements in the financing system, the standard problems of *adverse selection* and *moral hazard* with providing an insurance may arise. If the government cannot observe the riskiness of the type of student, adverse selection might occur if the good risk students do not want participate in the program, see also Nerlove (1975) and Oosterbeek (1998). The good risks can be better off by not participating since they have to pay a part of their incomes as a premium to cover to costs of default of the bad risks. The consequence is that the proportion of risky students in the total pool of students increases and the repayment rates increase accordingly. As the 'insurance' premium increases, the attractiveness of the GT or ICL system is reduced for the bad risks. Investment in human capital is reduced because the low risk students voluntarily under-insure themselves.

If the government cannot perfectly observe the actions of students and graduates moral hazard occurs. We may distinguish between a number of types of moral hazard. First, there is moral hazard relating to the risks of not earning a high enough income after graduation. Graduates may reduce their labour supply or work effort, even stop participating in the labour market, or switch to the black circuit in order to reduce or avoid the income contingent repayments. We take these effects into account in this paper, by considering effects of the repayment rate on life-time labour supply. Moral hazard could also be relevant for partners who want to raise children after they graduated rather than work. Based on our calculations we do not expect that this second form of moral hazard is of quantitative importance for repayment conditions.

Second, students are better informed about their capabilities and efforts to graduate than the government. Moral hazard occurs if the system with insurance of repayment risks induces students to reduce their learning efforts. Since students know that the costs of default are borne by their fellow students, there is a reduced incentive to study and there is too much risky borrowing accordingly. This drives up default premiums, and, consequently make the GT/ICL system less attractive. In turn, lower learning efforts may induce or worsen adverse selection problems, since worsening repayment conditions make the low risks to opt out.

Third, a form of moral hazard occurs if the repayment rate is not properly differentiated according to length of study. If repayments are not differentiated the graduates who are enrolled shortly, subsidise those who are enrolled longer. For a proper functioning of an ICL or GT, the repayment conditions should be dependent on length of enrolment to avoid distortions in education choices. Similarly, there is a case for differentiating costs of education for various education types to avoid implicit subsidies from cheap to expensive studies.

Fourth, education is not only a pure investment good but also features consumption and immaterial benefits, see also Lazear (1977) and Kodde and Ritzen (1985). Students with stronger preference for the immaterial aspects of education are perhaps also the students in more risky education types. If this is so, then financing education with full risk pooling implies that the agents with more preference for the immaterial aspects of education are implicitly subsidised by the agents with stronger investment motives. Education choices are distorted then and enrolment of consumption oriented students is inefficiently high.

The importance of adverse selection and moral hazard problems is hard to assess empirically. No real empirical evidence exists on the impact of the terms of the loan system on the risk-characteristics of the students involved in the system. The fact that no well developed capital market for education investments exists can be taken as an indication for the importance of asymmetric information. For example Rothshield and Stiglitz (1976) have shown that competitive markets may fail to exist under conditions of asymmetric information. If the government attempts to correct this market distortion, it can be confronted with similar information problems as the private market.

On the other hand, there are legal restrictions that prevent the proper functioning of private markets. In a non-slave state, claims on human capital cannot be traded. However, if there were no legal barriers, private markets would probably offer equity contracts rather than debt contracts for financing education, see Jacobs and Van Wijnbergen (2002). Since the government is the only legal authority to execute claims on human capital through the tax system, it can in fact resolve private market failures by financing investment in human capital through an equity participation scheme and recoup returns of the investment through the tax system. For similar reasons, insurance contracts cannot be executed by private parties. In addition, large transaction costs are involved in providing loans for education purposes since there is no collateral and enforcement of repayments is costly. Furthermore, these contracts may be costly from an administrative point of view given their long duration as indicated by our calculations. The government is arguably more efficient in enforcing and monitoring the repayments of the loan through the tax system. Monitoring and enforcement systems are already in place anyhow, so marginal costs of collecting repayments through the tax system go to zero.

The government may alleviate problems with asymmetric information in various ways. First, and most important is to generate more information on the risk characteristics, abilities and motivations of students. In general, the government is confronted with similar moral hazard problems as the private sector, unless it can gather the information on the 'rotten apples' in the system more efficiently that private parties. As stated above, repayment conditions should be dependent on easily observable characteristics such as length of enrolment and potentially also on the costs of education. Further, the government could select students upon enrolment and track them thereafter. The tracking is already a part of government policies ('temponorm'). Thereby the government circumvents the information problem that lies at the heart of the moral hazard mechanism. This may reduce problems with adverse selection as well. If the government can get the high risk students out of the student population, the low risk students voluntary participate, see also Oosterbeek (1998). Also, the repayments my be differentiated for graduates with different expected life-time earnings to avoid pure income redistribution, while at the same time maintaining income insurance for graduates within the same income categories. This requires that there is a sufficient number of graduates within each income category to make risk pooling possible.

Second, the effective insurance of the ICL can be reduced. The type of contract with adverse selection is that the low risk (high ability) students voluntarily under-insure themselves, or, in other words, they bear more risk. Similarly, the solution to moral hazard problems is to provide less insurance in order to strengthen economic incentives. Nerlove (1975) proposes a fixed limit on the default premium, so that repayments are never larger than principal plus interest plus the default premium. This is a so called *opting-out provision*. The possibility of opting out, provides incentives to the low risk students to participate in the program, so that adverse selection can be avoided to some extent. Further, moral hazard problems are mitigated since the benefits of loss preventing efforts are increased. An opting out provision is not a free solution because it has a price in terms of less effective insurance. Therefore, the under-investment problem due to lacking insurance, which the government attempted to solve in the first place, reappears if insurance is reduced.

The government may also offer multiple 'loan-insurance'-packages to different students. Then students can voluntarily choose the package that suits them best. Again, low-risk students want a package with less insurance and low default and solidarity premiums, whereas the high risk students want to have more insurance. This is similar to the opting-out provision. With multiple contracts potential problems may arise with horizontal equity. Some may regard multiple contracts as unjust if the type of contracts that students choose is potentially dependent on background characteristics. These may determine, for example, risk-aversion, and thereby the type of contract chosen. Principles of equality of opportunity are violated then.

Third, if the costs of default are borne by society, repayment conditions are independent of the risk-characteristics, preferences and abilities of the students. Low risk/high ability consumption students are not confronted with the costs of default of high risk/low ability students. This is the case in the Australian HECS system. Note however that this is not a real 'solution', since the average tax payer is confronted with the risks of default and the problem is simply shifted to other parties than students. There might be case for subsidies on education if moral hazard problems are reduced if people become more educated. For example, supplying less labour to avoid the repayment, has larger utility costs if one is higher educated and wage rates per hour are higher. Therefore, subsidising education may help to boost labour supply, and thereby reduce the moral hazard problem of low labour supply. This is what Arnott and Stiglitz (1990) call a 'non-pecuniary markets externality'. Fourth, participation may be *obligatory* so that low risk students have no choice of opting out and adverse selection does not occur. Most proposals of GT seem to assume that participation is indeed obligatory. This eliminates the adverse selection problem because the low risk students are obliged to participate, but introduces inefficiencies of obligatory redistribution from low risk - high return to high risk - low return students. These cross-subsidies may exacerbate the moral hazard problems – enrolment of too many high risk - low return students.

11.4 Positive selection effects

Some types of education clearly have higher monetary benefits than others, see also table 4.2. If private contributions are increased, not only the low risk graduates drop out of the system (adverse selection), but also the students with the lowest mean returns. This is what we call positive selection. These are the 'marginal students'. Since these students are confronted more with the real costs, enrolment of these groups tends to fall. If this is true, the average return to education in the student population increases, so that repayment conditions in the system become more attractive.

Again, consumption and immaterial benefits may matter. Students with stronger preferences for consumption and immaterial aspects of education are probably also the students in low return education types, see also table 4.2. One cannot explain why students pursue a low return study if there is no apparent non-economic benefit instead. We observe lower incomes of workers with particular types of education (say, art historians) compared to other workers with other education types (say, economists). Thus, incentives to enrol in types of education with more consumption and immaterial benefits are reduced if private contributions are increased, because these students are confronted with larger costs. If there are no convincing other reasons to subsidise education of non-economic oriented students, social efficiency is enhanced. Again, given the absence of any empirical evidence on these matters we cannot assess the potential strength of positive selection effects.

11.5 Accessibility effects

The question is whether lowering the subsidies and replacing these with income contingent repayments harms accessibility for students. At least theoretically there hardly seems to be a case for this mechanism to be relevant. The reason is threefold. First, the capital market imperfection is resolved so that every student with sufficient talents is able to obtain the necessary funds to enrol in education, *independently* of background conditions. Liquidity constraints for the poor are therefore avoided.

Second, enrolment of students in education types with low *returns* may be reduced in view of the larger private contributions. Low return education types are typically encountered in the 'softer' subjects (arts, languages, etc). If there are no other convincing reasons for subsidising low return education types, this drop in enrolment, creates a positive selection effects and actually improves social efficiency. The reason is that education in low earning subjects with a system of education subsidies is apparently too cheap from a private perspective and *over-investment* occurs with subsidies.

Third, large risk aversion, as a consequence of low initial wealth, ceases to be a serious problem, since all downside risks are eliminated. All redistribution of incomes goes in the direction of graduates with the most risky education types with the largest downside income *risks*. This runs counter the idea that providing ICL's or GT's for the financing of education imposes serious risks on students in the riskier education types. In fact, the graduates with little income risks are the ones who bear the costs in a risk-pooling system. These students may drop out of the system and have to self-finance their investments, cf. Rothshield and Stiglitz (1976). Low risk graduates opting for self-financing suffer from problems with imperfect capital markets and absent insurance, social inefficiencies may occur if the low risk students *under-invest*.

11.6 Administration

We did not pay attention to the administrative costs associated with the different proposals for education finance reform. Available evidence on the income contingent loan system in Australia suggests that administrative costs were as low as 1% of the total loans repaid, see Chapman (1997, p. 747). This is low given the complexity of the system. Furthermore, we expect that savings on administration costs can be made since the (ex ante) income check for income dependent grants can be abolished, see also Kane (1997, p.347). Additionally, integrating the repayments of education loans in the tax system makes it possible to save on collection costs. Marginal costs of including the repayment structure in the income tax are approximately zero. Furthermore, psychological barriers and compliance costs are lower when repayments are integrated in the tax system, so we expect that collection costs are low.

11.7 International environment

Some have expressed concerns that if private contributions in higher education are increased, an outflow of students and high skilled workers to foreign countries may take place which is harmful for the Netherlands. Distortions arise in any scheme where the intertemporal link between benefits and tax contributions is broken. I.e., a moral hazard effect may occur when academics permanently leave the country after graduation if the repayment rate in a GT or ICL is a residence based tax that can be avoided by moving to foreign countries.

It is however a matter of political choice to let the repayments in a GT/ICL take the form of a residence based tax. One may also opt for a source based GT or ICL in similar fashion as an income contingent loan to avoid the problem. Alternatively, a so called 'exit tax' can be applied for graduates that leave the country.

Note that the government is confronted with people leaving the country, for reasons of various sorts (including government policy). No matter how the financing of education is organised, governments have to deal with international movements of graduates in any case. This applies as well to, for example, the current loan scheme.

Similarly, financing conditions could be such that foreign students may be eligible for a graduate tax or income contingent loan. Again, moral hazard may occur if these graduates return to their own countries to escape the repayment obligations. This can be solved by basing the eligibility of the financing on residence principles, rather than source principles, or applying an 'exit tax'.

Moreover, increasing private contributions could also be a so called 'beggar thy neigbour policy'. Governments may shift the costs of education to foreign countries if students take up their education abroad, and *return* after graduation and work in the Netherlands. In that case, increasing private contributions increases welfare for the Netherlands.

Furthermore, the current fraction of higher educated workers that works abroad is only very low (about 2.5% for higher vocational graduates and about 4% for university graduates, see HBO Raad (1999) and VSNU (2000)). One may therefore argue whether international movements of students or graduates are of serious quantitative importance, apart from the question whether the government solves problems with evasion of repayment obligations. Both students and graduates seems to react hardly to international financial incentives for a number of reasons.

First, studies on international mobility of labour may shed light to what extent international mobility is really an issue quantitatively. Moreover, if workers respond to international differentials in incomes or unemployment rates, students may also be exspected to respond to international differences in educational costs. Studies like Nahuis and Parikh (2002), and the references therein, typically find very low estimates of international labour mobility of workers within the EU. Based on these findings, it is unlikely that increasing private contributions will induce significant labour movements.

Second, international labour movements are in fact labour supply effects. Therefore, international mobility effects on tax revenues are captured as well by the tax-elasticity of income. We took the latter into account in our analysis. Recall that estimates of labour supply elasticities are typically low and moral hazard in labour supply was not a serious problem in our analysis.

Third, students' potential responses to international differences in education costs is also indirectly related to the price-elasticity of demand for education. If the price-elasticity of demand for higher education is indeed rather low, as the figures reported earlier in this paper suggest, one should be surprised to find large sensitivity of enrolment with respect to foreign education costs.

Fourth, financial incentives are apparently to weak to provoke arbitrage flows of labour migration, since there are important non-financial factors that severely limit migration such as language and cultural barriers, social networks, family, relationships, and so on.

12 Conclusions

In this paper we have analysed the consequences of replacing government subsidies on education with a graduate tax (GT) or income contingent loan (ICL) system for the financing of higher education. GT's and ICL's are directly directed towards solving the problems with imperfect capital markets and the absence of insurance to cover the financial risks of pursuing higher education. Government resources are therefore directed towards those students facing problems in financing their education and being confronted with risks of low incomes after graduation, i.e., the potentially disadvantaged students/graduates. This is less costly than giving subsidies across the board. Further, an increase in private contributions by students can be defended on grounds of achieving a more equal distribution of incomes, to circumvent pressures on government budgets, and to increase the allocative efficiency of the educational system.

In both GT and ICL systems graduates obtain funds by the government to cover tuition and costs of living. Graduates pay a fraction of their incomes to the government in return for the funds received. With an ICL the amount of repayments has a maximum that is determined by the amount borrowed, whereas with a GT payments never stop. If a mark-up on the interest rate, a so called default or solidarity premium, covers the social losses in an ICL system, there is risk-pooling of income risks amongst graduates. We showed that the GT is therefore a special case of an ICL system with a large default/solidarity premium. The reason is that with higher default/solidarity premiums, the high-earning graduates remain in the system for a longer time and thereby contribute more to solidarity. The crucial difference between ICL's and GT's is that under a GT, the amount of income insurance and redistribution of incomes is larger because there is no ceiling on repayments. With an ICL the social risks may also be borne by society rather than the graduates. In that case default risks are shifted, which comes at the cost of achieving less savings on government outlays because (ex post) education subsidies still enter the system.

To analyse the consequences of a policy switch towards increased private contributions, we constructed a simulation model to analyse loans, GT's and ICL systems of education finance. We differentiated the financing regimes with full pooling, or (partial) risk shifting of default risks. We based our simulations on empirical estimates of the wage profiles of graduates where we differentiated the graduates according to their gender, whether they pursued higher vocational or university education, what type of education they did and we allowed for income uncertainty. Additionally, we adjusted the age-earnings profiles for labour supply and participation effects.

We analysed increases in private contributions by students from the current system to the abolition of all current education subsidies. A pure loan system served as a benchmark. Especially women run into repayment problems in a loan system if education subsidies are low. Also graduates in the low earning subjects would run risks of default. We have shown that the switch to a GT or ICL system can significantly reduce the default risks that graduates would experience if they had to finance their education under an ordinary loan system. This implies that the insurance element in an GT/ICL schemes is crucial. Notwithstanding that also redistribution of incomes takes place.

To get a quantitative idea of the effects, a net reduction in yearly government outlays on education of about 2.5 billion euro would result if education current subsidies are dropped to zero. The repayment rate in an GT is then about 6%. In an ICL system with full risk pooling - with a maximum of repayments by students - the repayment rate is higher depending on the ceiling of the repayments. The range varies from 6-10% depending on the size of the default/solidarity premium. If default risks are shifted to society the repayment rate may be lower, but this goes at a costs of a smaller reduction in government outlays. Increasing the contribution by students to about 50% of the costs would result in a GT of about 3%, and somewhat higher repayment rates in an ICL system with full risk pooling. Still a reduction in government outlays results of about 1.1 billion euro.

Under a risk-shifting regime, the government faces a trade-off between reducing ex ante subsidies on education subsidies on the one hand, and financing the costs of non-repayment (ex post subsidies) on the other hand. Nevertheless, replacing ex ante subsidies with ex post subsidies makes the resulting distribution of incomes more equal than in the current system since only graduates with insufficient incomes to repay their debts in full receive subsidies, whereas in the current system also graduates with potentially high enough incomes to repay their debts receive subsidies. Whether the government wants to give ex ante or ex post subsidies depends on the trade-off between equity/insurance and efficiency/incentives. Ex post subsidies are more equal, but less efficient because education and labour supply choices are distorted.

Our calculations of an income contingent loan system with repayment rates of 3% indicate that repayment periods are generally long (about 30 years or more) and that a substantial fraction of the graduates may not repay their debts in full. This is circumstantial evidence that the private sector is reluctant to provide education loans since administration and enforcement costs are high, whereas these problems are arguably less severe for the government when the repayment schedule is integrated in the tax system.

We took into account potential effects of the repayment rate on life-time labour supply and considered changes in the retirement age. These turned out not to be very important for the repayment conditions. Consequently, moral hazard effects regarding labour supply are not very important quantitatively. Nevertheless, net savings on government expenditures are importantly determined by the sensitivity of taxable labour income with respect to the repayment rate. The reason is that the government also looses tax revenues when labour supply is reduced. This can be mainly attributed to the fact that savings on government outlays are not rebated through for example lower taxes. The latter policy may substantially mitigate the adverse revenue effects of increasing private contributions.

Further, we investigated the potential effects of reducing the average duration of enrolment and the reduction of drop-out rates. These turned out to make the system substantially more attractive in terms of repayment conditions. This is important in light of avoiding moral hazard and adverse selection effects. We have also shown that the results are sensitive with respect to the assumptions regarding interest rates, default and risk premiums and growth rates of wages. So one has to be careful in drawing firm conclusions about the exact size of the repayment rates.

We discussed potential effects of raising private contributions upon enrolment in higher education and concluded that enrolment may decrease. We do not expect that enrolment of students with sufficient talents will decrease, but the 'marginal' students may choose not to pursue higher education. The enrolment effects are probably not very large, but empirical evidence is not very robust to vindicate this conclusion. Therefore, it seems most practical to increase private contributions only gradually while at the same time monitoring enrolment.

We do not expect that increasing private contributions will have any significant effects on international movements of graduates. And, in the case there are potential movements of graduates, there are solutions to deal with its consequences (source based repayments, or 'exit' taxes).

Finally, when a policy switch is made, a choice must be made with regards to who bears the costs of default: graduates (risk-pooling), the government (risk-shifting), or a mixture of both? If moral hazard, adverse selection and adverse incentive effects (arising from redistribution) can be avoided by means of selection and tracking mechanisms, making the repayment rates dependent on length of enrolment, the type of study and expected life-time earnings, there seems to be no need for the government to share the costs of default with the students.

However, if adverse selection/incentives and moral hazard are indeed important, the government can avoid the repercussions on repayment conditions by bearing (partially) the costs of default. This has the advantage that repayment conditions are independent from the risk-characteristics of the student population so that adverse selection is avoided, but may exacerbate moral hazard problems (high drop-out, long duration of enrolment). Further, savings on government outlays are less since education subsidies still enter the system in ex post fashion. Obligatory participation by students may also mitigate adverse selection effects. Adverse incentives can also be avoided by giving less insurance/income redistribution.

Problems with adverse incentives and asymmetric information are potentially more important in a GT system than an ICL system, because there is more insurance/redistribution in a GT compared to an ICL. More generally, the ICL features more degrees of freedom than a GT, so that policy targets are achieved more efficiently under an ICL.

Appendix A List of assumptions

- Growth rate of wages $g = .02$. Robustness checks for $g = .01$ and $g = .03$.
- Real risk free interest rate $r = .03$ per year. Robustness checks for $r = .01$, $r = .02$, $r = .04$, and $r = .05$.
- No risk premium in base-line calculations. Robustness checks for $\pi = .01$ and $\pi = .02$.
- Default/solidarity premiums ICL $\rho = 0$, $\rho = .02$, $\rho = 04$, $\rho = \infty$ (latter is equivalent to graduate tax with risk-shifting).
- No differentiation according tot differences in educational costs. Differentiation according to level of education (higher vocational/university) and length of education (β and medical education tracks).
- Flat repayment rate. Repayments not differentiated according to type of education, subject of education or sex. We do not allow for faster repayments than necessary. No income checks in general and no specific income checks for non-participants or part-time workers.
- Students receive funds equal to the current education expenditures on institutions and grants per student per year minus exogenously given education subsidies at level s euro. We vary average subsidy levels between $s = 0$ euro, $s = 2,119$ euro, $s = 4,237$ euro, and $s = 6,355$ euro. The current average subsidy level equals $s = 7,398$ euro
- Amount of funds exogenous. Robustness checks for +25% or -25% in total funds made available to students.
- Average duration higher vocational education 5 years. Average duration university education sciences and technical subjects 6 years, medical 7 years and other 5 years.
- Slopes earnings profiles invariant to education subject and labour supply effects. Slopes differ for men and women and higher vocational and university education.
- Risk classes based on estimated standard errors of residuals of wage profiles. Wages are assumed to be log-normally distributed.
- Participation index takes into account hours worked (differentiated by age and higher vocational or university education) participation rates (differentiated by higher vocational or university education), and growth in participation rates.
- Participation index $\Lambda = \Lambda_{age=26}$ if age < 26, $\Lambda = \Lambda_{age=55}$ if age > 55. Retirement age 65. Robustness checks for a retirement age of 70 years.
- All calculations based on 1997 figures except corrections for growth in participation rates.
- The model is assumed to be in the steady state and no general equilibrium effects are present (small open economy).
- $\theta = .5$ is the average marginal tax rate which is assumed to be constant. Average tax rate is assumed to be constant at .40.
- Uncompensated elasticity of life-time labour supply in base scenario: men $E = .1$, women $E = .5$. High scenario: men $E = .25$, women $E = 1$. Low scenario: men $E = 0$ women $E = 0$.

Appendix B Data

To estimate the earnings profiles we use data from 1997 on wages and education provided by the Statistics Netherlands (2000b) in the Wage Structure Survey 1997 (Statistics Netherlands, Loonstructuur Onderzoek (LSO) 1997). This data set contains information on earnings, education levels, work experience, job characteristics, etc. for working males and females. The total number of observations is about 150.000. We only use data on higher educated workers, which leaves us with about 35.000 observations.[1]

Wages are gross monthly earnings. For the estimation of the earnings profiles we computed hourly wages based on reported hours of work. Then hourly wages are converted into yearly wages by multiplying hourly wage rates with a measure of total hours worked in a year based on full-time employment. We take for this measure 1600 hours which is derived from a working year consisting of 40 weeks of 40 hours of work.[2] We use the log of the yearly wage in our estimations in conformity with the literature, see e.g. Becker (1993).

Statistics Netherlands provides data on education levels that are based on the standard education classification (Standaard Onderwijs Indeling), see also Statistics Netherlands (1993). For our purposes we transform the education classification to the so called HOOP classification used by the Dutch Ministry of Education (HOOP is an abbreviation of the Higher Education and Research Plan). This classification consists of eight aggregate subjects for university education: agriculture, sciences, technical, health, economics, law, behavioural and social subjects, and languages and culture. For higher vocational education essentially the same categories are used. For higher vocational education we use an extra category for education to become a teacher and we drop the sciences category.[3]

Next, we adjust the estimated earnings profiles for differences in labour supply. To that end we employ additional data. First, we use data from the Labour Force Survey 1997 (Statistics Netherlands, Enquete Beroepsbevolking (EBB) 1997) conducted by Statistics Netherlands (2000c) on labour force participation. Participation rates are defined as the fraction of the (random) sample that belongs to the working population, i.e., persons that are either working, or planning to be working, or actively searching for work for at least 12 hours a week. We were not able to disentangle the effects further to the various types of education as the EBB only uses a classification of technical, economic, health and other types of education.

Second, we use data on hours worked. These are also taken from the LSO'97 data provided by Statistics Netherlands (2000b). We take as a measure of labour supply the total hours worked in a year. Third, we adjust the earnings profiles for increases in labour force participation. An

[1] We excluded post-doctoral workers.

[2] Average labour supply for males at the university (higher vocational level) equals 1566 (1551) hours per year, see table D.1. Therefore, we think that 1600 hours is a good approximation for a full-time job.

[3] We constructed a concordance between both classifications that is available upon request from the author.

update of the data provided by the Statistics Netherlands/CPB Netherlands Bureau of Economic Policy Research (1997) is used to project growth in participation rates.

For the computations of the various policy experiments we use data on enrolment in higher education by type of education, HOOP-classification and gender from Statistics Netherlands (1999). Further we added data on the costs of education per student (grants, cost prices of education, and tuition rates) in various HOOP area's provided by the Dutch Ministry of Education (2000, 2001).

Appendix C Estimation earnings profiles

We estimate earnings profiles of graduates separately for men and women, and for higher vocational and university education. We adjust these wage profiles by taking into account labour supply decisions, participation rates, and the growth in participation rates, to correct the future earnings streams of graduates. In our analysis we differentiate between various types of education. It is expected that earnings profiles differ for the various subjects that students have chosen.

We estimate standard OLS regressions of Z-th order polynomial age-earnings profiles with fixed effects for every education type. Our estimating equation reads as follows:

$$\ln(wage) = const + \sum_{j=1}^{8-1} \alpha_j dum_j + \sum_{z=1}^{Z} \beta_z^z exp_j^z + \varepsilon,$$

where the dependent variable is the log of yearly gross wage income.[1] dum_j is a dummy variable equal to 1 if education type is $j = 1, ..., 8$. (Note that we drop one dummy for the last category in the estimations). exp_j is years of working experience. α and β are the parameter vectors to be estimated. ε is an error term.

Murphy and Welch (1992) argue that a quadratic wage profile misses some essential aspects of the age earnings profile. Therefore, we estimate a more flexible functional form with higher order terms. In order to determine the degree of the polynomial function we first estimated a age-earnings profile over the whole sample with age-dummies for every age. On the basis of this estimation we computed the predicted wage profile. Next we estimated a Z-th order polynomial profile and computed the predicted wages. We compared the predictions of both wage profiles and found that after the fourth order only marginal improvements in predictions were found. Lower order wage profiles turned to miss essential characteristics at the tails, i.e., at low or high levels of experience.

We do not estimate separate slope coefficients on experience for each education type since the number of observations in each 'age-type' cell is too low to obtain precise estimates on the experience terms. Only by reducing the number of estimated coefficients for experience to a quadratic wage profile one can obtain relatively precise estimates. This procedure has a large cost because a quadratic wage profile does not represent the actual pattern of life-cycle incomes very well. Consequently, we chose to do a fixed effects estimation.

We define the experience variable as follows. We subtracted from age, the approximate age at which the labour market is entered. We assumed that each higher vocational graduate starts to work at the age of 22. This is based on the notion that secondary education to enter higher vocational education (HAVO) ends at age 17 and the presumed duration of higher vocational education is 5 years. University graduates start one year later at the age of 23, since secondary

[1] Note that the yearly gross wage is a linear transformation of hourly wage rates (based on 1600 hours per year) so that labour supply effects do not enter here.

education to enter university takes one year longer (VWO). We maintain the assumption that it takes 5 years to complete an university education except for three education types. University graduates with a beta-education (science or technical) start to work at the age of 24 and university graduates with a medical education start working at age 25. The latter exceptions reflect the respective longer durations of their education.

Table C.1 gives the estimation results for men and women with higher vocational and university education types respectively. In general, our variables of interest are highly significant at conventional confidence levels.

Table C.1 Estimation results. Dependent variable is log yearly wage.

	Higher vocational		University	
	men	women	men	women
Agriculture	0.119	0.052	0.27	0.166
	(0.023)***	-0.051	(0.034)***	(0.057)***
Sciences			0.245	0.165
			(0.027)***	(0.046)***
Technics	0.207	0.006	0.365	0.288
	(0.012)***	-0.031	(0.024)***	(0.051)***
Medical	0.075	-0.064	0.335	0.219
	(0.018)***	(0.014)***	(0.033)***	(0.035)***
Economics	0.251	-0.011	0.383	0.225
	(0.011)***	-0.016	(0.024)***	(0.039)***
Law	0.126	-0.023	0.351	0.186
	(0.023)***	-0.038	(0.028)***	(0.034)***
Social & behavioural	0.057	-0.066	0.088	0.077
	(0.014)***	(0.014)***	(0.023)***	(0.025)***
Teacher	-0.066	-0.143		
	(0.025)***	(0.033)***		
Exp	0.157	0.163	0.135	0.146
	(0.006)***	(0.006)***	(0.011)***	(0.014)***
$Exp^2/100$	-0.856	-1.157	-0.669	-0.912
	(0.061)***	(0.069)***	(0.108)***	(0.165)***
$Exp^3/10000$	2.297	3.499	1.748	2.618
	(0.241)***	(0.297)***	(0.418)***	(0.715)***
$Exp^4/1000000$	-2.300	-3.695	-1.727	-2.675
	(0.315)***	(0.414)***	(0.541)***	(1.020)***
Constant	2.865	3.072	2.992	3.089
	(0.020)***	(0.019)***	(0.039)***	(0.043)***
s.e.e.	.448	.526	.428	.48
Observations	13560	11113	5664	3050
R-squared	0.33	0.19	0.36	0.22

Standard errors in parentheses.
* significant at10%; ** significant at 5%; ***significant at 1%.
Note: Teacher is the reference subject for higher vocational education. Arts, culture and languages is the reference subject for university education.

Appendix D Labour supply effects

We correct the wage profiles for differences in working time, participation rates, and growth in participation rates.

D.1 Hourly labour supply

Table D.1 shows the average number of hours worked per year ordered by education type for men and women respectively. The first thing to notice is that labour supply for males is by and large the same for various subjects at the higher vocational levels. Inspection of the figures reveals that men work approximately full-time. The only exception is the category 'arts' where labour supply is substantially lower. A similar pattern for men can be found at the university levels of education.

Table D.1 Yearly labour supply in hours by type of education.

	Men		Women	
	Higher vocational	University	Higher vocational	University
Agriculture	1569	1626	1308	1359
Science		1606		1273
Technical	1625	1646	1275	1586
Medical	1444	1542	1106	1305
Economics	1610	1630	1384	1513
Law	1502	1599	1161	1449
Social & behavioural	1473	1459	1189	1199
Arts	1146		1016	
Lang. & cult.		1428		1231
Teachers	1512		1129	
Average	1551	1566	1185	1288

Source: Statistics Netherlands (LSO, 1997).

As expected, women work less hours than men both at the university and the higher vocational education levels. At higher vocational level labour supply is about 15-20%-points lower, whereas somewhat smaller differences with men are found at the university levels of education. Again, labour supply is the lowest in the arts category. Female labour supply for the classes agriculture, sciences, technical, economics and law is systematically higher than for the 'softer' categories health, behavioural and social, arts, languages and culture and teachers.

D.2 Hourly labour supply over the life-cycle

Table D.2 shows labour supply for various age-classes. These figures are not surprising either. Male labour supply increases at the beginning of the life-cycle, and drops after the age of 55 for both higher vocational and university education. Figures for female hourly labour supply show that the drop in labour supply occurs around the age of 35 years, whereas it remains relatively constant thereafter.

Table D.2 Yearly labour supply in hours by age.

	Men		Women	
	Higher vocational	University	Higher vocational	University
age $\leq$ 25	1122	1447	1132	1222
25 $<$ age $\leq$ 35	1581	1613	1292	1382
35 $<$ age $\leq$ 45	1591	1597	1117	1218
45 $<$ age $\leq$ 55	1594	1550	1160	1166
age $>$ 55	1484	1435	1008	1231
average	1551	1566	1185	1288

Source: Statistics Netherlands (LSO, 1997).

D.3 Participation

The labour supply figures were based on working individuals only. However, we have to correct for labour force participation as well, since not everyone is working after graduation due to voluntary exit from the labour market or unemployment. Table D.3 shows participation rates for men and women at higher vocational and university education for various age classes.

Table D.3 Participation rates by age.

	Men		Women	
	Higher vocational	University	Higher vocational	University
age $<$ 25	.60	.80	.71	.77
25 $<$ age $\leq$ 35	.93	.93	.80	.85
35 $<$ age $\leq$ 45	.97	.96	.69	.80
45 $<$ age $\leq$ 55	.92	.93	.64	.75
age $>$ 55	.39	.54	.23	.45
average	.85	.89	.67	.79

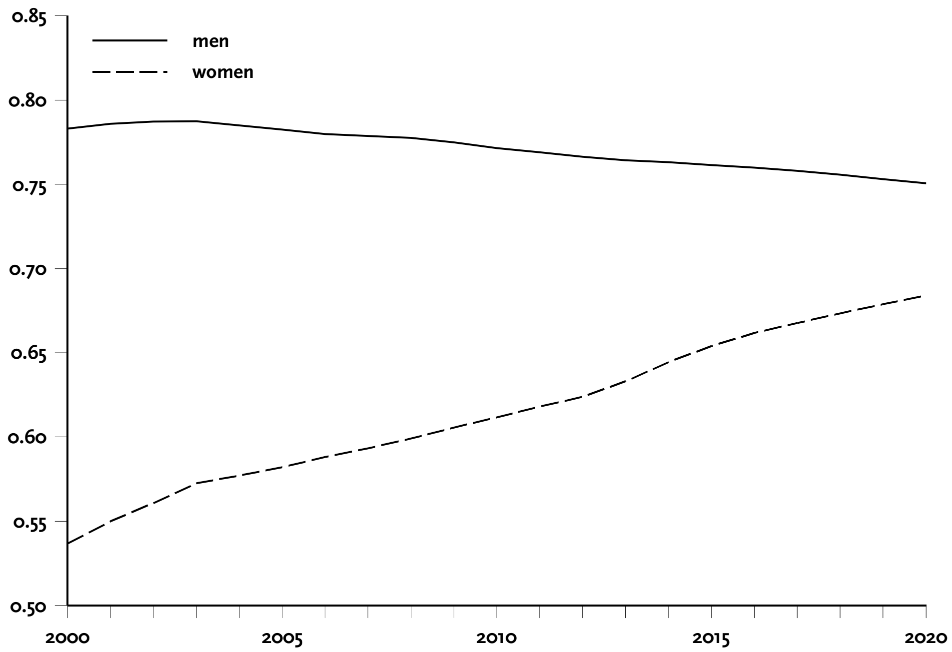
Source: Statistics Netherlands (EBB, 1997).

The pattern in table D.3 is well known. Labour force participation first increases and then decreases with age. For men the substantial drop in participation rates occurs after the age of 55, whereas for women a first drop occurs at the age of 35, and then a second drop in participation can be seen at the age of 55. Labour force participation rates for men at higher vocational and university education are roughly comparable. The differences lie in the fact that men at university levels of education start to participate earlier and remain to participate at higher rates when they are old.

The latter observation also holds for women. University educated women participate more when young and older. The major reason for the relatively low participation rate of women with higher vocational education is due to the fact that the first drop in labour force participation (at the age of 35) is much larger than for women with university education.

Projections for the future reveal that labour force participation rates increase. Only modest increases in labour supply of men are expected in the early years of the 21th century that level off, later on. For women the increases are more substantial. Figure D.1, based on Statistics Netherlands/CPB (1997), shows these trends.

Figure D.1 Participation rates 1998-2000



In order to relate the trend in labour supply to our figures of labour force participation we construct an index (1997=1) of labour force participation. We are not able to differentiate the aggregate trends in labour force participation between the various education levels, only age classes. As such, we cannot compare aggregate participation rates with participation rates of higher educated workers as the latter are much higher than the former. By using an index we attempt to correct for this trend. This procedure could generate an upward bias in participation growth because the participation rates of higher educated workers is already high and therefore probably less likely to increase at the same rate as the aggregate participation rate.

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