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VARIABLE TERM LOANS FOR HIGHER EDUCATION—ANALYTICS AND EMPIRICS*

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In the context of unsettled financial condition of institutions of higher education and concern over the effectiveness of existing public programs for the achievement of equality of educational opportunity, increasing attention has been given to a class of student credit instruments distinguished by repayment based on the future income of the borrower. Originally proposed by Milton Friedman and endorsed by the Zacharias Panel on Educational Innovation, implementation has now been announced by Yale and Duke Universities and is being sought by the Governor of Ohio. Given this interest, it is important that the underlying implications of the continuum of income contingency arrangements be systematically explored.

The purpose of this paper is the identification of the generic characteristics of one set of such income-contingent-repayment instruments: the variable term loan (VTL). Section I briefly examines the history and rationale of such a program. The VTL model is developed analytically in Section II. The data required for the solution of the model are developed in Section III. Section IV then solves the model for a continuum of "zero-profit" programs and compares programs incorporating alternative structural features. Section V examines the income redistribution features or incidence, and Section VI the capital requirements of a selected set of programs.

I. INTRODUCTION

It is beyond dispute that we are currently witnessing a major financial crisis in higher education. As portrayed by the Cheit Report, this crisis is, with minor exceptions, all pervasive, affecting or imminently threatening public and private institutions, large universities, and small colleges.[1] This current crisis is particularly significant in the context of the growing efforts to extend and insure equality of educational opportunity: to make access to post-secondary education a function only of academic ability, not of ability to pay. It is the threat to educational opportunity posed by the present financial crisis that underlies the present interest in innovation and reform.

The central fact in the present financial situation of higher education is that the cost to the student (tuition and other fees *and* foregone income) will not be reduced and in fact will probably increase significantly. With rising costs and shrinking endowments and with government education budgets under pressure from competing social claims, ever greater proportions of the cost are being passed on to students. In this situation, virtually any new financial option for students would help to ease some of the economic grimness in higher education.

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[1] Earl Cheit, *The New Depression in Higher Education*, Carnegie Commission Series, February 1971, McGraw-Hill.

The central concept of interest here is proposal made by Milton Friedman over a decade ago for financing a student's costs of higher education by extending credit against a promise of long-term payment of a percentage of annual income.[2] The first comprehensive plan of this sort came in 1967 from a Panel on Education Innovation chaired by Jerrold Zacharias of M.I.T. The Panel called for the creation of an "Educational Opportunity Bank" chartered by the federal government and empowered to borrow at government rates. The Panel recommended that students be allowed to borrow up to total tuition, fees, and living costs. The borrower would pledge to pay a fixed percentage of his annual gross income. Preliminary figures suggested that such a Bank, with access to funds at federal interest rates, could be self-sustaining if the repayment was 1 percent of gross income for each $3,000 borrowed, and the term of payment 30 years.[3]

The present analysis has as its objectives the delineation of the generic characteristics of an income-related-payment or variable term loan program and the development of a set of financially viable specific-options.

The remainder of the introduction considers the rationale for a development of the variable term loan concept and examines briefly two particularly controversial features of income-contingent loan programs: the implied redistribution of educational costs and the likelihood of adverse self-selection of participants. The analytics of the variable term loan are then briefly explored in Section II. Section III develops the underlying data base required for the identification of financially viable variable term loan alternatives. Section IV then "solves" the system for a continuum of consistent programs. Section V examines the income-redistributive incidence and Section VI the capital requirements of various programs.

Conceptual Origins and Rationale

This type of variable term loan (VTL) program has a number of implications for students; the most important relate to improved access of students to funds for the financing of higher education.

1. *Imperfections in the human capital market.* Unlike credit for investment in productive physical capital, which is readily available, the market for credit for investment in human capital is, with a few very narrow and imperfect exceptions, non-existent. The individual student finds it almost impossible to tap those sources of credit available to the corporate investor in plant and equipment; although both are borrowing against future income, the investor in physical capital has the capital stock itself as collateral, while the student (subject to strictures against involuntary servitude) has only his income prospects.

Furthermore, even when it is possible for the student to borrow for educational investment, the terms are grossly non-optimal with respect to the flexibility and

[2] Milton Friedman, in R. A. Solo, ed. *Economics and the Public Interest* (New Brunswick: 1955); also, "The Higher Schooling in America," *The Public Interest*, Spring 1968.

[3] *Educational Opportunity Bank*: A Report of the Panel on Educational Innovation (Washington) D.C.: U.S. Government Printing Office, August 1967). The Panel's proposal was subjected to more detailed analysis in Karl Shell *et al.*, "The Education Opportunity Bank: An Economic Analysis of a Contingent Repayment Loan for Higher Education," *National Tax Journal*, Vol. XXI, No. 1 (March 1968).

timing of repayments. In effect, his borrowing is restricted to some form of a personal loan requiring fixed repayments. At best he can anticipate the initiation of repayment at the end of his student or military career. At worst, he must pay at least interest on his borrowing from the time he accepts the loan. In either case the burden is greatest when his ability to pay (income) is least. The effect of these capital market imperfections is even greater in context of the apparent general desire to redistribute lifetime consumption toward earlier ages, when a confluence of life-cycle and other factors (risk avoidance, etc.) serve to raise the marginal utility of consumption, while the lifetime income profile displays rising incomes with age and experience.[4]

In short, investment in human capital is treated by the conventional credit market in the same terms as a personal consumption loan, while the expenditure is more similar to investment in productive capital than to payment for current consumption benefits. These restrictions on the forms of student borrowing are a major explanation of the well-documented inhibitions which many students express toward this form of educational finance. Furthermore, even given these inhibitions, the supply of the more desirable student loan funds is significantly less than current demand.

2. *Dependence on current ability to pay.* As a result of the foreclosure of the credit market as a source of funds for investment in education, access to higher education is to a high degree a function of current family income and wealth. The effect of this current means constraint on the socioeconomic composition of the student (or, more importantly, the non-student) population is obvious.

3. *Risk avoidance in the assessment of benefits to higher education.* Even when credit is available on reasonably acceptable terms, the student (or potential student) may weigh heavily the risks of shortfall in future income, especially relative to the fixed repayments. This would be expected to be particularly true of students whose experiences have led them to a skeptical attitude toward their future prospects and whose information concerning these prospects is most imperfect. Again, the socioeconomic impact is obvious.

4. *Improved self-selection of students.* The existing system of higher education finance almost insures that the student will bear only a small part of the total cost of his education. In consequence, the student has few incentives to refuse education or seriously consider other alternatives, especially if his parents' ability to pay is sufficiently great to offset, for him, foregone earnings. This improved self-selection is, then, the mirror image of point 2, above. By placing a substantial part of the cost of education on the student himself, and by breaking the relationship between current financial status and access to education, efficiency can be expected to improve both from the inclusion of previously excluded students and from the voluntary exclusion of some of those previously included.

5. *Secularly increasing real costs of higher education.* Ostensibly as a result of the effort to maintain educational quality, higher education represents to some degree a technologically stagnant sector in a non-stagnant economy. Thus, input per student has not undergone any major secular change, while productivity in

[4] On the optimal distribution of consumption, see Lester C. Thurow, "The Optimum Lifetime Distribution of Consumption Expenditures," *American Economic Review*, Vol. LIX, No. 3 (June 1969).

other sectors has increased continuously. As a result, cost (per unit of input and per student) has been rising and can be expected to continue to do so. Obviously, this is a particularly serious constraint in light of the previously mentioned imperfections in the market for higher education.

6. *Refusal of the broader society to directly compensate for these imperfections and constraints.* These difficulties associated with access to higher education and with educational finance could be overcome by direct social intrusion. Society could redirect resources to higher education (via, e.g. highly subsidized student loans) and could require appropriate changes in relative access. However, it has not done so. In the absence of some new initiative the strains on educational institutions will increase and the adverse effects of existing imperfections will be magnified.

Redistribution of Educational Costs Effected by the Plan

The central characteristic of an income contingency plan is that it relates the costs of education to the ability to pay. For the individual student it relates repayments in any year to income in that year; this is very different from conventional student loans which impose fixed repayments concentrated in the student's early, low-earning, high-desired consumption years. Thus the student, through the plan, is given access to the capital market on flexible repayment (quasi-equity) terms.

More fundamentally, the program imposes higher absolute burdens on those participants who realize higher incomes. For a number of students this is a very desirable feature. A major source of student unwillingness to borrow on conventional terms is uncertainty regarding future occupation and future income prospects. The risks to the student of investment in education are reduced through an effective risk-sharing pool: although his repayment may be greater than average if his income is high, short-falls in income reduce the absolute cost of education.

Thus, the program can be interpreted as a partial insurance against low income. Further, only through this risk-sharing pool can the credit market be tapped for educational investment. A "risk neutral" student with average income expectations is indifferent to variable versus fixed repayments; a "risk-avoiding" student prefers variable to fixed repayments. Only a "risk-seeking" student, or one with significantly above average income expectations, would prefer fixed repayments.[5]

Another interpretation of the plan is that of a beneficiary tax for the support of higher education, a tax relating payments to the financial benefits the student derives from his education. The VTL plan moves only partially in this direction. Most importantly the plan is not a general tax in that individuals may choose, by paying current tuition, not to participate. However, the greater burden on a high income participant relative to his counter-part non-participant is limited by the exit provision, which insures that he will not repay more than some maximum amount. This limited horizontal inequity may be off-set by the improved access to and terms of borrowing to finance education. If the plan were extended to a

[5] These statements must, of course, be qualified with reference to the specific terms of the payment provisions and the student's subjective probability distribution over alternative future incomes.

universal beneficiary tax it might be desirable to significantly increase the maximum liability of high income students.

Thus, the VTL plan has characteristics of both a tax and insurance. Because the income expectations of all potential participants are not identical and because appropriate alternative sources of finance are not provided by financial markets, the tax features necessarily but imperfectly intrude.

Adverse Selection of Participants

A major concern with respect to an income related payment plan is that the self-selection of participants would lead to concentrations of participants with very low income expectations, which, if unanticipated, could lead to the financial failure of the plan. Several considerations suggest that this would not be a serious problem:

1. It is not clear that an individual's income expectations, particularly for undergraduates, are at all well-founded, except in the case of those who expect to inherit substantial wealth. These individuals would be assumed not to participate. In consequence, only earned income, not income from wealth or family income, has been considered in deriving the income profiles used in the financial analysis.

2. Scholarship students can be expected to be significantly more highly represented, since *any* level of fees is most burdensome to this group. It might be expected that the income experience of this group would diverge from that of all students (on which basis the income projections would probably be made). Evidence from a study of Harvard graduates suggests that this would not be the case; students who received financial aid had approximately the same mean *earned* income as did non-aided students, although the shape of the distribution was somewhat different (higher representation in the lower and upper tails of the distribution). This is a major rationale for using only earned income in the construction of the income projections of participants.

3. While significant adverse selection, particularly in the graduate and professional schools, might be expected if alternative, flexible means of aid were available, in fact, such instruments are not available. That is, it is believed that the major advantages of the plan, relating repayment to the ability to pay over the individual's lifetime, are sufficient to lead even students with relatively high income expectations to prefer the variable repayment plan to the type of conventional loan available commercially.

Because of the above considerations and of the desire not to bias potential experiments by anticipating adverse selection (and thus creating a self-fulfilling prophecy), virtually no self-selection by future income has been anticipated.

II. Variable Term Loans: A General Analysis

Summary of VTL Characteristics

The student would receive a loan at a stated interest rate and would agree to repay in installments defined as a fixed percentage of his adjusted gross income for the preceding year. He would continue to repay until he had discharged his debt or until he had reached the *termination year*. At the termination year any further liability of the student would be forgiven.

The various loan options available to students could differ in (a) stated interest rate, (b) repayment "tax" rate, and (c) maximum repayment period. Thus, variations in terms, e.g., a lower repayment tax rate, would have costs, e.g., a higher interest rate. These compensating variations in terms derive from the application of a zero-profit condition in program derivation. In the following it is assumed that the future incomes (income distributions) of participating students would be the same for each of the program variants, i.e. that negative selection between VTL options would not be observed. The problems posed by self-selection of students among the available programs are discussed below.

The Analytics of VTL

Given:

(1) $\bar{r}$, the interest rate (including allowance for administrative and collection costs) *at which the program is funded* (the external interest rate);

(2) Y, a matrix of participant incomes by repayment year (participants measured in standard units of debt outstanding at the initiation of repayment).

Parameters:

(1) r, the interest rate charged the student participant (the *internal* interest rate);

(2) N, the maximum repayment period;

(3) t, the repayment "tax" rate.

The determination of any two parameters, plus the "financial viability" condition, i.e. a breakeven program, determines the values of the third. That is, only two parameters are independent.

Resultant characteristics:

(1) M, the anticipated average or "expected" repayment period;

(2) S, the internal subsidy incorporated in a program, redistributed from high to low income participants.

Zero Profit-Loss Condition, the "financial viability" condition subject to which parameters are determined:

$$\pi = 0 = f(r, t, N; \bar{r}, Y) \qquad (1)$$

Briefly stated, the parameters of a program which must be defined are the maximum repayment period, the interest rate charged the student, and the repayment tax rate. Given these, it is possible to estimate or predict two additional characteristics of the program: the expected or average repayment period, i.e. the length of time required by the average student to discharge his debt (less than or equal to the maximum repayment period) and the degree of internal subsidization (from high income to lower income former students). These are the particularly important features of which the student should be informed in guiding his choice among the available options. The expected incomes of the student participants and the interest rate at which the program is funded (including administrative cost and mortality factors) are necessary inputs into the determination of financially viable parameter sets.

Equation 1 provides an implicit relationship between r, t, and N, given $\bar{r}$ and Y. In equation 2, this relationship is made explicit:

$$(2) \qquad r = g(t, N; \bar{r}, Y)$$

$$\frac{\partial r}{\partial t} < 0, \qquad \frac{\partial^2 r}{\partial t^2} > 0$$

$$\frac{\partial r}{\partial N} < 0, \qquad \frac{\partial^2 r}{\partial N^2} \gtrless 0$$

(depending on rate of income growth and discount rate). The relationships embodied in equation 2 are portrayed graphically in Figure 1.

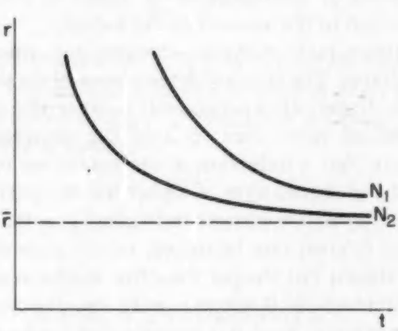

Figure 1 Zero-Profit *r-t-N* Combinations

Specifying the maximum repayment period, a schedule of financially viable interest rate (r)—repayment tax rate (t) combinations can be identified (equation 1); these combinations are consistent with a zero-profit/loss program. The general characteristic of this schedule is that reductions in the repayment tax rate must be compensated by increases in the internal (student) interest rate: reductions in the tax rate result in greater "losses" on "non-completers" (those who do not discharge their debts within the maximum repayment period), i.e. in a larger pool of non-completers and in greater shortfalls from previous non-completers, with these losses made up from the higher interest burdens placed on those who do complete. Thus, as the tax rate is reduced, the viability of the program is maintained by increasing the differential between the students' interest charge and the interest rate at which the program is funded.

Reductions in the maximum repayment period, implying lower total payments by "non-completers" (the lowest income participants), thus require compensating increases in the tax rate and/or the student interest rate. As a result the zero-profit *r-t* loci shift up and to the right with reductions in the maximum term.

The average repayment period, M, is determined as a function of the basic program parameters, i.e.

(3) $M = M(t, N; Y)$; r, determined by t and N in equation 2, does not appear explicitly.

$$\partial M/\partial t < 0$$

$$\partial M/\partial N > 0$$

$$(\partial M/\partial r)_t = (\partial M/\partial N)/(\partial r/\partial N) > 0.$$

Again holding the maximum repayment period constant, reductions in the interest rate compensated by increases in the tax rate reduce the average or expected repayment period: higher income participants exit sooner both because of the higher annual payments resulting from the higher tax rate and because their outstanding balances are accruing interest at a lower rate. The lower income participants either exit when they would previously have been held in the program for the maximum period or are unaffected in terms of their period of liability, although they are affected in the amount of the liability.

Even with the above restrictions iso-expected-repayment-period loci could take on a number of shapes. The primary determinant of the shape is the dispersion in participant incomes. If there are a substantial number of low income participants paying for the maximum term, then to hold the expected repayment period constant would require that a reduction in the maximum term be compensated by a lengthening of the observed term of higher income participants to offset the shortened term of liability of low income individuals, i.e. the tax rate would have to be reduced and the interest rate increased. In this case the M-constant locus would be negatively sloped but steeper than the break-even r-t loci, cutting the latter from below. Alternatively if incomes were less dispersed, with few participants paying for the maximum term, it is possible that a reduction in the maximum term accompanied by increases in *both* the interest and tax rates would leave the expected repayment period constant, i.e. the iso-expected-repayment period loci would be positively sloped. The alternative conceivable iso-expected repayment period loci are portrayed in Figure 2.

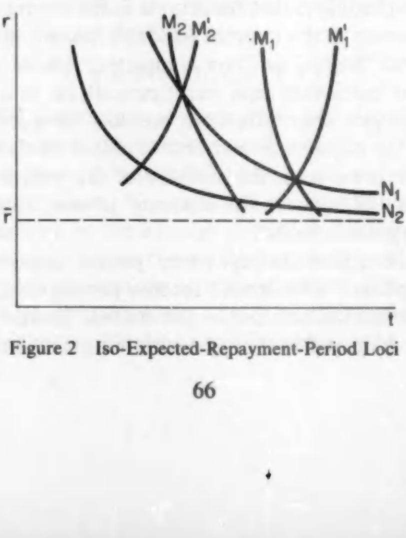

Figure 2 Iso-Expected-Repayment-Period Loci

The implicit subsidy, from high to low income participants, is similarly a function of the underlying parameters. For present purposes, the subsidy can be operationally defined as the *ratio* of the present value of the excess payments of high income students to the total loans to the group of borrowers:

$$S = \sum_{j=1}^{Z} \left[\sum_{i=1}^{\min(N,Q)} ty_{ij}(1 + \bar{r})^{-i} - P \right]_{\text{abs}} \Big/ 2PZ$$

where P = the base borrowing amount, to which the tax t is linked (assuming no lag from time of borrowing to repayment initiation);

Z = the number of "base amount borrowers";
y_{ij} = the income of borrower j in year i;
Q = is defined as that year in which the individual borrower's repayments fulfill the condition

$$P = \sum_{i=1}^{Q} ty_{ij}(1 + r)^{-i},$$

where r is the stated student interest rate, greater than the funds borrowing rate, $\bar{r}$; and abs means the absolute value of the expression in parenthesis.[6]

The subsidy thus defined is again a function of the program parameters t and N, and implicitly r, as in equation (4).

$$(4) \qquad \begin{aligned} S &= \dot{S}(t, N; Y) \\ \partial S/\partial t &< 0 \\ \partial S/\partial N &< 0 \\ (\partial S/\partial r)_t &= (\partial S/\partial N)/(\partial r/\partial N) > 0. \end{aligned}$$

The general shape of the iso-subsidy loci is more determinate than that of the iso-expected-repayment-period loci. First holding the maximum term constant, an increase in the tax rate, accompanied by a compensating reduction in the internal interest rate, results in a reduction in subsidy: high income participants exit sooner at lower interest rates (the contribution to subsidy being a function of (1) the *difference between* the internal and external interest rates, and (2) the period of time over which this differential is paid, actually of the weighted average outstanding balance)[7] while low income participants pay at higher tax rates for up to the full period. Then, to achieve the former level of subsidy at the new, higher tax rate, the maximum term must be reduced, reducing the payments of low income participants, and this reduction in term must be compensated by an increase in the internal (student) interest rate, resulting in greater subsidy contribution from higher income participants. Thus, the iso-subsidy loci will be positively sloped as shown in Figure 3.

[6] A more realistic, but complex, formulation of the subsidy is utilized in Section IV, taking into account interest accrual during the lag from time of borrowing to repayment initiation.

[7] The weight is $(1 + r - \bar{r})^i$, representing the value to the program of the interest differential paid in any future year. This expression is an approximation of $[(1 + r)/(1 + \bar{r})]^i$, but for r and $\bar{r}$ small the above expression is sufficiently accurate.

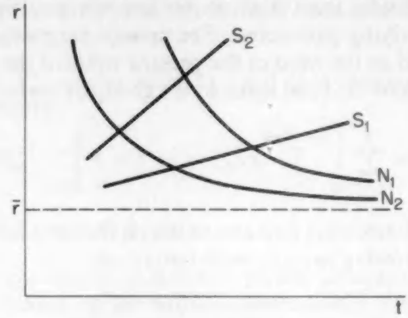

Figure 3 Iso-Subsidy Loci

Income Projections, Adverse Selection and Experimental "Neutrality"

Each of the zero-profit programs differs in a specifiable direction in terms of the degree of subsidy provided low income participants by their high income counterparts. This would suggest that high income expectors would be more likely to choose the lower subsidy program, *ceteris paribus*. In fact, of course, other things are not equal; the change in subsidy is the result of simultaneous, compensating changes in tax rates, interest rates, and maximum and average repayment periods (or some subset of these). Thus, it is not clear that students expecting high incomes would choose the less subsidizing option. However, the expectation that students *might* systematically self-select among alternatives might seem to recommend that, in the interest of financial viability, the income projections of the higher internal subsidy options should be adjusted downward relative to the lower subsidy options, i.e. that adverse self-selection should be anticipated. The problem with this course of action is that it could well be a "self-fulfilling prophecy:" the expectation of adverse selection would lead to a relative adjustment in program parameters which would reinforce and increase the incentives of students anticipating high incomes to enter the lower subsidy program.

In consequence, experimental programs should be based on "neutral" income projections, i.e. the income projections underlying the alternative options should be identical. The response of students with different income expectations to the alternative options, and the relative income experience of participants in each program would then provide information on the degree of self-selection and the importance of particular variations in terms.

III. Time of Borrowing, Educational Attainment and Future Income of Borrowers

To design a financially viable (zero profit) VTL program it is necessary to estimate the lag from the time of borrowing to the time of repayment initiation and the future incomes on which annual repayments will be based. Because the national-sample income data is identified by educational attainment, this procedure is broken into two stages: distributing borrowers by time of borrowing and educational attainment, and then distributing amounts borrowed (including interest accrued to time of repayment initiation) to educational-attainment-specific income profiles.

The distribution by time of borrowing and amount borrowed begins with some basic statistics on cohort retention ratios and educational attainment. Unfortunately, these data are fairly sparse, and significant interpolations and judgements must be made.

** 42 percent of freshmen entering into full-time study do not receive a baccalaureate degree.

** 43 percent of baccalaureate graduates *enter* graduate or professional schools.[8]

The judgementally interpolated retention profile is given in Table 1.

TABLE 1

COLLEGE ENTRANT RETENTION PROFILE

Year	Number of Entrants	Number of Exits	Comment
1	100	25	
2	75	10	
3	65	5	
4	60	31	2 drop before end of year; 58 receive baccalaureate degree; 29 enter post-graduate program.
5	29	6	6 drop before completing 5th year.
6	23	15	
7	8	2	
8	6	6	

Forty-two do not complete baccalaureate degree.
Thirty-five cease after baccalaureate degree or do not finish fifth year.
Twenty-three obtain at least one full post-graduate year.

The analysis assumes stability in the size of entering freshman classes. More significantly, it assumes equal *rates of participation* at all levels. While participation rates are not in fact known, assuming that they will be equal at all levels rests on (a) a claim of ignorance (no particular adjustment can be rationalized) and (b) the reasonable hypothesis that while income prospects of post-graduate students are higher (as is probably also true of current economic status of parents) their financial capabilities have been significantly reduced as a result of a protracted period of schooling.

Given the retention profile for each year's borrowers it is then possible to estimate the distribution of borrowers by class-year of borrowing, lag to repayment, and ultimate educational attainment (Table 2). Table 3 converts this to a distribution of a standard $1,000 unit of original borrowing.

[8] Robert H. Berls, "Higher Education Opportunity and Achievement in the United States," pp. 161, 169, Joint Economic Committee papers on *The Economics and Financing of Higher Education in the United States*, U.S. Government Printing Office, Washington 1969. Further data relevant to the interpolation–extrapolation of the complete retention profile were developed from a number of sources by Nicholas Triffin of the Ford Foundation.

TABLE 2

CLASS YEAR OF BORROWING, LAG TO REPAYMENT, AND ULTIMATE EDUCATIONAL ATTAINMENT

Number of Years from Borrowing to Repayment Initiation	Class Year of Borrowing							
	Freshman (1)	Sophomore (2)	Junior (3)	Senior (4)	1st Post Grad. (5)	2nd Post Grad. (6)	3rd Post Grad. (7)	4th Post Grad. (8)
1	25a	10a	5a	2a 29b	6b	15c	2c	6c
2	10a	5a	2a 29b	6b	15c	2c	6c	
3	5a	2a 29b	6b	15c	2c	6c		
4	2a 29b	6b	15c	2c	6c			
5	6b	15c	2c	6c				
6	15c	2c	6c					
7	2c	6c						
8	6c							
Total*	100	75	65	60	29	23	8	6

Ultimate educational attainment:
a: Less than baccalaureate.
b: Baccalaureate.
c: Five or more years.
* Of 100 entering freshmen, number entering each successive year.

TABLE 3

DISTRIBUTION OF A $1,000 "STANDARD BORROWING UNIT" BY ULTIMATE EDUCATIONAL ATTAINMENT AND LAG TO REPAYMENT

Number of Years from Borrowing to Repayment Initiation	Ultimate Educational Attainment			Total by Lag Year	
	Less than Baccalaureate	Baccalaureate	Baccalaureate Plus at Least One Full Year	Orig. $'s	Orig. $'s Plus Interest
1	114.8	95.6	62.8	273.2	281.4
2	46.4	95.6	62.8	204.8	217.3
3	19.1	95.6	62.8	177.5	194.0
4	5.5	95.6	62.8	163.9	184.6
5		16.4	62.8	79.2	91.8
6			62.8	62.8	75.0
7			21.9	21.9	26.9
8			16.4	16.4	20.8
Total by educational attainment	185.8	398.8	415.1	100.0	1,091.8

* Interest is accrued at a "real Fund borrowing rate" of 3 percent from year of borrowing initiation of repayment.

Finally, it is necessary to distribute borrowers, identified by educational attainment, over alternative future income profiles. To achieve this result, decile income classes by age were developed for each of the three educational attainment categories from a cross-classification of income by education by age derived from the 1970 Census and based upon 1969 money incomes.

For all educational attainment categories, it is assumed that the highest income decile contains no program borrowers. Beyond this highest-decile exclusion, participation rates are assumed not to vary systematically by income class. Thus, each of the lower nine deciles is assumed to contain approximately 11 percent of the participants with that ultimate educational attainment. Furthermore, it is assumed that each decile-division income is representative of that section of the distribution spanning it, e.g. that the eight decile income (separating the eight from the ninth decile) represents the incomes of all persons included in the 76th to 85th percentile range.

To reduce the number of separately observed income profiles an effort was made to identify decile age patterns for the various educational attainment categories which are closely similar and could be "collapsed" to provide a single "observed" income profile. Fifteen such groupings of income deciles were developed from the underlying data.

The income profiles relevant to the identification of viable variable term loan programs, of course, do not relate income to age but income to repayment year. For this purpose it is necessary to make some assumption concerning age at the time of repayment initiation. For simplicity it is assumed that all students commence repayment at age 23. While for "less than baccalaureate" students this procedure undoubtedly overstates early incomes, for "baccalaureate plus" students the reverse is true; as a result the possible effects of this assumption are not deemed to be significantly adverse. The final step in the conversion of income by age into income by repayment year is to assume that the mean 25 to 34 income is representative of income in the seventh repayment year, i.e. at age 29, and similarly for the other age-specific incomes.

The interpolation–extrapolation required to obtain income in *each* repayment year from income in four widely separated repayment years (the 7th, 17th, 27th, and 37th) involves further assumptions. First, income at age 55–64 is less than that at 45–54 in all cases. A reasonable hypothesis is that the age 59 income is downward-biased by the number of retirements concentrated at the end of the period, beyond what would amount to the 35th year of the program. Since 35 years will be the longest maximum repayment period examined, incomes at the end of the terminal period are not relevant. Therefore, only the first three income observations are utilized in the completion of the profiles.

A number of functional forms could be utilized to fit a "continuous" income profile to the three observed points. Because the increase in income is relatively less between the 17th and 27th years than between the 7th and 17th, it appears generally reasonable to stabilize income (cease income growth) at some point between the 17th and 27th years.

While the most reasonable assumption concerning the pre-stabilization portion of the income profile would be an exponential, or more likely, an S-shaped growth curve, greater simplicity argues in favor of linear growth (equal yearly increments). The generally sensible "starting salaries" (year one incomes) implied by fitting a straight line to the first two points add justification to the procedure. The general procedure was to (a) determine the annual increment by fitting a straight line to the 7- and 17-year points, (b) extrapolate beyond year 17 until the year 27 income is achieved, determining the "number of years of growth," (c) assume constant income beyond that point, and (d) extrapolate back from year 7 to year 1 at the year 7 to year 17 income growth rate to determine the starting salary.

TABLE 4

DISTRIBUTIONS OF PARTICIPANTS BY EDUCATIONAL ATTAINMENT OVER INCOME PROFILES

	Income Profiles				Educational Attainment		
No.	Starting Salary	Maximum Salary	Annual Increment	Years of Growth†	Less than Baccalaureate	Baccalaureate	Baccalaureate Plus at Least One Full Year
1	12,000	39,000	1,000	28		6	6
2	9,400	24,600	800	20			11
3	8,400	21,700	700	20	6	11	11
4	8,400	18,400	500	21		11	11
5	8,950	16,300	350	22	11	11	
6	7,650	13,950	350	19	11	11	11
7	6,900	12,300	300	19	11	11	11
8	5,150	11,450	350	19			11
9	6,600	10,400	200	20	11	11	
10	6,300	9,500	200	17	11		
11	2,900	9,700	400	18			11
12	5,300	8,500	200	17	11	11	
13	950	7,250	350	19	11		11
14	2,400	5,600	200	17	11	11	
15	2,000	2,000	0	1	6	6	6
Total*					100	100	100

* The top 10 percent of income receivers of each educational attainment are assumed not to participate and have been excluded from the distributions.

† Including year 1.

The complete "stylized profiles" are summarized in Table 4; the table also identifies the percentage of participants from each educational attainment group allocated to each of the fifteen profiles.

Only the first and the fifteenth profiles require special comment. With reference to the highest profile, for the range of plans to be tested, it is virtually necessary that individuals with these incomes exit prior to the end of the maximum repayment period. But the surplus to the fund contributed by these exiters is greater the longer they repay. Thus, *overstating* their incomes results in an understatement of the fund's surplus; to avoid resting the fund's success on the highest income participants (who might not participate) it is deemed advisable to overstate the starting salary and annual increment for the highest profile. For similar reasons, the lowest profile is arbitrarily understated.

Several conservative biases are incorporated in the income profiles. First, the "baccalaureate plus" income data refer to all persons who have obtained five or more years of school, regardless of when or under what circumstances they obtained the fifth year. However, the retention profile increments the educational attainment of only those graduates who enter full-time post-baccalaurete study in the year following the receipt of the bachelors degree. Thus, persons who obtain a fifth year of study on a part-time basis, e.g. teachers fulfilling certification requirements, are included in the derivations of the income data but are not eligible for the loan programs. This difference in mix would be expected to raise the incomes of the program's "baccalaureate plus" participants. Conversely, the completion of additional study by "baccalaureate" or "less than baccalaureate" participants is ignored, resulting in an understatement of their incomes; i.e. some of the "less than baccalaureate" participants will eventually complete a degree program, most on a part-time basis, and some "baccalaureate" participants will obtain post-graduate study, but the income effects of the additional education are not incorporated in the profiles in either case.

The analysis will allow for inflationary income increases (see Section IV). Thus, an individual's real income will rise over his lifetime due to the effect of age and experience, i.e. his lifetime real income will follow the relevant profile, and further, that profile, in its entirety, will rise in current-dollar terms as a result of inflationary increases in wages and prices over time. But in addition the entire profile shifts upward as a result of real productivity gains in the economy. As demonstrated by Table 5, a secular real income growth rate of from 1 to 2 percent per year would be defensible.

Finally, it is necessary to consider the impact of mortality on the performance of the programs. For this purpose age-specific survival rates were developed on the assumption that borrowing took place at age 20 and that repayment initiation

TABLE 5

REAL INCOME GROWTH BY EDUCAT[illegible] CLASS, 1956–1968

Year	Cumulative Lifetime Income at Age 18 and Annual Percentage Increases (Constant 1968 dollars, thousands)									
	College								High School Graduates Only	
	1–3 years		4+ years		4 years		5+ years			
1956	$303		$407						$270	
1958	300	− 0.5%	419	1.5%	$379		$458		257	− 2.5%
1961	324	2.5	434	1.0	423	3.5 %	454	− 0.5%	276	2.0
1963	334	1.5	452	2.0	435	1.0	473	2.0	294	3.0
1964	341	2.0	455	0.5	436	0.0	476	0.5	299	2.0
1966	366	3.5	500	4.5	478	4.5	529	5.5	320	3.5
1967	375	2.5	520	4.0	485	1.5	558	5.5	329	3.0
1968	378	1.0	515	1.0	489	− 1.0	544	− 2.5	336	2.0
Annual Increase		1.7%		1.8%		2.4%		1.7%		1.8%

Source: U.S. Bureau of the Census, Current Population Reports, Series P-60, No. 74 (October, 1970), *Consumer Income*.

occurred at age 23–24. The survival ratios range from 0.99 in the first year to 0.80 in the thirtieth. In Section IV two uses of this profile will be made: (1) the effect of mortality on zero-profit programs with group self-insurance will be assessed, and (2) lump sum life insurance premia will be determined.

IV. Deriving Zero-Profit VTL Programs

This section takes the previously developed distributions of borrowers by (a) lag to repayment and (b) future income and identifies sets of program parameters consistent with zero-profit/loss for the Fund. The basic parameters which must exhibit consistency are (1) the maximum repayment period, (2) the student's (internal) interest rate, and (3) the repayment tax rate. Also of interest are two additional characteristics of a program, implied by the preceding parameters: the degree of internal subsidization and the expected (average) repayment period.

The central "exogenous" variable in the derivation of consistent program parameter sets is the rate of interest at which the program is funded, the external interest rate of the previous discussion. The determination of the appropriate external interest rate is crucially related to the assumptions made concerning future income growth. The initial assumption, contrary to the available evidence, is that the income profiles shift over time only as a result of inflationary changes in prices and wages, i.e. that there is no observed secular increase in real (constant dollar) incomes.

Major changes in nominal interest rates, e.g. the prime rate, are related to changes in the rate of inflation. For example, in the ten year period 1960–1969 the prime commercial paper rate varied between 3 and 7.9 percent. But, as shown in Table 6, the real interest rate (prime rate minus the rate of inflation) varied only between 1.7 and 2.7 percent, significantly less both absolutely and relatively. In fact, a conservative, but not unreasonable, assumption would be that the real interest rate is approximately constant at a 2 to 3 percent level.

Thus, if we assume that nominal income change reflects only the effect of inflation, and that the same is true of nominal interest rate variations, then only base-year-dollar income predictions and the real interest rate are required for the derivation of VTL program parameters. In particular, consider the advancement of a principle amount P to be repaid in some future year n on an income contingent basis, with income in year n, measured in base year dollars, given by Y_n. To advance the amount P the VTL Fund borrows P and agrees to an annual interest rate $\bar{r}'$, the nominal external rate, which is equal to the sum of the real external rate, $\bar{r}$, and the rate of inflation d, i.e. $\bar{r}' = \bar{r} + d$. But nominal income is also assumed to grow at an annual rate d; then in year n nominal income is given by

$$Y_n(1 + d)^n.$$

The required repayment in year n is a proportion t of this income.

The amount the Fund will have spent on the individual is the principle amount P plus all accrued interest, i.e.

$$P(1 + \bar{r}')^n = P(1 + \bar{r} + d)^n.$$

TABLE 6

NOMINAL INTEREST RATES, RATES OF INFLATION AND REAL RATES OF INTEREST

Paper	Interest Rate on Prime Commercial Paper (1)	Consumer Prices: Index (1957–1959 = 100) (2)	Consumer Prices: % Change (3)	Real Interest Rate (4) = (1) − (3)
1950	1.45	83.8		
51	2.16	90.5	7.8	−5.6
52	2.33	92.5	2.2	0.1
53	2.52	93.2	0.8	1.7
54	1.58	93.6	0.4	1.2
55	2.18	93.3	−0.3	2.5
56	3.31	94.7	1.5	1.8
57	3.81	98.0	3.5	0.3
58	2.46	100.7	2.8	−0.3
59	3.97	101.5	0.8	3.2
60	3.85	103.1	1.6	2.3
61	2.97	104.2	1.1	1.9
62	3.26	105.4	1.2	2.1
63	3.55	106.7	1.2	2.4
64	3.97	108.1	1.3	2.7
65	4.38	109.9	1.7	2.7
66	5.55	113.1	2.9	2.7
67	5.10	116.3	2.8	2.3
68	5.90	121.2	4.2	1.7
69	7.83	127.7	5.4	2.4

The break-even condition is simply that the amount expended (principle and interest) equal the amount repaid in year n, i.e.

$$P(1 + \bar{r} + d)^n = tY_n(1 + d)^n.$$

This can be rearranged into the following expression and, for $\bar{r}$ and d small, an associated approximation:[9]

$$tY_n = P\left(\frac{1 + \bar{r} + d}{1 + d}\right)^n \approx P(1 + \bar{r})^n.$$

Of course, the VTL programs employ a series of future incomes, but the principle is unchanged.

More generally, the interest rate of relevance as the Fund's borrowing rate is what James Tobin has referred to as the "income rate of interest," defined as the difference between the nominal interest rate and the rate of growth of income, real

[9] If continuous, rather than annual, compounding were employed, the last relationship would be an identity:

$$tY_n e^{dn} = P e^{(\bar{r} + d)n}$$

$$tY_n = P\left(\frac{e^{\bar{r}+d}}{e^d}\right)^n \equiv P e^{\bar{r}n}.$$

plus inflationary. The real rate above is equivalent to Tobin's "income rate of interest" under the assumption of a zero rate of growth of real income.

Thus, the Fund's borrowing rate is initially assumed to be 3 percent, associated with inflationary income growth only. In recent terms these assumptions would translate into a nominal interest rate of 7 percent and a rate of inflation (and income growth) of 4 percent. When real income growth is incorporated, the Fund's income borrowing rate will be reduced by 1.5 percent (the assumed rate of secular real growth).

"Nominal" equivalents provide a benchmark for selecting a range of internal (student) interest rates to examine. With not insignificant attention to usury laws and probable student reactions, a nominal internal (student) rate of 12 percent was selected as the maximum for attention; assuming a 4 percent rate of inflation, this implies a five point spread between the Fund's real borrowing rate (3 percent) and the maximum real internal rate (8 percent). Within this interval $\frac{1}{2}$ point differentials (3.5 to 8 percent) were employed to empirically derive the VTL program tradeoff possibilities. Parameter sets with tax rates above 2 percent per $1,000 borrowing are ignored.

For convenience, five maximum repayment periods were utilized, ranging from 15 to 35 years in five-year increments. For each "internal interest rate—maximum repayment period" combination, the Fund's zero profit tax rate was computed.[10] Then, given the three parameters, the subsidy ratio and expected repayment period were determined.

The zero-profit parameter loci consistent with the underlying borrowing and income profiles and with the 3 percent external real interest rate-zero real income growth assumptions are displayed in Figure 4. In addition to mortality, the estimates incorporate administrative costs of $5 per year per $1,000 borrowed (augmented, in nominal dollar terms, by the rate of income growth).

Several features of the *r-t* loci warrant attention. First, the loci become flatter as the tax rate is increased ($\partial^2 r/\partial t^2 > 0$); or beginning with high tax and low internal interest rates, a slight increase in the interest rate permits a sunbstantial reduction in the tax rate. But the change in tax rate resulting from a given interest rate change declines continuously as the interest rate increases. This is explained by the fact that as the tax rate falls fewer and fewer income profiles exit prior to the end of the maximum repayment period; but interest rate increases permit tax rate reductions only by increasing the Fund's surplus on exiters; they exit later (because of the interest rate increase and the tax rate reduction) and at a higher rate differential. Thus, as the pool of exiters declines, the potential increase in exiter-surplus is reduced and the permitted tax reduction disappears. Using the 35-year program as a case in point, an increase in the interest rate from 4.5 to 5 percent permits an 0.25 percent reduction in the tax rate (from 0.96 to 0.71 percent). However, a change in the interest rate from 5.5 to 8 percent permits only an 0.09 percent change in the tax rate; in the first case only three of the income profiles

[10] For heuristic purposes it seemed clearer in the analytical section to form the explicit function with the internal interest rate as a function of the tax rate and the maximum repayment period. For purposes of empirical solution, however, the simplest procedure was to set an interest rate and maximum repayment period and solve for the tax rate. In general terms, the ordering of the variables in the explicit function is a matter of indifference.

are committed for the full 35 years, while in the second (an interest rate of 5.5 percent) ten profiles never exit.

EXPLANATIONS: FIGURES 4–11

These figures have been drawn using a computer controlled plotter. The variable names found in the diagrams are defined below:

ADCST: the administrative costs in real dollars per year per real dollar of original borrowing.

INT IN: *Y* (yes) interest is accrued prior to repayment initiation on outstanding student balances.
NO (no) interest is not accrued prior to repayment initiation.

LL: maximum number of years lag from original borrowing to repayment initiation. (In all cases examined here *LL* = 8.)

IMORT: *Y* (yes) adjustment of repayment streams to reflect effects of mortality is made.
NO (no) mortality adjustment is not incorporated.

RB: external interest rate (in fractional units) at which the programs are funded (real).

PRGM LGTH, SYM: the program length (maximum repayment period) in years and a symbol used in the plot which identifies the zero-profit locus for this maximum term and the five parameters initialized as shown at the left on the same line.

R: (vertical axis) internal student interest rate (real = nominal − rate of inflation).

T: (horizontal axis) repayment tax rate, percent per $1,000 real original borrowing.

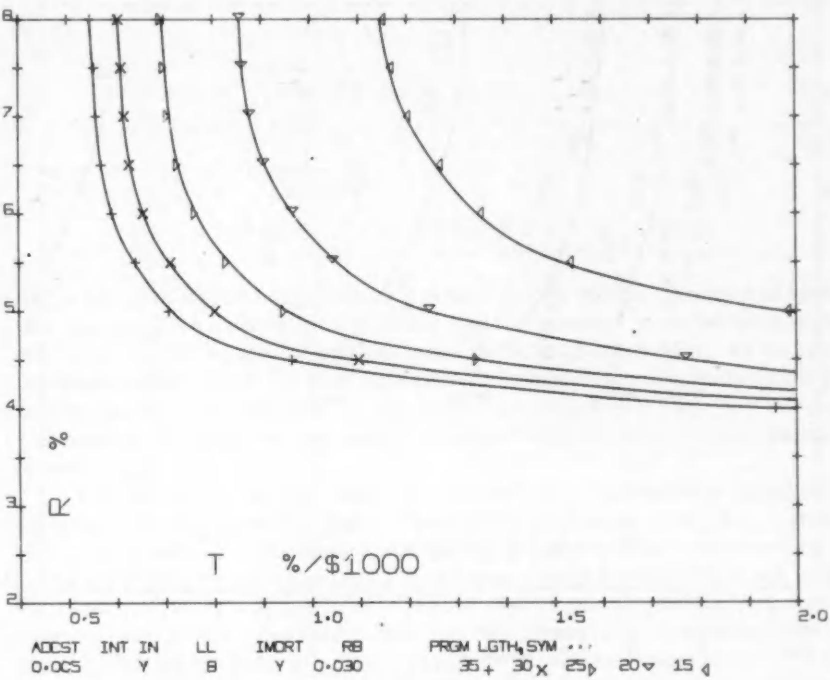

Figure 4

Secondly, the shift in the locus resulting from a reduction in the maximum repayment period becomes greater as the repayment period is reduced. For example, at a 6 percent interest rate, a shift from a 35- to a 30-year program requires an increase of only 0.07 percent in the tax rate (from 0.59 to 0.66 percent), while the shift from a 20 to a 15 year program requires the much greater tax rate increase of 0.38 percent (from 0.96 to 1.34 percent). Two factors explain this phenomenon. First, for all of the profiles except the lowest income is assumed to grow beyond year 15; therefore a 15-year program must compensate for the fact that it is taxing significantly lower average incomes. While this is true to some degree for all maximum term reductions, the impact is less for longer repayment periods because of the decline in the present value of income received further in the future. Thus, the second explanation is that income earned, and hence repayments made, in the 30th to 35th years have very low present values ($1 received 30 years in the future has a 3 percent discounted present value of about $0.41); the present value of year 15 income and repayments is much higher ($1 has a present value of $0.64, discounting at 3 percent for 15 years). As a result, the compensating tax rate reduction (holding the internal interest rate constant and lengthening the maximum repayment period) becomes smaller as the repayment period is increased.

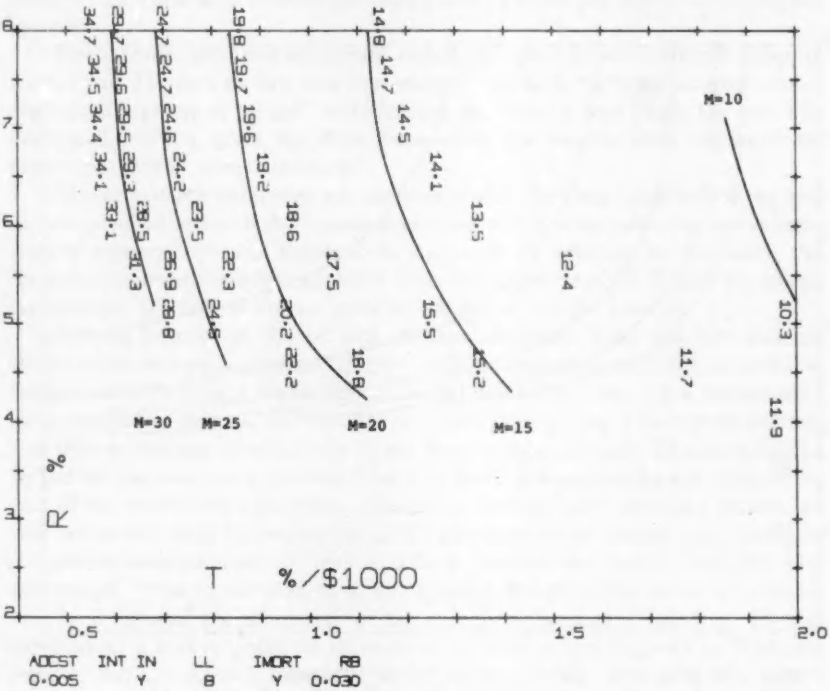

Figure 5

The associated iso-expected-repayment-period and iso-subsidy loci are graphically portrayed in Figures 5 and 6. Consistent with expectations, the iso-expected-repayment-period loci are negatively sloped and convex to the origin, but steeper than the zero-profit *r-t* loci. For any given maximum repayment period,

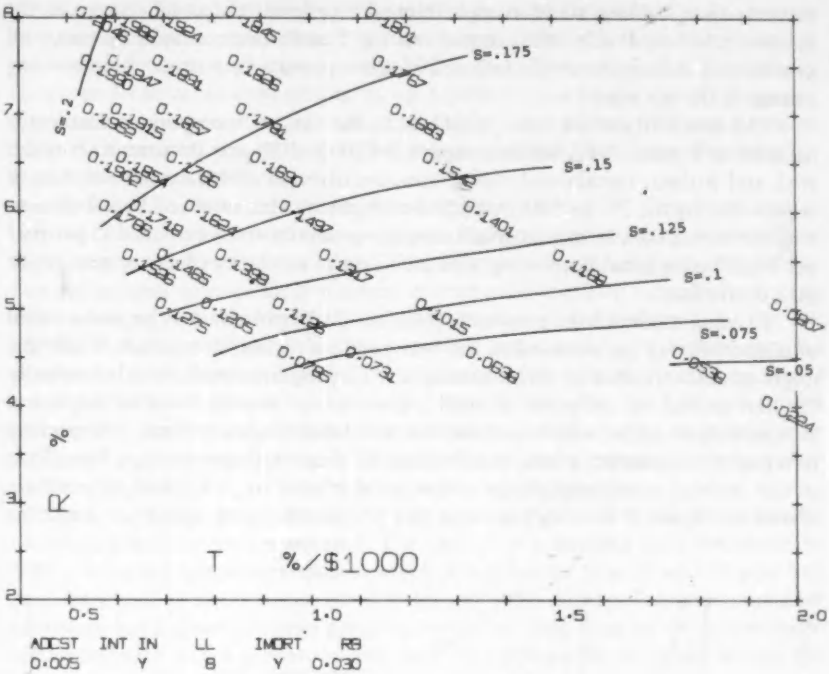

Figure 6

the expected repayment term increases as tax rates are reduced and interest rates are increased. Also, for a given interest rate the expected term decreases with reductions in the maximum term (increases in the tax rate); holding the tax rate constant, reductions in the maximum term (increases in the interest rate) imply reductions in average term due to the reduced term of liability of very low income participants, not offset by the longer repayment terms of higher income participants.

The iso-subsidy curves (Figure 6) are observed to be positively sloped and approximately linear, with a slight flattening at high interest rates. Thus, a given incremental increase in the interest rate requires that the tax rate be increased by a virtually constant absolute amount if the original subsidy level is to be maintained. For low levels of subsidy, increases in interest rates require substantial compensating increases in tax rates (and consequent reductions in maximum repayment terms) while higher levels of subsidy require much smaller changes in tax rates to compensate for a given interest rate increment. The explanation of this variation in compensating tax rate change is that, holding the tax rate constant, at low interest levels an incremental change in the interest rate raises the Fund's subsidy significantly, requiring that there be a major increase in tax rates to reduce the subsidy to its former level (a reduction achieved through the greater payments by the lowest income groups and earlier exits by the high income groups after the tax increase than before), while at high interest rate levels the same change in the interest rate has a very small impact on the Fund's internal subsidy (since all profiles not exiting are unaffected) and hence requires a very small compensating change in the tax rate.

The sensitivity of the zero-profit loci to the various incorporated features is assessed in Figures 7–11, which compare the 20- and 30-year maximum term loci with and without certain underlying characteristics. In each care the benchmark is provided by the 20- and 30-year plans of Figure 4, characterized by a 3 percent real borrowing rate, interest accrual in lag years, administrative costs of $5 per year per $1,000 of original borrowing, and inclusion of mortality effects in zero-profit plan derivation.

Existing student loan programs (NDEA, GLP) provide for the non-accrual of interest during lag years (when the borrower is a registered student). While this might be accomplished by direct subsidy, a VTL program could provide internally for non-accrual in lag years through higher tax or interest rates or maximum repayment periods, in which case students with longer lags from time of borrowing to repayment initiation would be subsidized by those with shorter lags. The effects of this internal compensation for non-accrual of interest prior to repayment are shown in Figure 7. For high interest rate programs, under which most income

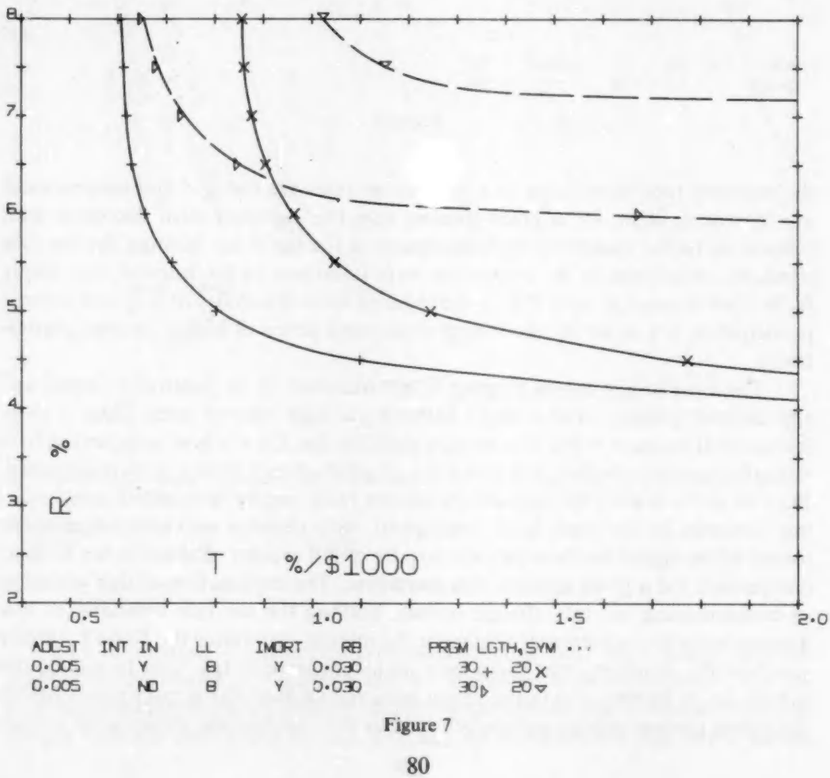

Figure 7

profiles repay for the full period, the tax rate increase compensating for interest non-accrual is quite small; at an 8 percent interest rate for a thirty year program the required tax rate change is only 0.04 percent (from 0.61 to 0.65 percent). However, for lower interest programs, e.g. 6 percent for a 30-year program, the tax rate increase compensating for non-accrual is a much higher 1.02 percent (from 0.66 to 1.68 percent), due to the fact that non-accrual and lower rates release higher income borrowers much earlier.

Because the lower income borrowers (predominantly "less than baccalaureate") have the shortest average lags to repayment, interest non-accrual has highly regressive implications. For a 30-year program with a 6 percent interest rate and interest accrual, the five lowest income profiles are subsidized (the present value of repayments is less than the present value of borrowing[11]) by the ten highest income profiles. With non-accrual of interest the two highest income profiles are subsidized, and of the low income profiles only the lowest receives a subsidy. Profiles 2 thru 13 provide the subsidy with the third lowest profile making the greatest subsidy contribution ($0.41 per $1 of debt at initiation of repayment). Thus, non-accrual of interest in lag years appears to be a highly undesirable feature when compensation is provided internally.

Governmental provision of free life-insurance is a universal characteristic of existing student loan programs. The impact of extending such insurance to VTL's is demonstrated in Figure 8, which compares the base 20 and 30 year loci to plans which do not include provision for mortality. The results are predictable: mortality has a greater impact proportionately on long than on short maximum term programs. At a 6 percent interest rate, the exclusion of mortality reduces the tax rate by 0.05 percent for both the 30-year plan (from 0.66 to 0.61 percent) and for the 20-year plan (from 0.96 to 0.91 percent); however, the relative change is almost twice as great in the case of the 30-year program (0.05/0.66 versus 0.05/0.96).

The value of the governmental subsidy implied by the provision of free insurance can be easily computed. If t_m is the zero-profit tax rate with adjustment for mortality and t_{nm} without such adjustment, then the borrower would have to pay a lump sum amount P for insurance in the second case and would receive in effect only an amount $1,000 − P at the lower tax rate. P is then given by

$$\frac{t_{NM}}{1{,}000 - P} = \frac{t_M}{1{,}000}$$

or

$$P = 1{,}000\left(1 - \frac{t_{NM}}{t_M}\right)$$

In the 6 percent interest case the 30-year program premium is $76 while for the 20-year program it is only $52 (in present value at the time of repayment initiation). Note that this insurance premium represents both (a) the value of the governmental subsidy in the case of free insurance and (b) the lump sum insurance premium equivalent to the higher tax rate under program self-insurance.

[11] In assessing the contribution to subsidy (positive or negative) the present value of payments relative to the present value of borrowing is always evaluated at the initiation of repayment.

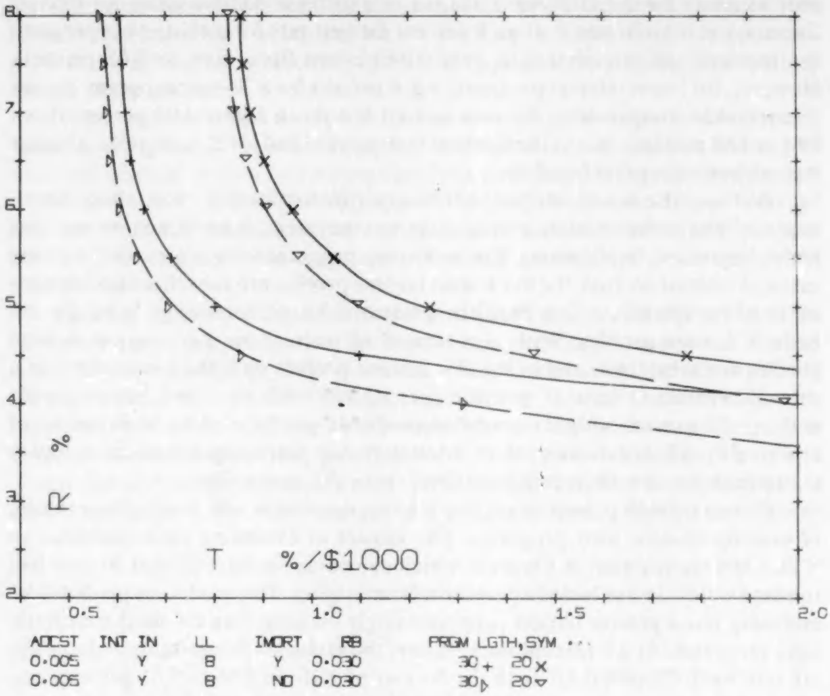

Figure 8

A significant difference between public and private VTL programs would be expected in the administrative cost dimension. At the extreme a federally-sponsored program could place all administrative-collection responsibilities on the Internal Revenue Service and the Social Security Administration, with virtually zero marginal cost.

The effect of zero administrative costs, holding other program characteristics constant, is shown in Figure 9.

Since administrative costs are recouped entirely through the differential between the external borrowing rate and the internal student rate, the reduction in tax rates is greatest at low student interest rate levels. Using the 30-year programs as cases in point at an 8 percent student rate the exclusion of administrative costs reduces the tax rate only by 0.07 percent (from 0.61 to 0.54 percent), but at a 5 percent interest rate the reduction is 0.16 percent (from 0.8 to 0.64 percent).

A final dimension in which a publicly sponsored program might differ from a private program is in the external interest rate at which the program is funded. A federal program would be able to (a) borrow at lower federal rates (on average implying a reduction of about 0.5 percent) and possibly (b) receive a direct interest subsidy (as under the NDEA and, over certain periods, the GLP programs). An indirect federal subsidy could be obtained via state-sponsored programs funded

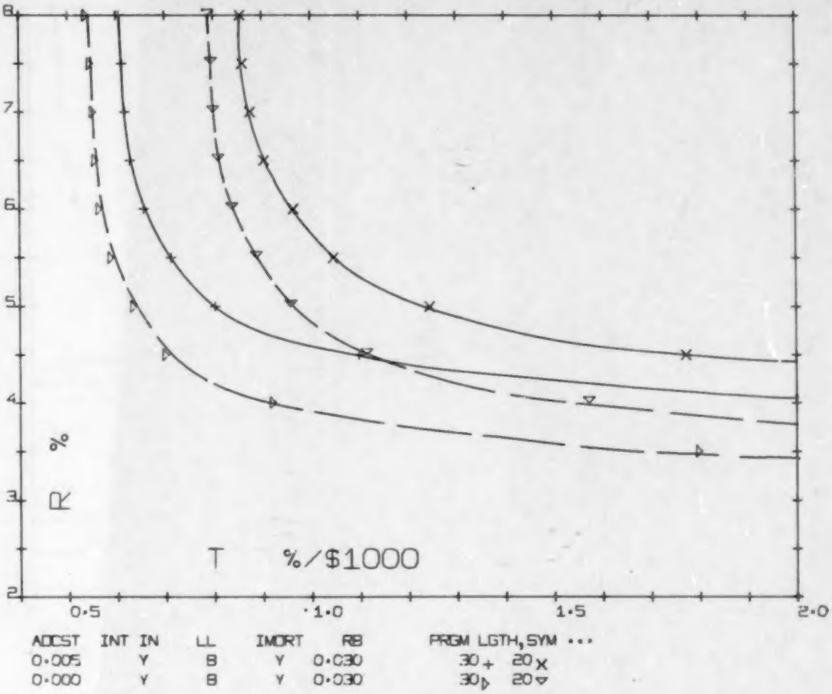

Figure 9

with tax-exempt borrowing (producing a reduction at current nominal interest rate levels of about 1.5 percent).

Taking a tax-exempt state program as an example, and employing a "real" external borrowing rate of 1.5 percent, the consequent shift in zero-profit loci is portrayed in Figure 10. With a 30-year, 6 percent student rate program, this reduction in the external interest rate permits a tax rate reduction of 0.18 percent (from 0.66 to 0.48 percent); at the lower student interest rate of 4.5 percent this tax rate reduction is even larger, 0.59 percent (from 1.10 to 0.51 percent). The reduction is also larger for a 6 percent—20 year plan; 0.25 percent (from 0.96 to 0.71 percent).

The effect of a (directly or indirectly) subsidized interest rate can also be examined by holding the tax rate constant. For a 30 year program with a tax rate of 0.63 percent, the unsubsidized 3 percent external rate requires an internal student interest rate of 6.5 percent; a subsidized 1.5 percent external rate reduces the student rate to 3.5 percent. For a 20-year, 0.86 percent tax rate program, subsidization reduces the student interest rate from 7.5 to 4 percent.

As was noted, the above programs were estimated on the assumption of zero secular real income growth. In fact, a more neutral assumption would be that the income profiles (in real dollars) shift up over time at a rate of about 1.5 percent

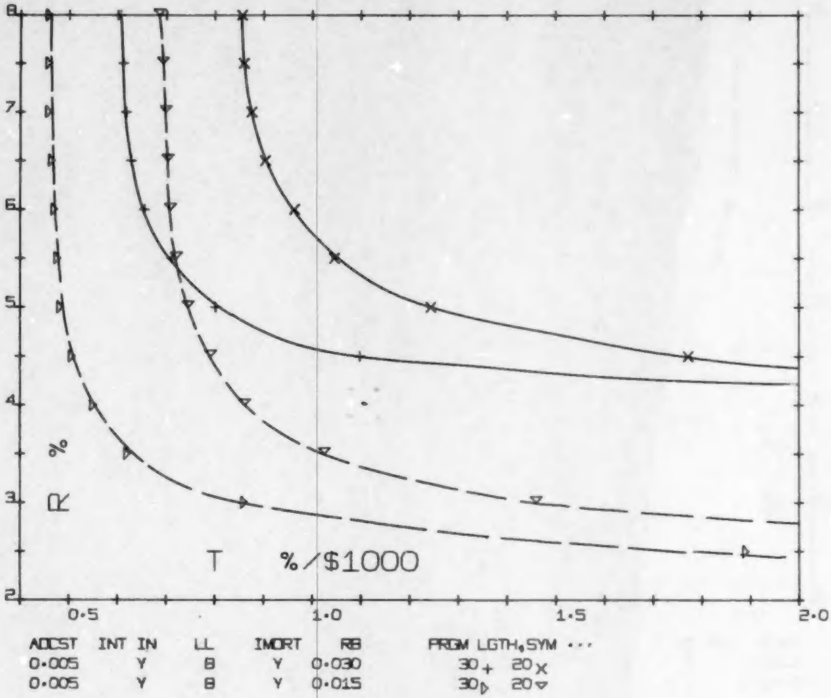

Figure 10

per year. With the real rate of interest assumed to be 3 percent this rate of real growth would imply an "income rate of interest" of 1.5 percent, i.e. the zero profit loci (for an unsubsidized plan) would be identical to those estimated for a subsidized plan with a real borrowing rate of 1.5 percent. However, the interpretations would differ. For the subsidized plans of Figure 10, the nominal student rate would be simply the "real" student rate plus the rate of inflation (e.g. 4 percent, as utilized earlier). But the inclusion of real income growth requires that the (real) income rate be augmented by both the rate of inflation and the rate of real growth (4 and 1.5 percent respectively). Thus to compare private (unsubsidized) plans including and excluding real growth the student "income rate of interest" in the real growth case must be augmented by the rate of real growth, i.e. comparisons utilizing different rates of growth must transform "income rates of interest" into conventional *real* rates of interest (defined as the nominal rate minus only the rate of inflation).

Such a comparison of 3 percent external real interest rate plans, including and excluding secular real growth, is contained in Figure 11. For a 30-year plan with a 6 percent real student rate, inclusion of income growth reduces the tax rate by 0.15 percent (from 0.66 to 0.51 percent). In the case of a 6 percent, 20-year plan the reduction due to real growth is 0.17 percent (from 0.96 to 0.79).

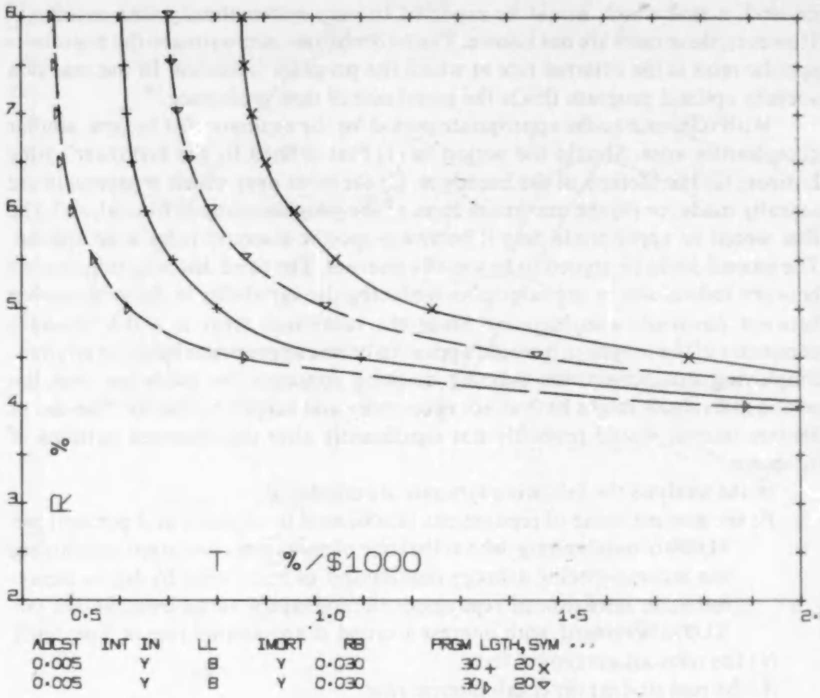

Figure 11

V. Repayment Incidence and Redistribution

As discussed in the Introduction one interpretation of VTL devices is in terms of beneficiary taxes applied to recipients (for support) of higher education. It differs in one major respect from other such taxes: it is voluntary. One can obtain education without being subject to the tax. However, for students without alternative means of support it is not optional, and for these the tax interpretation can be entertained. (However, recall that other interpretations can be argued to be more appropriate, specifically the income insurance interpretation.) Recognizing the incompleteness of the tax framework, it is still interesting to consider the redistributions implicit in VTL programs in terms applied to the incidence of other taxes, i.e. in terms of progressivity, proportionality, and regressivity.

Since individual borrowers repay over different periods of time (high income recipients exit earlier), it is necessary to analyze incidence in terms of the *present value* of income and repayments. Two questions arise at this stage. First, what discount rate should be employed in converting to present values? And second, over what period should income be discounted? Examining repayments from the vantage point of the repayment initiation year (year zero), it is clear that the appropriate discount rate is that interest rate at which former students can borrow or lend, a rate which would be expected to vary systematically with income.[12] However, these rates are not known. The only obvious alternative to the borrower-specific rates is the external rate at which the program is funded. In the case of a socially optimal program this is the social rate of time preference.[13]

With reference to the appropriate period for the evaluation of income, similar complexities arise. Should the period be (1) that defined by the borrower's time horizon, (2) the lifetime of the borrower, (3) the term over which repayments are actually made, or (4) the maximum term of the program subject to analysis? The first would be appropriate only if borrower-specific discount rates were applied. The second could be argued to be socially relevant. The third distorts comparisons between individuals in the same plan (reducing the variability in the relationship between payments and income). Since the maximum term is a discretionary parameter of the program, it would appear to be one appropriate basis for analysis. Employing this period, the effective question concerns the incidence over the period individuals might be (but not necessarily are) subject to the tax. The rise of lifetime income would probably not significantly alter the observed patterns of incidence.

In the analysis the following symbols are employed:

P: the present value of repayments (discounted in all cases at 3 percent) per $1,000 of outstanding debt at the time of repayment initiation (employing the income-specific average distribution of borrowing by lag to repayment; at initiation of repayment the average student owes $1,092 per $1,000 borrowed, with interest accrued at an external rate of 3 percent).

N: the relevant maximum term.

R: the real student (internal) interest rate.

The incidence of a given program for a particular student is then defined as P/Y, the ratio of payment to income.[14]

Incidence relative to income for two of the basic 30-year programs of Figure 4 is displayed in Figure 12. For comparison the absolute payments P are also displayed as a function of income. The high interest program, from which only the highest income profile exits prior to maximum term, exhibits a very narrow range of variation in the ratio of payments to income (about 0.45 to 0.55 percent); absolute payments rise continuously with income. The low interest (4.5 percent) program, from which twelve of the fifteen profiles exit prior to maximum term, exhibits sharp regressivity, the ratio of payments to income ranging from above 1 percent at $100,000 income to 0.25 percent at an income of $475,000. Similarly,

[12] In addition, differentials between borrowing and lending rates would be expected to exhibit systematic income variations, introducing additional complexities into the incidence analysis.

[13] In fact, the funding rate may differ from the social rate of time preference in the case of subsidization of interest to account for the external benefits of education. Thus, the social rate of time preference may be 3 percent, but educational externalities might require a funding rate of 1.5 percent, as in the state plans of section IV, to insure the optimal level of investment in education. In this case, incidence analysis should, for consistency, employ a discount rate of 3 percent, rather than the 1.5 percent subsidized funding rate.

[14] This will always be less than the tax rate since payments here are normalized per $1,000 of outstanding balance at the initiation of repayment, rather than per $1,000 of original borrowing. P/Y represents repayments as a proportion of income on original borrowing of less than $1,000, with an outstanding balance of $1,000.

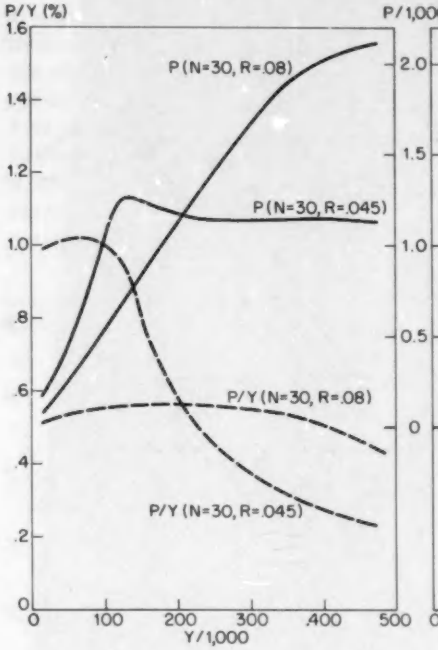

Figure 12

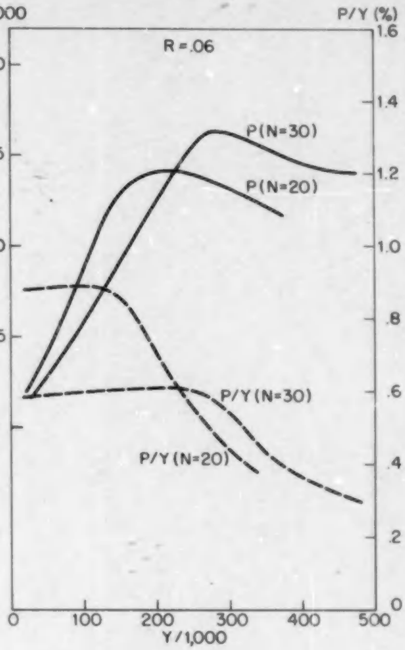

Figure 13

absolute payments peak at about $1,200 at a $125,000 income, and then decline to about $1.175.

As demonstrated in Figure 13, comparing a 30- to a 20-year plan, holding the interest rate constant, the longer term plan (employing a lower tax rate and thus obtaining a larger surplus from existing groups) is somewhat less regressive.

The regressivity of non-accrual of interest in lag years, with internal fund compensation, is clearly displayed in Figure 14, comparing 30-year, 6 percent student interest plans differing only in terms of interest accrual. With interest accrual payments as a percentage of income decline from 0.6 to 0.3, while with non-accrual the decline is from above 1.5 percent to about 0.2 percent, moving from low to high incomes. With non-accrual absolute payments are highest ($1,200) at a $100,000 income, and lowest (less than $1,000) at incomes above $300,000.

Finally, the virtual proportionality obtainable from a subsidized "state" plan is demonstrated in Figure 15, comparing 30-year plans, the subsidized plan borrowing at a real rate of 1.5 percent.[15] With a higher student rate of 7 percent virtually perfect proportionality could be attained. This is the limit in movement toward progressivity (with a fixed tax rate), unless income is significantly related, inversely, to average lag years.

[15] As noted in footnote 13, above, the appropriate procedure in case of subsidization is to discount incomes and payments at the unsubsidized 3 percent rate; this procedure has been employed.

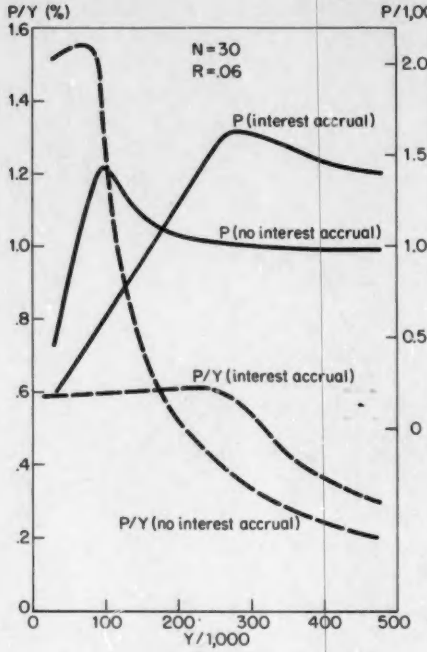

Figure 14

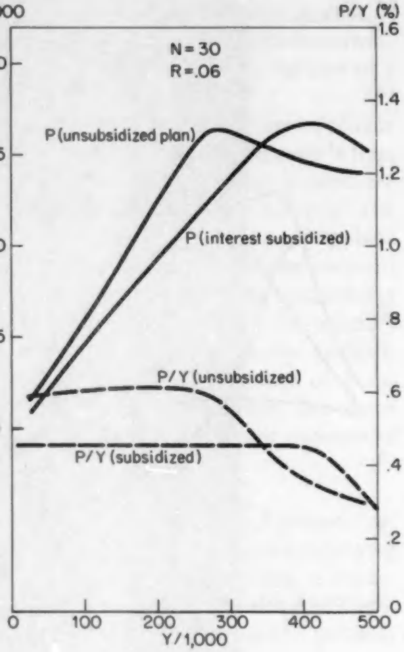

Figure 15

Of course, relative proportionality, while possibly desirable, might in practice be limited by the capacity of students to opt-out as program parameters become more onerous, given the individual's income expectations, than the available alternatives (alternative conventional loans, increased indebtedness to parents, alternation between study and work, increased part-time work, etc.). Most commonly such discussions of voluntary non-participation focus on the problem of negative or adverse selection, i.e. the opting out of high-income expectors, but this is simply a specific instance of what can be expected to be a general problem: for each income group some program or set of programs is more onerous than others, and non-participation can be anticipated when the relatively more burdensome program is also undesirable compared to non-VTL programs. This last condition could be met for any of the income groups at some parameter set.

While it is impossible to specify the desirability of a given VTL option relative to non-VTL alternatives for a given income group, relative desirability between VTL's can be assessed. This is done graphically in the lower panels of Figure 16, which relate the present value of future payments to the student interest rate (a proxy for the set of jointly determined parameters), for the basic twenty and thirty year plans of Figure 4 and for income profiles 1, 4, 6, 12 and 15. The first and fifteenth profiles are the highest and lowest, respectively. The fourth and twelfth are at approximately the upper and lower quartiles, and the sixth is the median.

The shape of the payment-interest rate functions is explained by the impact of interest rate changes on the actual repayment period. If a profile is not paying for the maximum term, then an interest rate increase (and a compensating tax rate reduction) will increase the present value of repayments (evaluated at the real 3 percent fund rate): the interest differential charged on the outstanding student balance will be higher, and the balance in any year will be larger and will persist for a longer period. However, once maximum term is reached, an income profile reaps absolute benefits from interest rate increases: the tax rate is reduced and in consequence the value of payments declines.

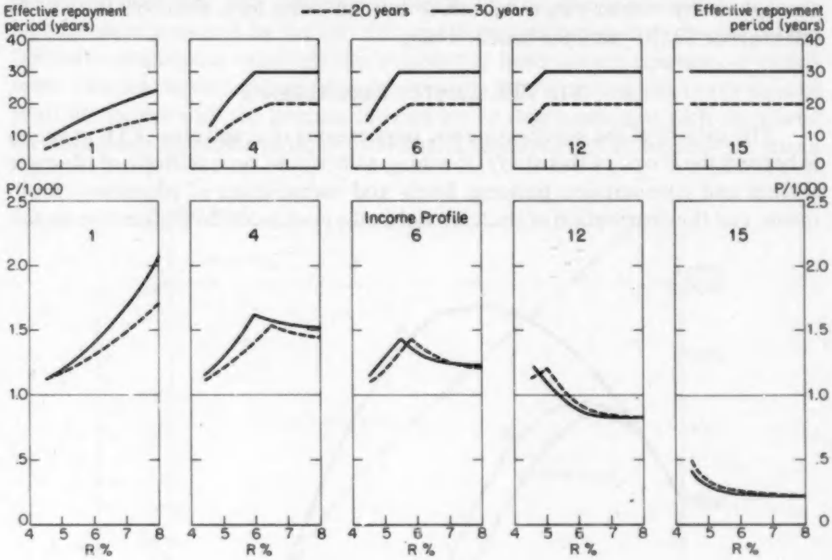

Figure 16

For the lowest income group (15), increases in interest rates are beneficial throughout, since this profile does not exit prior to maximum term under any of the programs examined. At this low income the present value of repayments never exceeds the value of borrowing; as a result this group would never find conventional loans preferable to a VTL, although at low interest rates other alternatives might be preferred.

In the case of the low quartile income profile, interest rate increases are always beneficial for a thirty year plan (the borrower repays for the maximum term) but are beneficial only above 5 percent for 20-year plans. This group repays less than its borrowing only at rates above 5.5 percent, and interest rates of 4.5 to 5 percent produce repayments of almost $1.25 per $1 benefit (amount borrowed plus lag year interest).

For the median income group, repayment for the maximum term occurs at interest rates of 5.5 and 6 percent; these programs are least desirable, with repayments of somewhat less than $1.5 per $1 benefit. Here significant shifts to other forms of finance might be expected.[16]

For a borrower with high-quartile income payments reach a maximum of over $1.5 per $1 benefit at interest rates of about 6 percent. Interestingly, this is the first income group for which 20-year maximum term programs dominate 30-year programs at each interest rate. This suggests that if both 20- and 30-year options were available the longer term alternative might experience significant negative selection in favor of the shorter program.

This domination of the longer by the shorter program is also observed for the highest income profile. Since this group never is held for full term, it is "damaged" throughout by interest rate increases, its burden rising from about $1.10 to $1.75 (20-year) or $2 (30-year) per benefit dollar.

VI. VTL Capital Requirements

The subject of the macroeconomic implications of a universal VTL program is beyond the scope of this study, touching as it would on questions of life-cycle savings and consumption patterns, levels and composition of education enrollments, and the distribution of students within the post-secondary education sector.

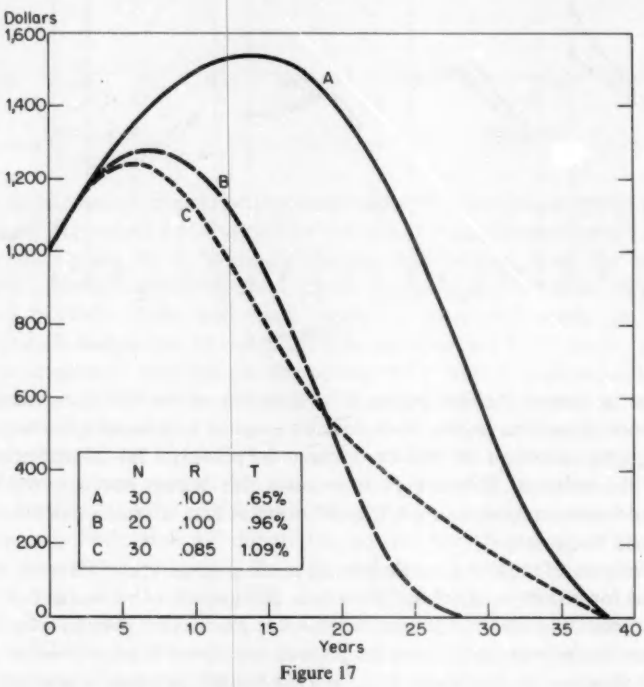

Figure 17

[16] Such expectations of non-participation assume that future income is known with certainty, which is, of course, not true. With significant uncertainty, and particularly if risk-aversion is a significant force, even middle-income expectors might prefer a 6 percent—20-year VTL to, e.g., a conventional loan at lower interest rates.

However, it is within the purview of this study to examine the financial characteristics of VTL lending programs over time.

The debt profiles of a fund offering three alternative VTL options with one year of original lending and a 4 percent rate of inflation are displayed in Figure 17. Of the two 30-year plans, the debt requirements of the high interest (10 percent)—low tax (0.66 percent) plan are significantly greater than those of the low interest (8.5 percent)—high tax (1.09 percent) alternative. In the first case total debt outstanding reaches a maximum of $1,540 (per $1,000 of year 0 lending) in year 14, while in the second case total debt reaches only $1,240 in year 6. A 20-year plan with an intermediate tax rate of 0.96 percent (an interest rate of 10 percent) has a maximum debt of $1,280, occurring in year 7. This rapid increase in debt to fairly high levels is explained by the low or non-existent payments in early years, when borrowers experience relatively low incomes or have not yet commenced repayment. The debt of the fund on the account of any year's lending is not extinguished until borrowers with the greatest (8-year) lag to repayment and with the lowest incomes reach maximum term, i.e. after 28 and 38 years in the 20- and 30-year plans.

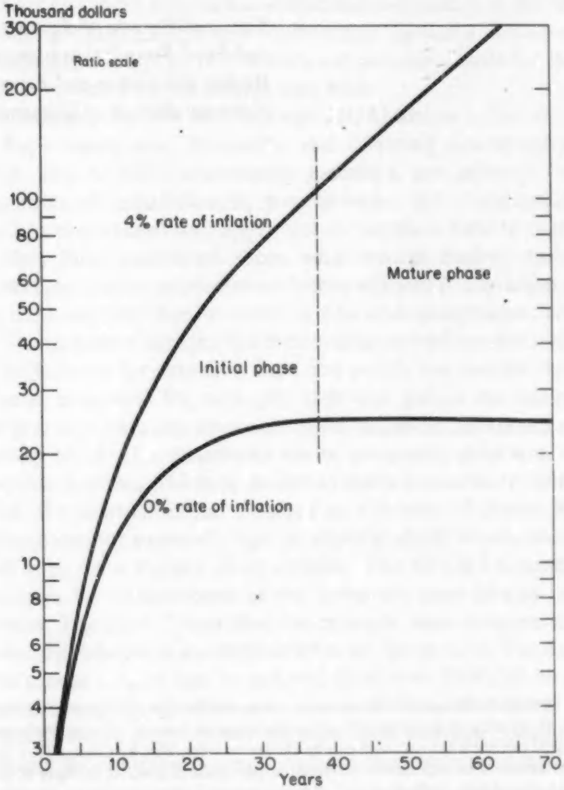

Figure 18

More interesting than the debt profile of a fund on account of one year's lending is the debt history of a fund offering a constant real level of new lending in each year.

Two such continuous-lending debt profiles are displayed in Figure 18. In real terms the two plans are identical: a real external rate of 3 percent, zero secular real growth, real student rates of 6 percent, tax rates of 0.66 percent, and maximum terms of 30 years. However, the lower profile assumes a zero rate of inflation (new lending of $1,000 in each year), while the upper profile incorporates the effects of a 4 percent annual rate of inflation, with new lending in each year increasing at the rate of (inflationary) income growth.[17]

In the absence of inflation, debt reaches a stable, zero-growth plateau after thirtyeight years, when the plan contains a full contingent of borrowers from each income profile and each lag to repayment at each *stage* of repayment. Thus, the rate of growth of debt in the mature phase is equal to the rate of inflation, in this case zero. When inflation is incorporated, the mature phase exhibits a constant rate of growth of debt equal to the rate of inflation, e.g. 4 percent as in the higher debt profile of Figure 18.

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[17] Income growth (inflationary or real) serves to reduce the tax rate per nominal $1,000 of borrowing by a factor $1/(1 + g)$, where g is the total rate of secular income growth. Alternatively, as treated here, the amount borrowed per basic tax rate unit can be viewed as increasing by a factor $(1 + g)$. If the higher education sector is assumed to experience increases in per student costs at the rate of income growth (because of secular stagnation, including real income growth), then the latter alternative, reflecting increasing student charges, is more appropriate.