A NEW VARIANT OF THE EDUCATIONAL OPPORTUNITY BANK DESIGNED FOR STABILITY AND EASE OF ADMINISTRATION IN "SMALL-SCALE" APPLICATION*

Richard Berner
Michael B. Johnson
Karl Shell

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Department of Economics
University of Pennsylvania
Philadelphia, Pennsylvania 19104

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ABSTRACT

A new variant of the contingent-repayment loan is proposed for higher education. The new variant, which we call "the Partially Contingent Educational Opportunity Bank plan," is designed to be very stable (i.e., relatively insensitive in overall operating characteristics to assumptions about basic parameters) and to economize on administrative costs, especially when applied at the institutional level rather than as a program of the federal government.

Under the Partially Contingent EOB plan, a student borrower would agree to repay his debt over a fixed period after graduation. The method of repayment would be somewhat like that of a conventional home mortgage except that coupon repayments would increase each year in accordance with expected ability to repay rather than remaining level for the entire period. There would also be low-income protection for borrowers: In each year, the PCEOB borrower would be given the option of coupon repayment (described above) or payment contingent upon his income, whichever is to his advantage. For stability and ease of administration, the well-designed PCEOB plan sets the contingency-repayment-tax rate sufficiently high so that this option is selected only by those participants with the lowest incomes. In this way, the PCEOB offers mutualization of the most salient borrower risks while minimizing administrative costs and risks to lending institutions: The borrower is given protection from full repayment when his income turns out to be very much less than could be anticipated, probably the student's greatest worry about the "albatross" of repayment commitment. Because most borrowers will elect the noncontingent

coupon method of repayment, the lending institutions can very accurately predict the stream of annual repayments from any graduating class. Also, because few borrowers will elect the contingency option, the administrative costs to the lending institution of verification of individual borrowers' incomes would be substantially less than in a program where all incomes had to be verified.

In this report we develop PCEOB operating parameters to be applied to US Medical Schools. Given the required rate-of-return, r, (or break-even interest rate) and the low-income-contingency-repayment-tax rate, τ, we solve for the required coupon interest rate, r_c, which determines repayments for borrowers not electing the contingency option. (Study, for example, Figure II, page 43 .) For the well-designed plan the coupon rate of interest, r_c, is only slightly greater than the overall rate of return, r. E.g., in Figure II, if the overall rate of return, r = 6% and the income-contingent-repayment-tax rate is .2% per $1,000 borrowed, then the coupon interest rate, r_c, should be set at 6.17%, only .17 percentage points higher than r. This means that the borrower who turns out to have had high incomes in each repayment year, and therefore has never elected the contingency option, pays an additional .17% in interest rate in order to offset "losses" from the low-income borrowers. If we like, the additional .17 percentage points in interest rate could be thought of as the borrower's insurance premium - insurance against his having income substantially below the average expected income of his graduating class. (The only difference between the terms of this insurance and more conventional insurance policies is that in this case the "premium" is paid by those who have avoided the risk and to some extent only after the insurance period is over.)

A widespread worry about the stability of any contingent repayment loan scheme centers on the question of adverse-self selection by borrowers: The problem that students with poor income prospects might participate in the program with greater frequency than students with good income prospects. We do not see this as a problem for the PCEOB with a coupon rate of interest which is attractive compared to other interest rates facing the borrower. Nonetheless, we have tested the effect of various (rather extreme) adverse self-selection scenarios on the PCEOB. (See, e.g., Figures III and IV, pages 45 and 46.) If adverse self selection is anticipated by the lending institution then the coupon rate, r_c, must be higher than without adverse selection in order to achieve the same overall rate of return, r. r_c is relatively insensitive to adverse selection scenario, see Figure III where at expected income growth rate of 4% even the most extreme anticipated adverse selection (no participants with above median income!) does not increase r_c by as much as a percentage point. From Figure IV we see that the plan is also relatively insensitive to unanticipated adverse selection. If the lender is expecting a return of 6% (at income growth rate of 4%) then even the most extreme adverse selection scenario will yield an overall rate of return, r, greater than 5 1/2%. The PCEOB is also stable with respect to assumptions about income growth rates (Figures III and IV) but when poor income growth rate forecasting is combined with a very extreme adverse selection scenario, the unanticipated shortfall in overall rate of return could nearly reach two percentage points.

The partially contingent (PCEOB) is compared to two other EOB variants: (1) The "fully contingent" variant (essentially the Shell-Zacharias version) and (2) the "semi-conventional" variant (the PCEOB without the contingency option). The fully contingent plan offers the greatest mutualization of risk to the borrower while imposing the most administrative cost on the lender since all borrower incomes are subject to verification. In practice, the fully contingent plan seems to be only slightly less stable in the face of adverse selection than the partially contingent plan. The semi-conventional plan is studied as a benchmark. It is the easiest program to administer, the most stable and offers no mutualization of borrower risk, all because there is no provision for income-contingent repayment.

A brief theoretical section relates the particular applied problem to the pure theory of optimal adverse risk selection, a problem in control and decision-making under uncertainty. Also included is reference to administrative and transactions costs in the theory of equilibrium.

Our basic computer programs are catalogued in several appendices. One appendix attempts to survey the recent (and very rapidly unfolding) experience with pilot-project contingent repayment loan schemes in American higher education.

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INTRODUCTION

We have designed a new variant of the education loan in which repayments are contingent on the borrower's lifetime income stream. We call this variant "the partially contingent Educational Opportunity Bank plan." It has three important properties: (1) relative stability (or insensitivity) of the rate-of-return to assumptions about underlying parameters, (2) relative ease and economy of administration on a smaller-scale or pilot-project basis, while (3) offering much of the income insurance and psychological protection for borrowers provided by earlier EOB proposals. Most noteworthy is the strong stability of the partially contingent program to assumptions about adverse self-selection by EOB participants. We compare the partially contingent variant to two other variants: (1) the "semi-conventional variant," which economizes most on administration costs and is most stable but provides the least insurance for participants, and (2) the "fully contingent variant," which provides the most insurance for participants, but is least economical to administer and is the least stable, (i.e., the most sensitive to assumptions about underlying parameters.)

The Educational Opportunity Bank proposal has been a subject of intensive debate within American higher education ever since the 1967 release of the _Report of the Panel on Educational Innovation_ [3]. Two _National Tax Journal_ articles, Shell _et. al._ [11] in 1968 and Shell [10] in 1970, attempted to sharpen the basis for debate over fundamental issues in higher education finance by providing detailed economic analyses of and "hard numbers" for the Ed Op Bank proposal.

The general Ed Op Bank concept, that students have the opportunity to contract for educational loans which may be repaid over relatively long periods, contingent upon the borrower's lifetime income stream, has by now become a reality on some university campuses.[1] Financial pressure has forced educational institutions to set up their own pilot-project Ed Op Banks.

By contrast, the original proposals had envisioned a federally operated Ed Op Bank which would coordinate its activities with the Internal Revenue Service. Coordination with the IRS would make the contingent-repayment feature relatively easy to enforce since the IRS would have income tax returns at its disposal for crosschecking. Indeed, it was suggested that[2] Ed Op repayments be collected by the IRS in conjunction with the collection of personal income taxes.[3] It was argued, therefore, that <u>economic transactions costs</u> - including costs of <u>collection</u> and <u>enforcement</u> - would be relatively small for the <u>nationally operated Ed Op Bank</u>.

On the other hand, there is no reason to expect transactions costs necessarily to be small for independently operated or pilot-project contingent-repayment loan schemes. In these cases, "true copies" of IRS Form 1040 are not available for confirmations of the incomes on which repayments will be based.[4] If the borrower's statement of income is not to be taken on face value, costly investigation and perhaps legal fees must be incurred by the scheme. Furthermore, independent mailings

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[1] See Appendix D for a brief survey and history of implementations and attempted implementations of income contingent loan repayment plans for higher education.

[2] See, Shell <u>et</u>. <u>al</u>. [11].

[3] The thought was that Form 1040 could accomodate the collection of Ed Op repayments after adding a few extra lines.

[4] It has come to our attention that participants in Yale's Deferred Tuition Plan give Yale the right of receiving true 1040 copies from the IRS. The IRS would charge Yale for each investigation. This is obviously a costly procedure but is perhaps less costly than we seem to imply in the text.

and record-keeping are costly to the lending institution. If the relatively small scale contingent loan scheme is looked upon as a test or pilot project pointing toward the possibility of ultimately adopting the principle on national scale, then a strong case can be made for "outside" support of administrative, research, and those transactions costs expected to disappear when the schemes "go national" and coordinate with the Internal Revenue Service. It seems to us that support of administrative, research, and transactions (collection and enforcement) costs in pilot-project contingent-repayment loan schemes is a proper rôle for the federal government and private philanthropy.

The federal government and private philanthropy have so far been reluctant to provide such support. It is essential, therefore, that the Ed Op Bank be redesigned for smaller-scale application with a view to substantially reducing transactions costs.

We present in this paper a variant of the Ed Op Bank which we call the "partially contingent" scheme.[1] If the operating parameters of this variant are chosen correctly, only a small percentage (between, say, 10% and 30%) of participants are expected to elect repayment contingent upon income. For this reason, enforcement costs and risk to the smaller-scale lending institution can be substantially reduced. In designing the "partially contingent" program, we retain attractive features of the original (or "fully contingent") EOB scheme: (1) The long repayment period (of, say, 20 or 30 or more years) is an essential part. (We even consider the new feature of an after-graduation grace period.[2])

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[1] After completing this study, it has come to our attention that the Ford Foundation PAYE group has proposed a somewhat similar plan which they call their "hybrid" plan. See Pay-As-You-Earn, Ford Foundation Studies in Income Contingent Loans for Higher Education: Summary Report and Recommendations, New York, 1972. Also the forthcoming New Patterns for College Lending: Income Contingent Loans by D. Bruce Johnstone assisted by S. P. Dresch, Columbia University Press.

[2] We understand that Duke University offers a repayment grace period in the terms of their current tuition postponement plan.

(2) Expected <u>repayment increases through time</u> for each borrowing cohort. (3) <u>Insurance against low future income</u> for any participant is retained, but in a simpler form. Only those participants who fall into what is expected to be the lowest few income deciles of their borrowing cohort will base their repayments on income. All others pay a prearranged "coupon rate" per $1,000 borrowed. Unlike the conventional mortgage repayment, coupon repayments are not equal over the life of the loan but instead increase at an exponential rate to accomodate the typical borrower's "ability to pay."

Our "partially contingent" variant is precisely defined in what follows. Its operating characteristics are studied and compared to those of the "fully contingent" variant - essentially the schemes studied by Shell *et. al*. [11] and Shell [10] and what we call a "semi-conventional" variant - essentially the "partially contingent" variant *without* the income contingent provision but with the long repayment period and exponentially increasing repayments geared to *expected* ability to repay.

The "stability" properties of an EOB scheme are of great importance. Any lender, including the federal government, must be concerned with the robustness of expected rate-of-return to assumptions about growth-of-incomes, adverse selection of participants,[1] and so forth. For a variety of reasons, "stability" considerations seem to be more important for the smaller-scale EOB than for the federal EOB: (1) The smaller-scale EOB must be more adverse to financial risk than would a federal EOB because of its relatively small financial base. (2) Because it must support relatively greater administrative and transaction costs and because it

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[1] There is said to be adverse selection of participants when the average income prospects of participants is poorer than that of the college class as a whole.

must borrow money at higher interest rates than the federal government, the smaller-scale EOB will probably seek a higher gross rate-of-return than is envisioned for the national EOB. This, in turn, accentuates the problem of adverse self-selection by participants in the smaller-scale EOB.

Our partially-contingent variant is very robust to assumptions about underlying parameters, especially to assumptions about adverse self-selection by participants. This is another reason why the partially contingent variant should be especially attractive to the smaller-scale EOB. Since stability is also important for the national EOB (but not as vital as it is for the smaller-scale EOB), the partially-contingent variant may also prove to be attractive for any federally-sponsored program.[1]

Our calculations are based on United States medical school data. At the time we began this study, it seemed to us that we might find our first practical EOB applications in this area.[2] In retrospect, this choice appears less than ideal since medical schools as a group now seem to be more resistant to EOB proposals than the other professional schools

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[1] Shell [10] shows that the fully contingent EOB has a stable rate-of-return with respect to what seems to us to be quite extreme assumptions about adverse self-selection of participants. Nonetheless, Hartman [5] and Nerlove [8] express nervousness about the adverse-self-selection problem. Perhaps they will find our partially-contingent variant so stable that adverse self-selection will no longer be considered an issue. In what follows, we clarify aspects of the adverse self-selection problem for it, *per se*, does not entail problems, but coupled with poor income forecasting, it could.

[2] See Shell [9] and Shell [10].

and even some undergraduate colleges. This study stands as a possible guide to medical schools should they turn to this option. More importantly, we hope this study will be of general use in higher education finance;[1] only the data are specific to the medical school case.[2]

We conclude our analysis by relating our underlying and basic problem, the design of an optimal Educational Opportunity Bank, to the recent theoretical literature on optimal adverse risk selection; see, e.g., Akerlof [1] and Arrow [2], optimal income taxation; see, e.g. James Mirrlees [7] and Eytan Sheshinski [12], and economic equilibrium with transactions costs, see, e.g., Foley [4] and Heller [6]. It turns out that the concepts needed for our purposes are just those touched upon by Kenneth Arrow [2] in his remarks on the new theory of optimal adverse-risk selection.

I. The Three EOB Variants

We consider and compare three related loan repayment schemes: a "semi-conventional" plan, a "fully contingent" plan, and a "partially contingent" plan. In all cases, loans are made in the same way; only the way in which loans are repaid distinguishes one plan from the others.

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1 This study is part of a larger report being prepared for the U.S. Department of Health, Education, and Welfare. The larger report will tabulate all our basic computer programs. Users can test their own data on these programs. When available, the larger report can be obtained by writing to Professor Karl Shell, Department of Economics, University of Pennsylvania, Philadelphia, Pa. 19104.

2 However, recent developments among medical schools such as that of the University of Pennsylvania suggest that state legislatures are increasingly unwilling to finance the education of MD's who do not practice in the state in which the university is located. Hence, the proposal seems to have as much a priori appeal as ever. See also Appendix D for a summary of proposals.

Loans are extended to all participants at the beginning of each medical school year. Graduates borrow in each of the four years of medical education, while those who drop out only borrow during their actual enrollment years. (Assumed to equal 2 years) For all participants, interest accrual begins immediately and continues throughout medical school and the ensuing repayment period.

We distinguish borrowers by three classifications in each "cohort," or entering class: income decile, educational achievement (medical-school graduate or dropout), and age (25-64 years). This is the DEA nomenclature of the undergraduate program (see Shell et. al. [11]). Thus, marital status and sex are not elements considered in the present study even though the incomes of female physicians are relatively low. However, we examine the returns of all physicians, in the aggregate, since at least at present female medical students are few in number and, most importantly, since female MD's can be assumed to pursue more or less full-time careers.

Since the medical student's income is likely to be low for a few years after graduation, when he is in the military or in internship, we vary the year in which the repayment period begins. In our computations, we considered at least three alternatives:

(a) repayment begins one year after graduation (at the end of the first year out of medical school; this adds one year's accumulated interest - no grace period);

(b) repayment begins three years after graduation (two-year grace period);

and (c) repayment begins five years after graduation (four-year grace period).

The required parameters for a program utilizing the two-year grace period lie midway between those of programs with no grace period and those with a four year grace period, and thus simulation results for that alternative are presented below only to illustrate aspects of the partially contingent variant.

A. The Semi-Conventional Variant

In this variant there is no income contingency provision. Thus, while no insurance is provided the student borrower, the lender is only exposed to risks from default and - if the lender has borrowed short-term to finance the loan portfolio - risk of increases in the short-term interest rate.[1] The borrower is required to repay his loan plus interest over a given period of time. The semi-conventional loan is thus like a conventional home mortgage, but the repayments stream is not necessarily level during the repayment period. Indeed, in the examples studied here repayments grow at an exponential rate roughly equal to the expected average rate of growth of income for the borrower's cohort, or medical school class.

Our major purpose in examining the semi-conventional repayment scheme is to compare and contrast its terms with those of the other two plans. Notice, however, that its repayment terms are in some ways more favorable to the borrower than existing loan opportunities. Its terms differ from a commercial bank loan in the following ways:

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1 Yale is currently borrowing on a very short term basis - semiannually - to finance its "Postponed-Tuition" loan program.

- the borrower gets a longer repayment period (twenty to thirty years after graduation) than currently available from commercial sources (five to ten years after graduation);
- the borrower has the option of a "grace period," i.e., delay after graduation before beginning repayments;
- the borrower's repayments will grow over time roughly in accord with his expected income growth rather than being maintained at a constant amount.

The first feature makes this repayment scheme closer to that of a home mortgage loan than to a normal bank loan, while the third feature allows repayments to grow roughly with average cohort incomes, reflecting expected ability to pay.

B. The Fully Contingent Programs

Under the "fully contingent plan," the borrower agrees to pay in each of the years of the stated repayment period a fixed fraction of his income in that year. To lessen the impact of adverse self-selection, an opt-out provision is included in the fully contingent plan: no borrower will ever repay more than principal plus interest calculated at the annual rate R, the opt-out interest rate.[1,2] The plan analyzed here and applied to medical education is the same as that described in detail and applied to undergraduate education by Shell *et. al.* [11] save for: (1) inclusion in this study of a grace period in which repayment-taxes are not collected, and (2) equal treatment in this study regardless of sex or martial status, while the undergraduate study

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[1] Making "*fully* contingent" something of a misnomer.

[2] Adverse self-selection occurs when those with poorer income prospects change to participate more frequently than the members of the class with higher income prospects.

provided for special tax-repayment treatment for married women. It has been shown in Shell [10] and replicated in this study's results that the fully contingent plan, with the opt-out provision, generates a rate of return which is quite insensitive to unanticipated adverse self-selection.

C. The Partially Contingent Program

The partially contingent program, which can be thought of as the result of merging features of the semi-conventional plan with features of the fully contingent plan, will be the focus of much of our analytic and empirical investigation. The partially contingent scheme allows each borrower, at the end of each (annual) repayment period, to elect one of two alternative repayments: τ multiplied by his current income Y_t, (τY_t),or the "coupon" from a semi-conventional loan repayment schedule. (Both τ and the "coupon" are set for a $1,000 loan; larger loans increase τ and the "coupon" proportionately.) We expect that low-income earners will choose the former, and that those in higher deciles will opt for the coupon, so that the i^{th} physician's repayment (per thousand dollars borrowed) in period t, P^i_t, may be represented by $P^i_t = \min(\tau Y^i_t, C_t)$, where C_t is the coupon repayment in period t.[1,2] In this program, τ must be set substantially higher than that of a fully

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1 This is a conservative assumption. Documentation would be required for contingent repayment. To avoid the effort of documentation, an MD close to the margin (where $\tau Y^i_t = C_t$) could be expected to choose coupon repayment even though $\tau Y^i_t < C_t$.

2 To protect against possible ambiguities, we will follow the convention that year of repayment, t , will always be relative to the beginning of the repayment period itself (<u>after</u> the borrowing period <u>and</u> grace period.)

contingent scheme earning a comparable rate of return to guarantee that the income-contingent repayment option will be elected only by those participants falling in the lowest few income deciles.

Why is "low contingency" desirable? The coupon program is very simple to administer, whereas tax repayments require both verification of income tax returns and individualized computation of tax. Hence, the fewer participants who elect the income contingency option, the lower the resultant administrative costs will be. Among partially contingent plans yielding the same overall rate of return r, the required rate of interest r_c of the coupon schedule is inversely related to the repayment tax rate τ. Decreasing τ decreases the dollar repayments for individuals electing the income contingency option and thus increases the frequency of election of this option. Therefore, if τ is decreased, ceteris paribus, then r_c must be increased sufficiently to offset the loss of revenue from lower individual repayments under the contingency option and from increased frequency of election of this contingency option which allows the participant to make a smaller payment than is required by the coupon option. As r_c approaches r (from above), τ must become very large to choke off election of the contingency option. It is infeasible to set the coupon rate of return below the overall rate of return ($r_c < r$).

On the other hand, if τ is relatively large, then r_c will be relatively insensitive to a change in τ because of the low frequency of election of the contingency option. In designing the "optimal" partially contingent scheme, the overall required rate of return, r, can be thought of as exogenously given by, say, the lending institution's cost of capital. There is a set of τ and r_c that are compatible with the given r.

Among these feasible (τ, r_c) pairs, the policy-maker will choose τ to be sufficiently large so as to limit expected frequency of election of the contingency option to a manageable level from the point of view of the lender's costs of administration. Since when τ is high fewer elect the contingency option, high τ's tend to make the program relatively insensitive to unanticipated changes in structure, e.g., changes in the rate of growth of incomes or changes in the pattern of adverse self-selection. However, the higher τ, other things being equal, the less income insurance is afforded participants. This then is the trade-off for the policy-maker: the higher τ, the greater the stability and ease of administration, but the lower the income insurance protection afforded to participants.

It is our feeling that a well-designed program has the following approximate characteristics: (1) τ is sufficiently high so that only the lowest few deciles (say the lowest two or three deciles) elect the income contingency option on anything like a regular basis and thus (2) the coupon rate is not very much greater than the overall rate of return. In practice, we focus on programs in which the difference, r_c-r, is roughly between 1/10% and 1%. Such programs, it seems to us, provide much of the most desirable income insurance protection provided by the less stable and more costly-to-administer fully contingent plan.

In judging whether or not a repayment commitment can be an "albatross around his neck," the potential borrower is most likely to focus on what would happen to him in very low income situations. This may be especially the case for the borrower from a low-income family. Such a borrower may be unfamiliar with the high incomes available to members of his profession and may be particularly naive about financial arithmetic and the "miracle of compound interest" as it applies to expected income growth. It seems to us that insurance of the form "you need never pay more than τ per cent of your income for each thousand dollars borrowed" should provide very strong psychological assurance to potential borrowers.[1]

II. Calculations

A. Semi-conventional loans

The most important single parameter for the semi-conventional program is the interest rate or rate of return, r. Since this program allows no income contingency, r can be also thought of as the coupon rate of interest, the overall rate of return, and the opt-out interest rate, since all these rates are the same in this simple program. The semi-conventional loan is fully described by specification of the parameters: r, T, t, and γ. T is the length of the repayment period, t is the length of the grace period after graduation in which repayments are not made, and γ is the prespecified constant annual rate of increase in repayments.

For example, when T = 25 years, t = 0, γ = 10%, and r = 6%, the starting repayment per $1,000 borrowed would be $31.56. The effects of the grace period are substantial, since interest accumulates continually. When t = 4 years, the initial payment rises to $40.57. In both cases, this starting payment and the remainder of the repayment stream are like coupons in a booklet for a mortgage loan - except each

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[1] We are aware that important questions of psychological fact are involved here. We urge study of these questions. At this time we put forward our strong *a priori* beliefs about the role of risk aversion in the student-loan participation decision.

TABLE I-A

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 0.0 % = Y
FROM STARTING PAYMENT OF $ 92.74
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 0 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3099.00	-3000.00	-28099.99
1976	22750.00	416.55	81563.75	4645.39	-4223.94	-26973.94
1977	22750.00	415.82	110156.69	6258.92	-5843.00	-28593.00
1978	0.0	8808.95	107957.13	6609.40	2199.55	2199.55
1979	0.0	8793.34	105641.19	6477.43	2315.91	2315.91
1980	0.0	8777.75	103301.88	6338.47	2439.28	2439.28
1981	0.0	8762.45	100631.50	6192.11	2573.35	2573.35
1982	0.0	8747.13	97922.25	6037.89	2709.24	2709.24
1983	0.0	8731.94	95065.69	5875.34	2856.50	2856.50
1984	0.0	8716.53	92053.06	5703.95	3012.58	3012.58
1985	0.0	8701.22	88875.00	5523.19	3178.03	3178.03
1986	0.0	8682.86	85524.63	5332.51	3350.35	3350.35
1987	0.0	8664.48	81991.63	5131.49	3532.99	3532.99
1988	0.0	8646.14	78264.94	4919.51	3726.63	3726.63
1989	0.0	8627.78	74333.06	4695.91	3931.87	3931.87
1990	0.0	8609.42	70183.63	4460.00	4149.42	4149.42
1991	0.0	8582.09	65812.56	4211.04	4371.05	4371.05
1992	0.0	8554.77	61206.57	3948.78	4606.00	4606.00
1993	0.0	8527.44	56351.55	3672.42	4855.02	4855.02
1994	0.0	8500.10	51232.56	3381.12	5119.09	5119.09
1995	0.0	8472.79	45833.76	3073.98	5398.80	5398.80
1996	0.0	8430.12	40153.69	2750.05	5680.07	5680.07
1997	0.0	8387.41	34175.53	2409.24	5978.16	5978.16
1998	0.0	8344.74	27881.35	2050.56	6294.18	6294.18
1999	0.0	8302.04	21252.21	1672.90	6629.14	6629.14
2000	0.0	8259.36	14269.02	1275.16	6984.20	6984.20
2001	0.0	7805.75	7318.38	856.11	6949.64	6949.64
2002	0.0	7741.30	16.21	439.13	7302.17	7302.17

TABLE I-B

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 0.0 % = Y
FROM STARTING PAYMENT OF $ 118.54
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54599.98	[illegible]	[illegible]	[illegible]
1976	22750.00	0.0	81990.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	528.74	131690.69	7484.12	-6955.38	-6955.38
1981	0.0	527.81	139064.31	7901.44	-7373.63	-7373.63
1982	0.0	11181.77	136226.38	8343.86	2837.91	2837.91
1983	0.0	11162.20	133237.75	8173.60	2988.62	2988.62
1984	0.0	11142.66	130089.21	7994.27	3148.39	3148.39
1985	0.0	11123.06	126771.56	7805.36	3317.70	3317.70
1986	0.0	11099.61	123278.25	7606.30	3493.31	3493.31
1987	0.0	11076.11	119598.81	7396.70	3679.41	3679.41
1988	0.0	11052.66	115722.06	7175.94	3876.72	3876.72
1989	0.0	11029.19	111636.19	6943.34	4085.86	4085.86
1990	0.0	11005.74	107328.63	6698.18	4307.56	4307.56
1991	0.0	10970.79	102797.56	6439.73	4531.05	4531.05
1992	0.0	10935.84	98029.56	6167.97	4767.97	4767.97
1993	0.0	10900.91	93010.44	5881.79	5019.13	5019.13
1994	0.0	10865.99	87725.06	5580.64	5285.34	5285.34
1995	0.0	10831.06	82157.50	5263.52	5567.54	5567.54
1996	0.0	10776.50	76310.44	4929.47	5847.03	5847.03
1997	0.0	10721.93	70167.13	4578.65	6143.27	6143.27
1998	0.0	10667.36	63709.82	4210.05	6457.30	6457.30
1999	0.0	10612.81	56919.63	3822.62	6790.19	6790.19
2000	0.0	10558.24	49776.59	3415.21	7143.04	7143.04
2001	0.0	10471.77	42291.45	2986.62	7485.14	7485.14
2002	0.0	10395.32	34443.64	2537.52	7847.81	7847.81
2003	0.0	10298.88	26211.41	2066.65	8232.23	8232.23
2004	0.0	10212.43	17571.70	1572.72	8639.71	8639.71
2005	0.0	9648.84	8977.19	1054.33	8594.50	8594.50
2006	0.0	9525.20	-9.34	538.66	8986.54	8986.54

TABLE I-C

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 31.56
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 0 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3090.00	-3090.00	-28089.99
1976	22750.00	141.77	81838.50	4640.30	-4498.62	-27248.61
1977	22750.00	155.67	110709.06	6275.30	-6119.63	-28869.63
1978	0.0	3027.73	114322.81	6642.48	-3614.75	-3614.75
1979	0.0	3324.61	117857.56	6859.37	-3534.76	-3534.76
1980	0.0	3650.58	121278.44	7071.46	-3420.88	-3420.88
1981	0.0	4008.63	124546.50	7276.71	-3268.07	-3268.07
1982	0.0	4401.79	127617.50	7472.79	-3071.01	-3071.01
1983	0.0	4833.48	130441.06	7657.05	-2823.57	-2823.57
1984	0.0	5307.50	132960.00	7826.46	-2519.96	-2519.96
1985	0.0	5828.00	135109.56	7977.60	-2149.61	-2149.61
1986	0.0	6397.25	136918.88	8106.58	-1709.32	-1709.32
1987	0.0	7022.11	138005.88	8209.14	-1187.03	-1187.03
1988	0.0	7707.94	138578.25	8280.36	-572.42	-572.42
1989	0.0	8460.72	138432.19	8314.70	146.02	146.02
1990	0.0	9286.97	137451.13	8305.95	981.03	981.03
1991	0.0	10183.23	135514.94	8247.09	1936.14	1936.14
1992	0.0	11165.91	132479.94	8130.91	3034.99	3034.99
1993	0.0	12243.25	128185.50	7948.82	4294.43	4294.43
1994	0.0	13424.41	122452.19	7691.15	5733.27	5733.27
1995	0.0	14719.34	115079.94	7347.15	7372.19	7372.19
1996	0.0	16109.70	105875.00	6904.82	9204.88	9204.88
1997	0.0	17630.94	94596.56	6352.53	11278.41	11278.41
1998	0.0	19295.32	80977.06	5675.82	13619.49	13619.49
1999	0.0	21116.25	64719.46	4858.66	16257.60	16257.60
2000	0.0	23109.40	45494.27	3883.20	19225.20	19225.20
2001	0.0	23787.78	24436.18	2729.69	21058.09	21058.09
2002	0.0	25950.51	-48.12	1466.21	24484.30	24484.30

TABLE I-D

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 40.57
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3090.00	-3090.00	-28089.99
1976	22750.00	0.0	81980.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	182.96	132038.44	7484.12	-7301.16	-7301.16
1981	0.0	198.71	139762.00	7922.31	-7723.61	-7723.61
1982	0.0	3864.81	144282.88	8385.73	-4520.91	-4520.91
1983	0.0	4243.84	148696.00	8656.98	-4413.14	-4413.14
1984	0.0	4660.04	152957.69	8921.77	-4261.73	-4261.73
1985	0.0	5117.03	157018.13	9177.47	-4060.44	-4060.44
1986	0.0	5616.86	160922.31	9521.10	-3904.25	-3904.25
1987	0.0	6165.46	164406.19	9649.36	-3483.90	-3483.90
1988	0.0	6767.64	167396.94	9858.39	-3090.75	-3090.75
1989	0.0	7428.58	170012.19	10043.83	-2615.25	-2615.25
1990	0.0	8154.06	172058.81	10200.75	-2046.69	-2046.69
1991	0.0	8940.99	173441.38	10323.55	-1382.56	-1382.56
1992	0.0	9803.76	174044.06	10406.50	-602.74	-602.74
1993	0.0	10749.66	173737.06	10442.66	307.00	307.00
1994	0.0	11786.73	172374.56	10424.24	1362.49	1362.49
1995	0.0	12923.72	169793.31	10342.49	2581.23	2581.23
1996	0.0	14144.43	165936.50	10187.62	3956.81	3956.81
1997	0.0	15480.12	160306.56	9950.21	5529.91	5529.91
1998	0.0	16941.45	152983.50	9618.41	7323.04	7323.04
1999	0.0	18540.27	143622.25	9179.02	9361.25	9361.25
2000	0.0	20289.42	131950.13	8617.35	11672.07	11672.07
2001	0.0	22135.59	117731.56	7917.03	14218.56	14218.56
2002	0.0	24148.09	100647.38	7063.91	17084.18	17084.18
2003	0.0	26341.76	80344.44	6038.87	20302.89	20302.89
2004	0.0	28732.70	56432.43	4820.69	23912.01	23912.01
2005	0.0	29569.11	30249.30	3385.97	26183.13	26183.13
2006	0.0	32109.22	-44.93	1814.99	30294.23	30294.23

payment is larger than the one preceding. To illustrate the effects of growth in repayments, we drop γ to zero - all payments are thus equal. For the above two grace period variants, ceteris paribus, when $\gamma = 0\%$, the respective starting (and all succeeding) repayments are $92.73 and $118.54. Over 25 years, the MD would pay over $600 extra in interest for the privilege of a four year grace period, per $1,000 borrowed, when all payments are equal ($\gamma = 0$). To compare these repayment schedules with repayment terms more generally available today, if the repayment period (T) were shortened to ten years, with $\gamma = 0$, $t = 0$, and $r = 6\%$, repayments would be $158.96 per year per $1,000 borrowed.

Tables I(a) through I(d) present the cash flows resulting from these four parameter combinations in the semi-conventional repayment plan. The parameters which are operative in each plan are outlined above the cash flow table, all parameters being held constant except the starting payment, which is solved for by an iterative process. These cash flows also illustrate our basic experimental design:

a. 100 borrowers (91 graduates and 9 dropouts)

b. $250 loan per year for each borrower

c. Graduates borrow 4 years, dropouts borrow 2 years

d. Mortality considerations - see Appendix B (note slight decrease in dropouts' repayments from 1976 to 1977 and continual decrease in repayments for grads and dropouts from 1978 on - in the equal repayments design, $\gamma = 0\%$)

e. Repayment period (if no grace period) begins immediately after year of graduation or of dropping out (thus drop-outs start and end repayments two years before graduates)

It is instructive to note the starting payment and maximum outstanding debt in each of these four programs for the above group of 100 borrowers entering medical school in the year 1974:

t	T	γ	Starting Payment	Max Outs Debt (Year) In Thousands of Dollars
0	25	0%	92.73	110 (1977)
4	25	0%	118.54	136 (1982)
0	25	10%	31.56	138 (1988)
4	25	10%	40.57	174 (1992)

Of course, equal repayments (and thus high starting payment) with no grace period require the least outstanding debt, as bank receipts begin reduction of principal immediately after graduation (1977). It must be stressed that all four programs yield a 6% return over the 25-year repayment period, only the timing of repayments (and thus the interest charges) differ.

B. Fully Contingent Program

The results of our tax and interest rate calculations for the fully contingent scheme are presented in Tables III and IV. The fully contingent program is precisely described by the parameters τ, g, R, r, T and t, where τ is the repayment tax rate per $1,000 borrowed, g is the growth rate of incomes assumed for the borrowing cohort, R is the opt-out rate of interest at which a borrower may exit from the program before T years have elapsed, and the other parameters are the same as in the semi-conventional variant. Given a desired (r, R) pair, τ is the single most important decision parameter, and it is the one for which we solve, given the others (Naturally g is not a policy parameter, but it is nonetheless an exogenous parameter of the program).

The annual payment made prior to opting out in year x of the repayment period for a borrower in the ith income decile (per $1,000 borrowed at the end of medical school), P_x^i,[1] will be τY_x^i. Hence, outstanding debt of such an individual in year T_j in thousand dollars calculated at the opt-out rate R is equal to

$$\tilde{B}^i - \sum_{\theta=1}^{\theta=T_j} (1 + R)^{-(\theta+t)} \tilde{B}^i \tau Y_\theta^i \equiv B^{*i}(T_j)$$

where $T_j < T_i \leq T$, T_i is the opt-out year, and $\tilde{B}^i$ in the graduation debt in thousands of dollars of individual i. In the opt-out year, T_i, $B^{*i}(T_i) \leq 0$, while $B^{*i}(T_j) > 0$ for $T_j < T_i$. In year T_i payments are reduced so that the equality $B^{*i}(T_i) = 0$ holds. If $T_i < T$, this individual opts out, and if $T_i \geq T$, he does not. Actually, interest must be paid on the first year's loan during the four years in medical school, on the second year's loan for the next three years, and so on, it being assumed that the loan is evenly distributed over four years of medical school, so that

$$\tilde{B}^i = 250 \quad B^i[\sum_{j=1}^{4} (1+R)^j],$$

where B^i is the number of thousands of dollars actually borrowed exclusive of interest accumulated during medical school.

Medical school drop-outs (assumed to leave school after their second year and enter repayment period immediately)[2] must "solve for" T_i, their opt-out year, such that

$$250 \; B^i[\sum_{j=1}^{2} (1+R)^j] \leq \frac{1}{2} \tau \; B^i \sum_{\theta=1}^{T_i} [(1+R)^{-(\theta+t)} Y_\theta^i].$$

---

[1] See Page 11 for explanation of P_x notation.

[2] This differs from the undergraduate proposal in Shell, et. al., Op. cit. in which all members of the cohort pay back over the same period. Here drop-outs begin and end their loan repayment period two years before the graduates.

Then if $T_i < T$ the payment required from ith the decile borrowers in their opt-out year, T_i , is:

$$P^i_{T_i} = (1+R)^{T_i+t} [B^*i - \sum_{\theta=1}^{(T_i-1)} P^i_\theta (1+R)-(\theta+t)] ,$$

and obviously $P^i_x = 0$ when $x > T_i$ (or $x > T$), since the loan is paid off. (See Appendix C for the cash-flow algorithm actually used in solving for the desired variables.)

In our computations, the breakeven interest rate (r) is set at 6%, the opt-out rate (R) is stipulated to be 8%, and we vary the length of the grace period (t), the expected growth rate of incomes after 1974 (g), and the possibilities of adverse self-selection under several scenarios. Table II enumerates seven possible participation scenarios, ranging from 100% in all deciles, to partial participation by only the lower five deciles. We do not expect much adverse selection, but anything can happen, as critics of such plans suggest (cf. Nerlove [8] and Hartman [5]). Further, adverse selection may be "unanticipated." We recognize this possibility and test the strength of the programs to these very extreme scenarios, using the rate of return as a criterion. Testing for "unanticipated" adverse self-selection is done only for the partially contingent program. We may infer, however, from our exercises with "anticipated" adverse selection with the fully contingent plan, that the rate of return will behave analogously to that in the exercises in Shell [10]; the two plans are not dissimilar.

Table II

Adverse Self-Selection Scenarios

Scenario No.	% Decile participating in the program									
	Decile									
	1	2	3	4	5	6	7	8	9	10
1	100	100	100	100	100	100	100	100	100	100
2	100	95	90	85	80	75	70	65	60	55
3	100	90	80	70	60	50	40	30	20	10
4	100	90	80	70	55	45	30	15	0	0
5	100	90	80	70	45	30	15	0	0	0
6	100	90	80	60	40	20	0	0	0	0
7	100	80	60	40	10	0	0	0	0	0

Our income data are more limited in scope than we would like (see Appendix A for derivation of income data). They do not indicate precisely at what age the largest jump in income occurs; however, in 1959, for MD's thirteen years after graduation, mean income was of the order 2.6 times that of those physicians out of school three years. (See Appendix Table A-1). Thus, allowing repayment to begin five years after graduation yields about a 20% drop in the magnitude of the tax rates required to enable the Bank to break even, cet.par.

The computational results in Table III for the fully contingent program emphasize the high returns to medical education as well as the relative stability to adverse selection of this variant. A physician entering medical school in 1974 would, if required to pay his loan back over twenty years starting one year from graduation day, pay Ed-Op repayment taxes at the rate of τ = .17% per $1,000 borrowed. (See Part 3, Table III.) If T = 30 years, τ drops to .10%, as compared with a .59% rate for the same undergraduate cohort, with similar assumptions (Shell, et. al., Table IV.15, p. 25). As mentioned above, the postponement of the repayment period's initial year substantially reduces the tax rate. For example, for T = 20, boosting t to 4 drops τ by 20% (.167% versus .132%), and when T = 30, τ drops by 11% (.100% versus .089%).

Given these parameters, the program is so attractive that only the top three deciles opt-out prior to the normal terminal year, T. Table IV presents the opt-out years (relative to T) for each of the four scenarios above, plus those for T = 25 years. The opt-out year for the 10th decile for t = 0, T = 20, occurs half-way through the repayment period, a fact which depends explicitly on the high average income we assume for that decile relative to the others, since given the assumed Pareto distribution, the top five percent of physicians earn nearly 50% more than the top 15 percent on the average (see Table A-4 in Appendix A). Hence, we expect that these physicians would be breaking even on their investment in medical education, even at 8%, in a short time period.

As can be seen from Part 4 of Table III, boosting the required rate of return to the bank to 8% and the opt-out rate commensurately to 10% raises the repayment tax rate, τ , by slightly more than the same percentage amount; i.e., the elasticity of τ with respect to the r , setting R by R-r = 2%, is greater than one and positive. Using the midpoint ARC elasticity:

$$\left(\frac{E\tau}{Er}\right)_{R-r=2\%} = \left[\frac{(r_1+r_2)/2}{(\tau_1+\tau_2)/2}\right]\left[\frac{\Delta\tau}{\Delta r}\right] = \left(\frac{r_1+r_2}{\tau_1+\tau_2}\right)\left(\frac{\tau_2-\tau_1}{r_2-r_1}\right)$$

This is because, with the higher opt-out rate, R , rich MD's cannot opt-out so quickly, thus accruing more interest to pay off in the form of a higher per-year (higher τ) payment, while delay of the opt-out dates through increasing pre-opt-out mortality shifts a greater burden of repayment onto the survivors.

Figure I depicts the relationship between r and τ , when R = 8%. The opt-out rate is an asymptote for $r = f(\tau)$, and of course, as $\tau \to 0$, $r \to -\infty$.

The cash flow outlined in Table V (D) shows the total repayment stream $\left(\sum_{i=1}^{10}\sum_{X=1}^{25} P_X^i\right)$* for all borrowers participating in a fully contingent program with parameters similar to those of the semi-conventional plan represented in Table I (d): t = 4, T = 25, r = 6%. The total repayments in this fully contingent program are larger than those of the comparable semi-conventional scheme in years 1984-1996, but drop off

* See Page 11 for explanation of P_X^i notation.

Figure I

Fully Contingent Program: Rate of Return, r, as a Function Tax Rate, τ, for the Fully Contingent Program with:

Opt-out Rate, R, = 8%
Grace Period, t = 0 years
Repayment Period, T = 25 years

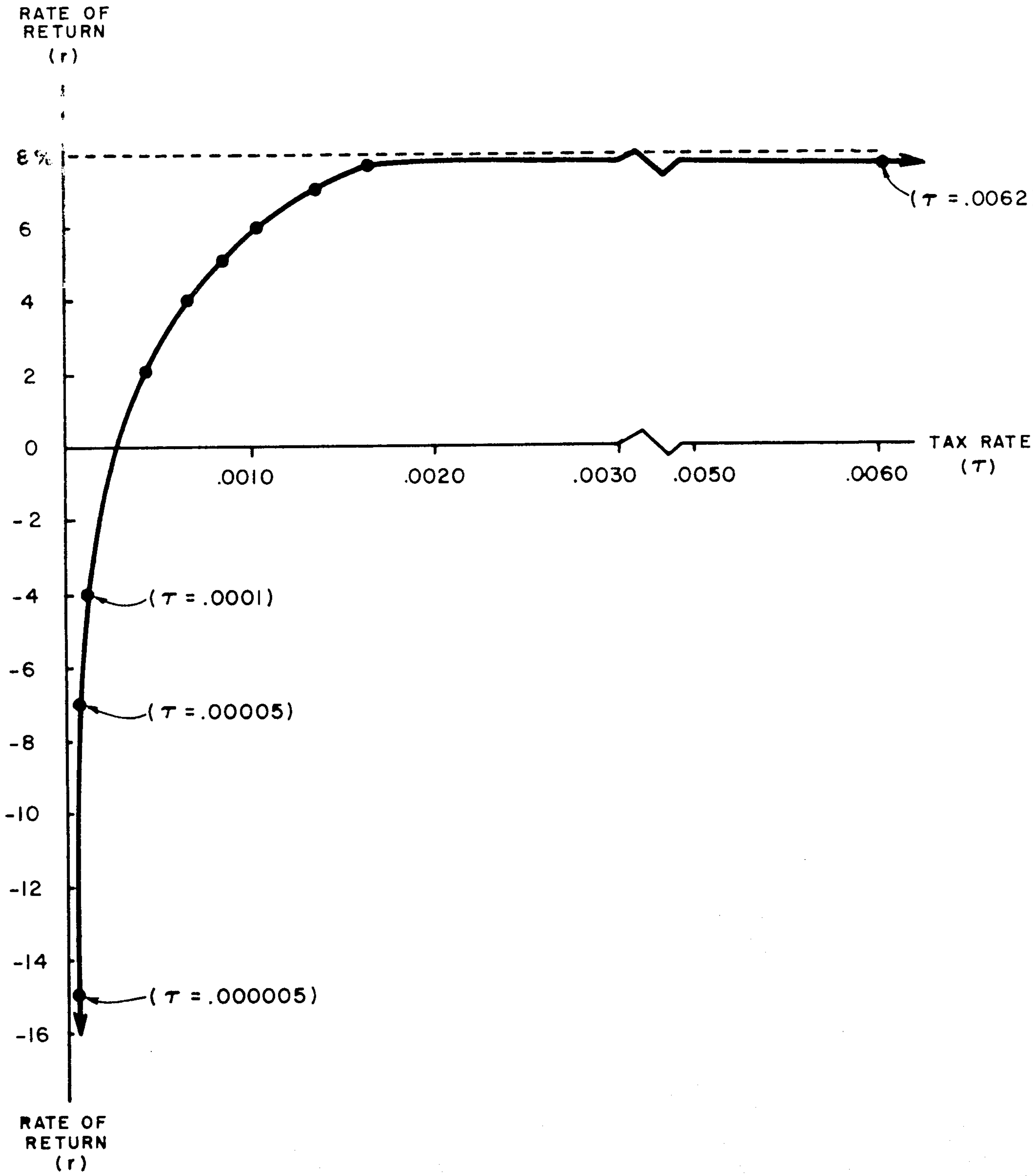

TABLE III

Fully Contingent Program:

Repayment tax rate, per thousand dollars borrowed, when the rate of return (r) = 6%, the opt-out rate (R) = 8%, repayments begin t years (varied) after graduation, and the repayment period (T) = 25 years, and g is the assumed rate of growth of physicians' incomes after 1974, for a class entering in 1974.

1. t = 0 (no grace period): τ (per cent/$1,000 borrowed)

Adverse self-selection Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1*	.1223%	.1461%	.1741%	.2041%
2	.1269	.1513	.1803	.2144
3	.1347	.1604	.1905	.2258
4	.1388	.1650	.1957	.2317
5	.1422	.1690	.2003	.2368
6	.1443	.1714	.2031	.2399
7	.1464	.1735	.2051	.2416

2. t = 4 (4 year grace period)

Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1*	.1045%	.1276%	.1552%	.1884%
2	.1093	.1331	.1617	.1958
3	.1167	.1417	.1717	.2073
4	.1208	.1466	.1774	.2139
5	.1240	.1504	.1818	.2190
6	.1259	.1525	.1842	.2217
7	.1270	.1545	.1862	.2234

* Scenario #1 represents full participation - no adverse self-selection.

3. τ for varying (t,T) with no adverse self-selection and g=5% (r=6%, R=8%)

T	t	τ
20	0	.1673%
20	4	.1323
30	0	.1000
30	4	.0889

4. τ for varying (t,T) with no adverse self-selection and g=5% (r=8%, R=10%)

T	t	τ
20	0	.2259%
20	4	.1864
25	0	.1723
25	4	.1537
30	0	.1457
30	4	.1357

TABLE IV

Fully Contingent Program:

Opt-out years by income decile, expressed as years after the repayment period begins.

Program	Decile 8th	Decile 9th	Decile 10th
t=0, T=20	19	17	11
t=4, T=20	*	18	12
t=0, T=25	*	21	14
t=4, T=25	*	18	15
t=0, T=30	*	26	22
t=4, T=30	*	29	18

*Eighth decile does not repay principal plus eight per cent interest in less than T years.

Parameters correspond to those in Table III, Part 3 (r=6%, R=8%, g=5%, no adverse selection).

TABLE V-A

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54589.98	3090.00	-3090.00	-28089.99
1976	22750.00	0.0	81990.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111314.66	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.88	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	64.28	132155.13	7484.12	-7419.84	-7419.84
1981	0.0	68.83	140015.56	7929.31	-7860.48	-7860.48
1982	0.0	3369.09	145047.38	8400.94	-5031.85	-5031.85
1983	0.0	4145.89	149604.31	8702.85	-4556.96	-4556.96
1984	0.0	4989.65	153590.88	8976.27	-3986.62	-3986.62
1985	0.0	5904.97	156901.31	9215.46	-3310.50	-3310.50
1986	0.0	6894.38	159421.00	9414.09	-2519.71	-2519.71
1987	0.0	7964.75	161021.50	9565.28	-1600.52	-1600.52
1988	0.0	9121.58	161561.19	9661.31	-539.73	-539.73
1989	0.0	10370.63	160884.19	9693.69	676.94	676.94
1990	0.0	11718.09	158819.13	9653.17	2065.02	2065.02
1991	0.0	13156.73	155191.56	9529.17	3627.56	3627.56
1992	0.0	13867.95	150635.13	9311.52	4556.43	4556.43
1993	0.0	14616.75	145056.50	9038.13	5578.62	5578.62
1994	0.0	15405.13	138354.75	8703.41	6701.72	6701.72
1995	0.0	16235.06	130421.00	8301.31	7933.75	7933.75
1996	0.0	15965.88	122280.38	7825.29	8140.59	8140.59
1997	0.0	14575.64	115041.56	7336.86	7238.79	7238.79
1998	0.0	15323.86	106620.19	6902.53	8421.33	8421.33
1999	0.0	16109.36	96908.06	6397.25	9712.12	9712.12
2000	0.0	16934.11	85788.44	5814.52	11119.59	11119.59
2001	0.0	17745.85	73189.88	5147.34	12598.51	12598.51
2002	0.0	18155.76	59425.55	4391.43	13764.32	13764.32
2003	0.0	18568.05	44423.08	3565.58	15002.47	15002.47
2004	0.0	17626.14	29462.37	2665.43	14960.71	14960.71
2005	0.0	15943.66	15286.50	1767.79	14175.88	14175.88
2006	0.0	16195.74	8.00	917.23	15278.50	15278.50

OPT-OUT YEARS (BY DECILE OF MOIS , STARTING WITH THE LOWEST) : 25-25-25-25-25-25-25-25-23-15-.

OPT-OUT YEARS (FOR DROPOUTS) : 25

TABLE V-B

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 1

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.99	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.41	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.98	-741.98
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	174.53	14667.12	840.10	-665.57	-665.57
1983	0.0	232.97	15314.18	880.03	-647.05	-647.05
1984	0.0	296.63	15936.40	918.85	-622.22	-622.22
1985	0.0	365.87	16526.71	956.18	-590.31	-590.31
1986	0.0	440.94	17077.37	991.60	-550.66	-550.66
1987	0.0	522.33	17579.67	1024.64	-502.31	-502.31
1988	0.0	610.49	18023.96	1054.78	-444.29	-444.29
1989	0.0	705.87	18399.53	1081.44	-375.57	-375.57
1990	0.0	808.96	18694.54	1103.97	-295.01	-295.01
1991	0.0	919.30	18896.90	1121.67	-202.37	-202.37
1992	0.0	967.77	19062.95	1133.81	-166.05	-166.05
1993	0.0	1018.73	19187.99	1143.78	-125.05	-125.05
1994	0.0	1072.33	19266.94	1151.28	-79.95	-79.95
1995	0.0	1128.71	19294.24	1156.02	-27.30	-27.30
1996	0.0	1185.86	19266.04	1157.65	28.20	28.20
1997	0.0	1245.81	19176.19	1155.96	89.85	89.85
1998	0.0	1308.73	19018.02	1150.57	158.16	158.16
1999	0.0	1374.75	18784.35	1141.08	233.67	233.67
2000	0.0	1444.01	18467.40	1127.06	316.95	316.95
2001	0.0	1512.09	18063.35	1108.04	404.05	404.05
2002	0.0	1540.95	17606.20	1083.80	457.15	457.15
2003	0.0	1569.52	17093.05	1056.37	513.15	513.15
2004	0.0	1597.72	16520.91	1025.58	572.14	572.14
2005	0.0	1606.20	15905.96	991.25	614.95	614.95
2006	0.0	1626.01	15234.30	954.36	671.65	671.65

TABLE V-C

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 5

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.99	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11191.49	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.98	-741.98
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	234.09	14607.56	840.39	-606.30	-606.30
1983	0.0	302.65	15181.36	876.45	-573.80	-573.80
1984	0.0	377.29	15714.95	910.88	-533.59	-533.59
1985	0.0	458.40	16199.45	942.90	-484.50	-484.50
1986	0.0	546.25	16625.17	971.97	-425.72	-425.72
1987	0.0	641.44	16991.24	997.51	-356.08	-356.08
1988	0.0	744.45	17255.66	1018.88	-274.42	-274.42
1989	0.0	855.85	17435.14	1035.34	-179.49	-179.49
1990	0.0	976.18	17505.07	1046.11	-69.93	-69.93
1991	0.0	1104.88	17450.59	1050.30	54.57	54.57
1992	0.0	1163.78	17333.75	1047.03	116.75	116.75
1993	0.0	1225.76	17148.01	1040.03	185.73	185.73
1994	0.0	1290.98	16885.91	1028.88	262.10	262.10
1995	0.0	1359.61	16539.45	1013.16	346.46	346.46
1996	0.0	1429.21	16102.61	992.37	436.84	436.84
1997	0.0	1502.28	15566.48	966.16	536.13	536.13
1998	0.0	1578.99	14921.47	933.99	645.00	645.00
1999	0.0	1659.52	14157.24	895.29	764.23	764.23
2000	0.0	1744.04	13262.63	840.44	904.61	904.61
2001	0.0	1827.19	12231.20	795.76	1031.43	1031.43
2002	0.0	1866.77	11098.30	733.87	1132.90	1132.90
2003	0.0	1906.37	9357.83	665.90	1240.47	1240.47
2004	0.0	1945.94	8503.36	591.47	1354.47	1354.47
2005	0.0	1966.13	7047.43	510.20	1455.93	1455.93
2006	0.0	1996.40	5473.88	422.85	1573.55	1573.55

TABLE V-D

FULLY CONTINGENT PROGRAM

OPT-OUT RATE = 8.00 % = R
REQUIRED RATE OF RETURN = 6.00 %
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.001045500 = τ

DECILE # 10

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5453.99	303.99	-303.99	-2803.99
1976	2275.00	0.0	9198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	6.43	13215.51	748.41	-741.98	-741.98
1981	0.0	6.88	14001.56	792.93	-786.05	-786.05
1982	0.0	922.58	13919.07	840.09	82.49	82.49
1983	0.0	1048.35	13705.87	835.15	213.21	213.21
1984	0.0	1184.09	13344.14	822.35	361.73	361.73
1985	0.0	1330.45	12814.33	800.65	529.80	529.80
1986	0.0	1487.63	12095.56	768.86	718.77	718.77
1987	0.0	1656.78	11164.51	725.73	931.05	931.05
1988	0.0	1838.69	9995.69	669.87	1168.82	1168.82
1989	0.0	2034.18	8561.25	599.74	1434.44	1434.44
1990	0.0	2244.14	6830.79	513.68	1730.46	1730.46
1991	0.0	2466.92	4773.71	409.85	2057.07	2057.07
1992	0.0	2604.89	2455.25	286.42	2318.46	2318.46
1993	0.0	2750.35	-147.79	147.32	2603.03	2603.03
1994	0.0	2903.67	-3060.32	-8.86	2912.54	2912.54
1995	0.0	3065.29	-6309.23	-183.62	3248.90	3248.90
1996	0.0	2118.01	-8805.79	-378.55	2496.57	2496.57
1997	0.0	15.72	-9349.86	-528.34	544.07	544.07
1998	0.0	16.24	-9927.08	-560.99	577.23	577.23
1999	0.0	16.78	-10539.48	-595.62	612.40	612.40
2000	0.0	17.33	-11189.18	-632.37	649.70	649.70
2001	0.0	17.84	-11878.37	-671.35	689.19	689.19
2002	0.0	18.19	-12609.26	-712.70	730.89	730.89
2003	0.0	18.55	-13384.36	-756.55	775.10	775.10
2004	0.0	18.90	-14206.32	-803.06	821.96	821.96
2005	0.0	0.0	-15058.69	-852.38	852.38	852.38
2006	0.0	0.0	-15962.21	-903.52	903.52	903.52

sharply in 1997 and then again in 2005. This may be explained by noting the exercise of the opt-out feature by deciles nine and ten (decile ten opts-out in 1996, 15 years after his initial payment; decile five opts-out in 2004, 23 years after his initial payment.) Looking to Tables II (b), (c) and (d), one sees how the incidence of the repayment burden is distributed over three representative deciles:
one, five and ten. The largest difference, of course, is between deciles five and ten, as the highest-income graduates make relatively large repayments until their opt-out year, 1996. The last four payments made by this decile ten borrower represent his subsidization of deciles one through nine (note that he had almost repaid his loan, at 6%, in 1992.) This pattern holds over all of our sample fully-contingent repayment schemes: High payments by the upper two or three deciles serve to reduce the debt rapidly in the early years of the cohort repayment period and thus lessen interest accrual and the repayment burden of the lower income deciles.

C. Partially Contingent Plan

To describe the partially contingent variant we add a new parameter to and delete an old one from the parameters of the fully contingent scheme. The coupon rate (the new parameter), r_c, is the interest rate implied by the coupon repayment schedule which constitutes one of the two options available to the MD each year. To determine r_c, and thus the payments schedule, (which grows at γ per cent per annum, as in the semi-conventional variant), we must set T, the length of time over which all borrowers are obligated to make repayments, τ, the repayment tax rate per $1,000 borrowed, and t, the grace period, and we must make an assumption about g, the rate of growth of MD's incomes. The coupon payment option replaces the opt-out feature, and R is therefore not included in the parameter list of the partially contingent scheme. If we specify a rate of return, r, and all other parameters except τ and r_c, we may solve equally well for either τ or r_c, given the other. In practice, we set τ and solve for r_c, so that we may retain τ's which are comparable to those tested in the fully contingent variant.

Perhaps the borrowing MD's repayment choice may best be illustrated by presentation of the following specimen form letter, Figure II, which might be sent as his annual bill.

As mentioned above, P_t^i, the payment made by a doctor in the ith income decile in year t following graduation, is min $(\tau Y_t^i, C_t)$, per thousand dollars borrowed. Borrowings, $\tilde{B}^i$, inclusive of accumulated interest during medical school remain the same as above; i.e.

$$\tilde{B}^i = 250\ B^i\ [\sum_{j=1}^{4} (1 + r_c)^j]$$

Note that here, r_c is used to compute interest accumulated, whereas under the fully contingent scheme, the opt-out rate, R, is used to determine B^{*i} and thus T_i. Given a feasible (τ, r_c) combination it will always be true that the present value of the coupon schedules repayment stream at the time of graduation will be greater than or equal to the outstanding debt at that time:

$$\sum_i B^{*i} \leq \sum_{\theta=1}^{T} (1+r_c)^{-(\theta+t)}(1 + \gamma)^{\theta} C_0 ,$$

where C_0 is the payment in the initial year. Now, $C_t = C_0(1 + \gamma)^t$. Note also that this inequality becomes an equality if, and only if, τ is sufficiently high so that the contingency option is never exercised and there is no mortality during the period.

FIGURE II

UPSTATE UNIVERSITY

Medical Education Opportunity Bank

College Town California 94302

April 15, 1979

Dr. John Q. Borrower
Smalltown Hospital
Smalltown, New York 10708

Dear Dr. Borrower:

In 1974 you borrowed $x thousand for your medical education to be repaid over a 30-year period. As you know, each year you are given the choice of meeting your repayment obligation with a coupon, which this year is $Y, or with a tax repayment, for which the tax rate is 0.Z% (0.00Z) from your current adjusted gross income, whichever is less. The coupon payment is Y% higher than last year, reflecting your increased ability to pay as your income grows.

Your payment is due within thirty (30) days of the date on this letter. Please transfer funds electronically if possible, to our account number xxxyyy-zzz. If you choose the tax payment, code your social security number with the payment and attach a certified "true copy" of the form 1040 you submitted with your Federal Income tax.

Sincerely,

Joseph H. President
Medical Educational
Opportunity Bank

JHP/ecc

Similarly, a feasible (τ, r_c) combination will insure the validity of the following inequality, where P_θ^k represents the repayments by all individuals belonging to the set K in year θ of their repayment period.

$$\left[\sum_{j=1}^{4} L_j \left\{\sum_i n_1^i (1+r)^j\right\}\right] \leq \sum_{\theta=1}^{T} (1+r)^{-(\theta+t)}\left[\sum_{k\in D} n_\theta^k P_\theta^k + \frac{1}{2}\sum_{k\in D} n_\theta^k P_\theta^k\right]$$

where L_j is the loan extended in year j , $i \in G, D^*$ if $j \leq 2$, $i \in G$ otherwise and n_y^i is the number of persons in the ith decile in year $\frac{x}{y}$. Now, since $P_\theta^k = \tau Y_\theta^k$, if we hold τ fixed, we may determine C_0 from the above, and hence r_c . This constitutes the relationship between r_c and τ: given r and τ, the payments min $(\tau Y_t^i , C_t)$ must be sufficient to reduce outstanding debt to zero in T years.

Results from the partially contingent program are presented in Tables VI - IX and Figures III and IV. In Table VI, we explore r = 6% with τ = .26%. This yields a "coupon rate," r_c , which becomes increasingly close to the rate of return, r, as the grace period, t, is extended. This is because MDs' incomes grow very quickly in the first four years, so fewer chose the τY_t option when the grace period was available. In general, for both r = 6% and r = 8%, it was felt that the τY_t option was elected too frequently (to realize our goal of minimizing administrative costs) in schemes with a short or no grace period, since even the higher income MD's exercise the option. A τ of .33% seems to give a somewhat "attractive" pattern in the r = 8% program; except for low or zero t, there is not much change.

(Attractive has the meaning of the above discussion with reference to

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* G means graduates, and D means dropouts.

Figure III

Partially Contingent Program with: ISO - r LOCI

Grace Period, t = 4
Repayment Period, T = 25
Income Growth, g = 5%

No Adverse Selection
(scenario = 1)
Growth of Coupon Payments
γ = 10%

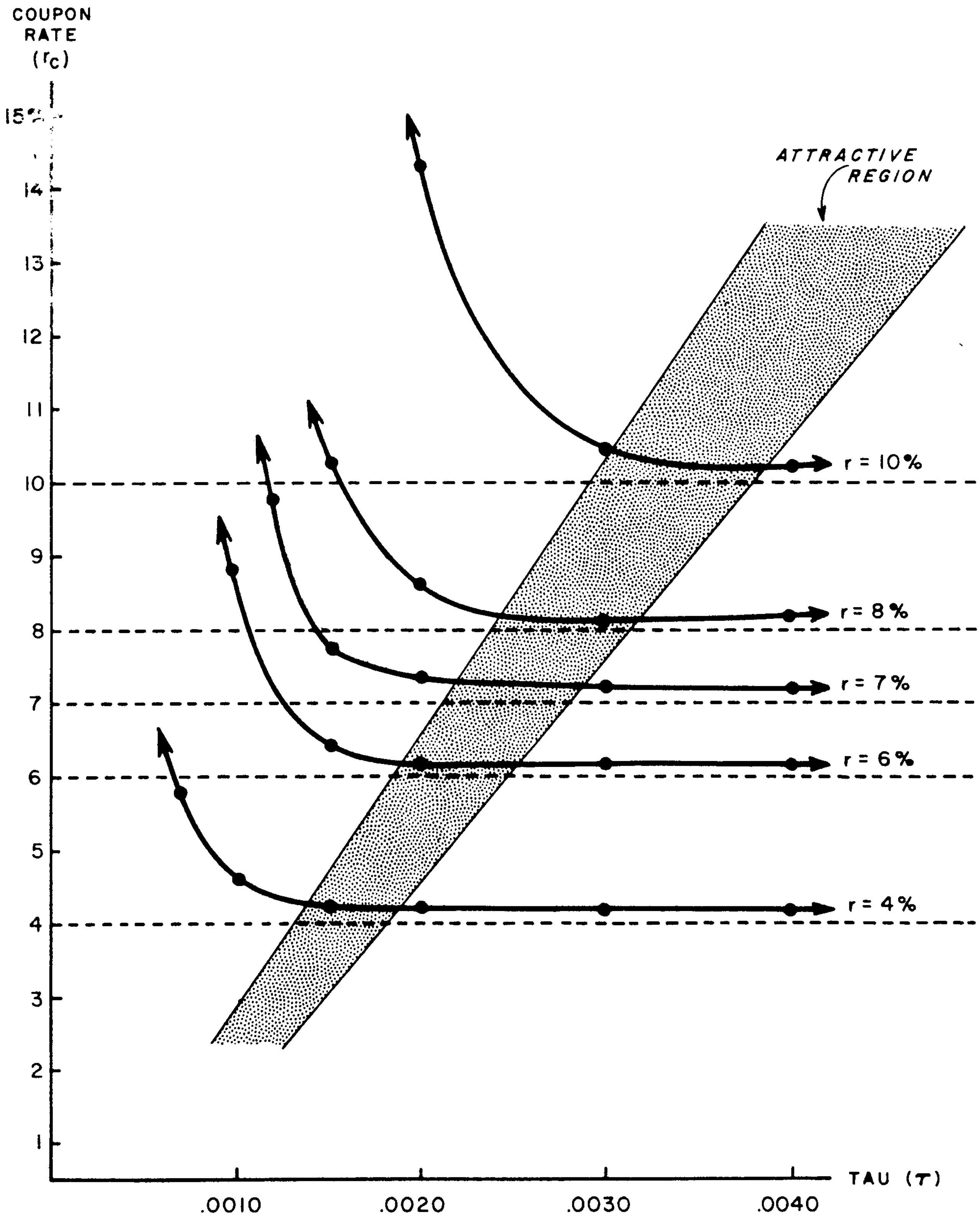


Figure IV

Partially Contingent Program: Anticipated Adverse Selection
Coupon Rate, r_c, required to maintain rate of return, r, at 6%
When Income Growth is Anticipated to be g, with:
Tax Rate, τ = .0020
Repayment Period, T = 25 Years
Growth of Coupon Payments, γ, = 10%
For Various Anticipated Adverse Selection Scenarios
and Differing Lengths, t, of grace period

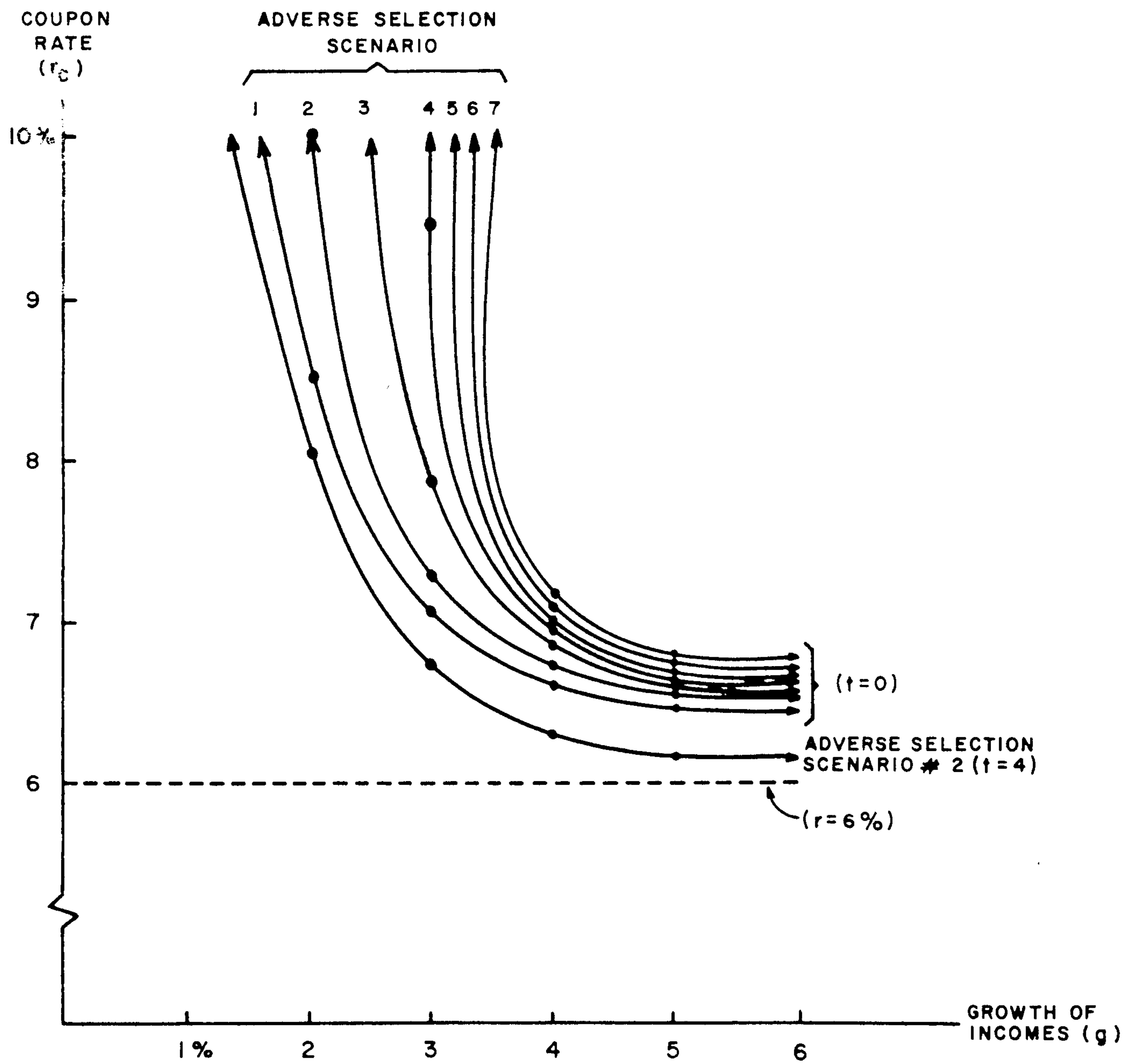


TABLE VI

Partially Contingent Program:

"Coupon rate," r_c, given τ, the repayment tax rate per thousand dollars borrowed; r, the rate of return; t, the grace period after which the repayment period begins; T, the repayment period = 25 years; g, income growth after 1974 = 5%; and λ, rate of growth of repayments for the coupon option = 10%.

1. τ = .26%, r = 6%

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	6.39%	5	5	4	4	3	3	2	1	-	-
1	6.25	4	3	3	3	2	2	1	-	-	-
2	6.17	2	2	2	1	1	1	-	-	-	-
3	6.14	1	1	1	-	-	-	-	-	-	-

2. τ = .26%, r = 8%

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.60%	7-1	6	6	6	5	4	4	2	-	-
1	8.48	6-1	5-1	5	4	4	3	2	1	-	-
2	8.34	4-2	4-1	4-1	3	3	2	1	-	-	-
3	8.30	3-3	3-2	2-1	2-1	2	1	-	-	-	-

3. t = .33%, r = 8%

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.44%	5	5	5	4	4	3	3	2	-	-
1	8.34	4	4	3	3	3	2	1	-	-	-
2	8.23	3	3	2	2	2	1	-	-	-	-
3	8.18	2	2	1	1	-	-	-	-	-	-
4	8.16	1	-	-	-	-	-	-	-	-	-

4. τ = .40%, r = 8%

t (grace period)	r_c	Contingency by Decile* 1	2	3	4	5	6	7	8	9	10
0	8.35%	4	4	4	3	3	3	2	1	-	-
1	8.26	3	3	3	2	2	1	1	-	-	-
2	8.16	2	2	2	1	1	-	-	-	-	-

*The notation used here indicates the number of years for which physicians in each decile exercise the τY_t, or contingency, option. A single number, e.g., 6, indicates that the option was exercised during the first six years of the repayment period. Two numbers separated by a dash, say 5-1, denote exercising of the option in both the beginning five (5) years and the ending (1) years of the repayment period.

TABLE VII-A

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.[illegible]
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26499.99	1500.00	-1500.00	-26499.99
1975	24999.99	0.0	54580.98	3090.00	-3090.00	-28089.99
1976	22750.00	0.0	81980.31	4640.39	-4640.39	-27390.39
1977	22750.00	0.0	111014.06	6283.81	-6283.81	-29033.81
1978	0.0	0.0	117674.89	6660.84	-6660.84	-6660.84
1979	0.0	0.0	124735.31	7060.49	-7060.49	-7060.49
1980	0.0	122.97	132096.44	7484.12	-7361.15	-7361.15
1981	0.0	131.67	139890.59	7925.79	-7794.12	-7794.12
1982	0.0	3804.05	144479.98	8393.43	-4589.38	-4589.38
1983	0.0	4290.26	148859.28	8668.80	-4378.54	-4378.54
1984	0.0	4706.32	153083.56	8931.51	-4225.19	-4225.19
1985	0.0	5162.70	157105.88	9185.02	-4022.33	-4022.33
1986	0.0	5661.32	160870.88	9426.36	-3765.05	-3765.05
1987	0.0	6208.06	164315.06	9652.27	-3444.20	-3444.20
1988	0.0	6807.63	167366.31	9858.92	-3051.29	-3051.29
1989	0.0	7465.10	169943.19	10041.99	-2576.89	-2576.89
1990	0.0	8186.12	171953.63	10196.61	-2010.48	-2010.48
1991	0.0	8967.51	173303.31	10317.23	-1349.72	-1349.72
1992	0.0	9817.75	173883.75	10398.21	-580.46	-580.46
1993	0.0	10749.38	173567.38	10433.04	316.34	316.34
1994	0.0	11770.25	172211.13	10414.05	1356.19	1356.19
1995	0.0	12888.88	169654.88	10332.68	2556.20	2556.20
1996	0.0	14089.04	165745.13	10179.30	3909.73	3909.73
1997	0.0	15401.57	160288.25	9944.72	5456.85	5456.85
1998	0.0	16837.04	153068.50	9617.31	7219.73	7219.73
1999	0.0	18406.92	143845.69	9184.12	9222.80	9222.80
2000	0.0	20123.79	132352.63	8630.75	11493.04	11493.04
2001	0.0	21934.57	118359.19	7941.18	13993.39	13993.39
2002	0.0	23904.45	101556.25	7101.57	16802.88	16802.88
2003	0.0	26051.13	81598.50	6093.39	19957.74	19957.74
2004	0.0	28390.32	58104.12	4895.93	23494.38	23494.38
2005	0.0	30570.55	31019.84	3486.27	27084.27	27084.27
2006	0.0	32910.38	-29.32	1861.22	31049.16	31049.16

TABLE VII-B

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.96
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 1

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5458.99	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	333.97●#	14494.53	839.34	-505.48	-505.48
1983	0.0	429.03 #	14935.18	869.67	-440.65	-440.65
1984	0.0	470.63 #	15360.65	896.11	-425.48	-425.48
1985	0.0	516.27 #	15766.02	921.64	-405.37	-405.37
1986	0.0	566.13 #	16145.85	945.96	-379.83	-379.83
1987	0.0	620.81 #	16493.79	968.75	-347.94	-347.94
1988	0.0	680.76 #	16802.65	989.63	-308.86	-308.86
1989	0.0	746.51 #	17064.30	1008.16	-261.65	-261.65
1990	0.0	818.61 #	17269.54	1023.86	-205.24	-205.24
1991	0.0	896.75 #	17408.96	1036.17	-139.42	-139.42
1992	0.0	981.78 #	17471.72	1044.54	-62.76	-62.76
1993	0.0	1074.94 #	17445.08	1048.30	26.64	26.64
1994	0.0	1177.03 #	17314.76	1046.71	130.32	130.32
1995	0.0	1288.89 #	17064.75	1038.89	250.01	250.01
1996	0.0	1408.91 #	16679.73	1023.89	385.02	385.02
1997	0.0	1540.16 #	16149.35	1000.78	539.38	539.38
1998	0.0	1683.71 #	15425.06	968.42	715.29	715.29
1999	0.0	1840.69 #	14509.87	925.50	915.19	915.19
2000	0.0	2012.38 #	13368.08	870.59	1141.79	1141.79
2001	0.0	2193.46 #	11976.70	802.08	1391.38	1391.38
2002	0.0	2390.45 #	10304.86	718.60	1671.84	1671.84
2003	0.0	2605.12 #	8319.03	618.29	1986.82	1986.82
2004	0.0	2839.03 #	5978.08	499.08	2339.95	2339.95
2005	0.0	3057.06	3279.71	358.69	2698.37	2698.37
2006	0.0	3110.50●	366.00	196.78	2913.71	2913.71

● IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII C

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 5

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5459.00	309.00	-309.00	-2809.00
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	391.09 #	14437.30	839.34	-448.25	-448.25
1983	0.0	429.03 #	14874.52	866.24	-437.21	-437.21
1984	0.0	470.63 #	15296.35	892.47	-421.84	-421.84
1985	0.0	516.27 #	15697.86	917.78	-401.51	-401.51
1986	0.0	566.13 #	16073.60	941.87	-375.74	-375.74
1987	0.0	620.81 #	16417.20	964.42	-343.61	-343.61
1988	0.0	680.76 #	16721.47	985.03	-304.27	-304.27
1989	0.0	746.51 #	16978.24	1003.29	-256.78	-256.78
1990	0.0	818.61 #	17178.32	1018.70	-200.08	-200.08
1991	0.0	896.75 #	17312.27	1030.70	-133.95	-133.95
1992	0.0	981.78 #	17369.22	1038.74	-56.96	-56.96
1993	0.0	1074.94 #	17336.43	1042.15	32.79	32.79
1994	0.0	1177.03 #	17199.59	1040.19	136.84	136.84
1995	0.0	1288.89 #	16942.67	1031.98	256.92	256.92
1996	0.0	1408.91 #	16550.32	1016.56	392.35	392.35
1997	0.0	1540.16 #	16003.18	993.02	547.14	547.14
1998	0.0	1683.71 #	15279.67	960.19	723.52	723.52
1999	0.0	1840.69 #	14355.75	916.78	923.91	923.91
2000	0.0	2012.38 #	13204.72	861.35	1151.03	1151.03
2001	0.0	2193.46 #	11893.54	792.28	1401.18	1401.18
2002	0.0	2390.45 #	10121.30	708.21	1682.23	1682.23
2003	0.0	2605.12 #	8123.46	607.28	1997.84	1997.84
2004	0.0	2839.03 #	5771.84	487.41	2351.63	2351.63
2005	0.0	3057.06	3061.09	346.31	2710.74	2710.74
2006	0.0	3319.67	-74.91	183.67	3136.00	3136.00

@ IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
# IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII-D

PARTIALLY CONTINGENT PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = Y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
REPAYMENT TAX RATE = 0.002000000
INTEREST RATE = 6.0000% = r

DECILE # 10

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	2500.00	0.0	2650.00	150.00	-150.00	-2650.00
1975	2500.00	0.0	5459.99	309.99	-309.99	-2809.99
1976	2275.00	0.0	8198.03	464.04	-464.04	-2739.04
1977	2275.00	0.0	11101.40	628.38	-628.38	-2903.38
1978	0.0	0.0	11767.48	666.08	-666.08	-666.08
1979	0.0	0.0	12473.53	706.05	-706.05	-706.05
1980	0.0	12.30 #	13209.64	748.41	-736.11	-736.11
1981	0.0	13.17 #	13989.05	792.58	-779.41	-779.41
1982	0.0	391.09 #	14437.30	839.34	-448.25	-448.25
1983	0.0	429.03 #	14874.52	866.24	-437.21	-437.21
1984	0.0	470.63 #	15296.35	892.47	-421.84	-421.84
1985	0.0	516.27 #	15697.86	917.78	-401.51	-401.51
1986	0.0	566.13 #	16073.60	941.87	-375.74	-375.74
1987	0.0	620.81 #	16417.20	964.42	-343.61	-343.61
1988	0.0	680.76 #	16721.47	985.03	-304.27	-304.27
1989	0.0	746.51 #	16978.24	1003.29	-256.78	-256.78
1990	0.0	818.61 #	17178.32	1018.70	-200.08	-200.08
1991	0.0	896.75 #	17312.27	1030.70	-133.95	-133.95
1992	0.0	981.78 #	17369.22	1038.74	-56.96	-56.96
1993	0.0	1074.94 #	17336.43	1042.15	32.79	32.79
1994	0.0	1177.03 #	17199.59	1040.19	136.84	136.84
1995	0.0	1288.89 #	16942.67	1031.98	256.92	256.92
1996	0.0	1409.91 #	16550.32	1016.56	393.35	393.35
1997	0.0	1543.16 #	16003.18	993.02	547.14	547.14
1998	0.0	1683.71 #	15279.67	960.19	723.52	723.52
1999	0.0	1840.69 #	14355.75	916.78	923.91	923.91
2000	0.0	2012.38 #	13204.72	861.35	1151.03	1151.03
2001	0.0	2193.46 #	11803.54	792.28	1401.18	1401.18
2002	0.0	2390.45 #	10121.30	708.21	1682.23	1682.23
2003	0.0	2605.12 #	8123.46	607.28	1997.84	1997.84
2004	0.0	2839.04 #	5771.84	487.41	2351.63	2351.63
2005	0.0	3057.06	3061.09	346.31	2710.74	2710.74
2006	0.0	3319.67	-74.91	183.67	3136.00	3136.00

@ IMPLIES CONTINGENCY OPTION EXERCISED BY GRADUATES
# IMPLIES CONTINGENCY EXERCISED BY DROPOUTS

TABLE VII-E

SEMI-CONVENTIONAL LOAN PROGRAM

FIXED REPAYMENTS GROW AT 10.00% = y
FROM STARTING PAYMENT OF $ 41.94
REPAYMENT PERIOD = 25 YEARS = T
GRACE PERIOD = 4 YEARS = t
TOTAL # OF BORROWERS = 100.
LOAN PER YEAR = $ 250.00
INTEREST RATE = 6.1674% = r

CASH FLOW TABLE UNDER ABOVE ASSUMPTIONS :

YEAR	NEW LOANS ($)	CURRENT REPAYMENTS ($)	OUTSTANDING DEBT ($)	INTEREST DUE ($)	PRINCIPAL PAID ($)	CASH FLOW ($)
1974	24999.99	0.0	26541.83	1541.84	-1541.84	-26541.83
1975	24999.99	0.0	54720.59	3178.77	-3178.77	-28178.76
1976	22750.00	0.0	82249.44	4777.88	-4777.88	-27527.88
1977	22750.00	0.0	111474.00	6475.63	-6475.63	-29225.62
1978	0.0	0.0	118349.00	6875.00	-6875.00	-6875.00
1979	0.0	0.0	125648.00	7299.00	-7299.00	-7299.00
1980	0.0	187.09	133210.06	7749.16	-7562.07	-7562.07
1981	0.0	205.44	141220.13	8215.54	-8010.11	-8010.11
1982	0.0	3995.79	145933.94	8709.55	-4713.85	-4713.85
1983	0.0	4387.57	150546.63	9000.28	-4612.70	-4612.70
1984	0.0	4817.86	155013.50	9284.76	-4466.89	-4466.89
1985	0.0	5290.33	159283.38	9560.25	-4269.91	-4269.91
1986	0.0	5807.07	163299.88	9823.59	-4016.51	-4016.51
1987	0.0	6374.27	166996.88	10071.30	-3697.03	-3697.03
1988	0.0	6996.84	170299.31	10299.31	-3302.46	-3302.46
1989	0.0	7680.17	173122.06	10502.98	-2822.81	-2822.81
1990	0.0	8430.21	175368.88	10677.07	-2246.86	-2246.86
1991	0.0	9243.79	176940.69	10815.64	-1571.84	-1571.84
1992	0.0	10135.79	177717.44	10912.58	-776.79	-776.79
1993	0.0	11113.72	177564.19	10960.48	153.24	153.24
1994	0.0	12185.91	176329.25	10951.03	1234.88	1234.88
1995	0.0	13361.41	173842.69	10874.87	2486.55	2486.55
1996	0.0	14623.49	169949.69	10721.51	3901.98	3901.98
1997	0.0	16004.39	164417.13	10480.86	5523.52	5523.52
1998	0.0	17515.20	157042.13	10140.20	7375.00	7375.00
1999	0.0	19169.17	147559.31	9685.36	9482.88	9482.88
2000	0.0	20976.56	135683.25	9100.52	11876.04	11876.04
2001	0.0	22885.27	121166.00	8368.08	14517.19	14517.19
2002	0.0	24965.94	103672.81	7472.75	17493.18	17493.18
2003	0.0	27233.91	82832.75	6393.89	20840.02	20840.02
2004	0.0	29705.79	58235.57	5108.61	24597.18	24597.18
2005	0.0	30570.55	31256.64	3591.61	26978.93	26978.93
2006	0.0	33196.68	-12.31	1927.73	31268.95	31268.95

TABLE VIII

Partially Contingent Program:

"Anticipated" adverse self-selection: Solve for r_c, the coupon rate, given τ, the repayment tax rate = .20%; r, the rate of return = 6%; T, the repayment period = 25 years; λ, the rate of growth of coupon repayments = 10%; and varying t, the grace period, and g, the rate of growth of incomes after 1974.

1. t (grace period) = 0 years

Adverse selection Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1	6.51%	6.60%	7.02%	8.50%
2	6.55	6.67	7.23	10.02
3	6.64	6.82	7.86	infeasible
4	6.69	6.92	9.47	
5	6.72	7.00	infeasible	
6	6.74	7.07		
7	6.78	7.20		

2. t = 4 years

Scenario No.	g = 5%	g = 4%	g = 3%	g = 2%
1	6.17%	6.27%	6.63%	7.56%
2	6.17	6.29	6.72	8.04
3	6.17	6.34	6.95	infeasible
4	6.17	6.37	7.11	
5	6.18	6.40	7.26	
6	6.18	6.42	7.38	
7	6.18	6.47	7.67	

Table IX

Partially Contingent Program:

"Unanticipated" adverse self-selection: solve for r, rate of return, given τ, repayment tax rate = .20%; T, repayment period = 25 years; γ, rate of growth of coupon repayments = 10%; r_c, coupon rate, from Scenario 1, Table V, and varying g, rate of growth of incomes, and t, the grace period.

1. t = 0 years

Scenario No.	g = 5% (r_c = 6.51%)	g = 4% (r_c = 6.6%)	g = 3% (r_c = 7.02%)	g = 2% (r_c = 8.5%)
1	6.00%	6.00%	6.00%	6.00%
2	5.96	5.95	5.89	5.74
3	5.90	5.85	5.69	5.26
4	5.86	5.80	5.57	4.96
5	5.83	5.75	5.48	4.78
6	5.81	5.73	5.42	4.67
7	5.79	5.68	5.32	4.49

2. t = 4 years

Scenario No.	g = 5% (r_c = 6.17%)	g = 4% (r_c = 6.27%)	g = 3% (r_c = 6.63%)	g = 2% (r_c = 7.56%)
1	6.00%	6.00%	6.00%	6.00%
2	6.00	5.98	5.94	5.85
3	6.00	5.95	5.82	5.56
4	5.99	5.92	5.75	5.39
5	5.99	5.90	5.69	5.28
6	5.99	5.89	5.66	5.21
7	5.99	5.86	5.59	5.01

the bank and administrative costs.) The sensitivity to changes in the grace period naturally reflects the low income of those early intern years in our data, as shown in Table A-5 of the Appendix. We conjecture, however, that interns are nowhere near as poor (relative to physicians' lifetime incomes) today as in 1960, and that therefore our $t = 4$ might yield a more realistic approximation to the same program run with, say, 1970 census data and a lower t. Most of the 1970 census data was published before this writing, but the publication presenting incomes by profession was not available to us.

Figure III presents iso - r loci in (r_c, τ) - space: for a given rate of return, the $\tau - r_c$ trade-off is illustrated. Each of these loci has two asymptotes - the coupon rate can never fall below r, and there exist positive τ's for each r such that r_c approaches infinity. Thus, the iso - r loci are convex to the origin in the positive quadrant of (τ, r_c) space. Infeasible r_c's occur at τ's somewhat below the break-even τ's from the fully contingent program, (cf. Table III) or southwest of each locus, which thus defines a feasibility frontier for the program, given r.

This frontier may be described more precisely by noting that, by design of the fully contingent and partially contingent variants, it will always be true that:

$$\lim_{r_c \to \infty} \tau_{pc} (\bar{r}, r_c) = \lim_{R \to \infty} \tau_{fc} (\bar{r} , R) .$$

This is so because for an equal rate-of-return in the two variants, the above limits imply that the income-contingent repayment will be made by all borrowers in each year of the repayment period (i.e., there will be no coupon payments in the partially contingent scheme and no opting-out in the fully contingent scheme). It will also be true that:

$$\lim_{r_c \to \infty} \tau_{pc}(\bar{r}, r_c) \leq \tau_{fc}(\bar{r}, R) \quad \text{for } \bar{r} < R < \infty ,$$

the inequality holding only for R sufficiently small that some opting-out occurs, thus requiring a larger τ than that of the comparable partially contingent scheme, where no opting-out is possible, and the coupon option is never exercised with r_c very large.

Tables VII (a)-(e) present the cash flow for a partially-contingent program which may be considered attractive for both the borrower and lender (relatively low tax rate and very little contingency exercise.) This may be verified by noting in Figure II the $\tau = .0020$ point on the $r = 6\%$ locus. Higher tax rates do not significantly improve the low rate of contingency exercise, lower tax rates boost the required coupon rate rather quickly. For this reason, we have chosen this particular parameter combination to test the stability of the program to extreme adverse selection and income growth assumptions (see Tables VIII and IX, Figures IV and V).

If one compares these cash flows with those given to illustrate the semi-conventional and fully-contingent plans (see Table I (d) and Tables V (a)-(d)), it is very apparent that the partially-contingent plan's repayments are very close to those of the semi-conventional plan. This is consistent, of course, with the extremely low contingency exercise implied by this particular parameter combination. Looking to the decile cash flows, one sees that only in decile one do graduates take advantage of the contingency option (τ = .0020), in the first and last years of his repayment period.

This partially contingent plan thus illustrates a loan contract which guarantees the borrower that he will pay no more than 6.17% interest (the coupon rate corresponding to the required starting payment of $41.94 in the optimal fixed-repayment schedule - see Table VII (e)) over the twenty-five year repayment period. Indeed, he will pay less if in any year .20% of his income is less than the required coupon payment in that year ($41.94 in year 1, ($41.94) (1.10) 24 = $454.63 in year 25). This gives income protection to potential low-earners, yet does not burden high-earners with the 8% opt-out interest rate of the fully contingent program. The cost of this compromise solution (between semi-conventional and fully-contingent plans) is two fold:

(1) slightly higher coupon payments than comparable semi-conventional plan (coupon rate = 6.17% rather than 6.00%)

(2) higher tax rate than comparable fully-contingent program (τ = .0020 rather than τ = .00105).

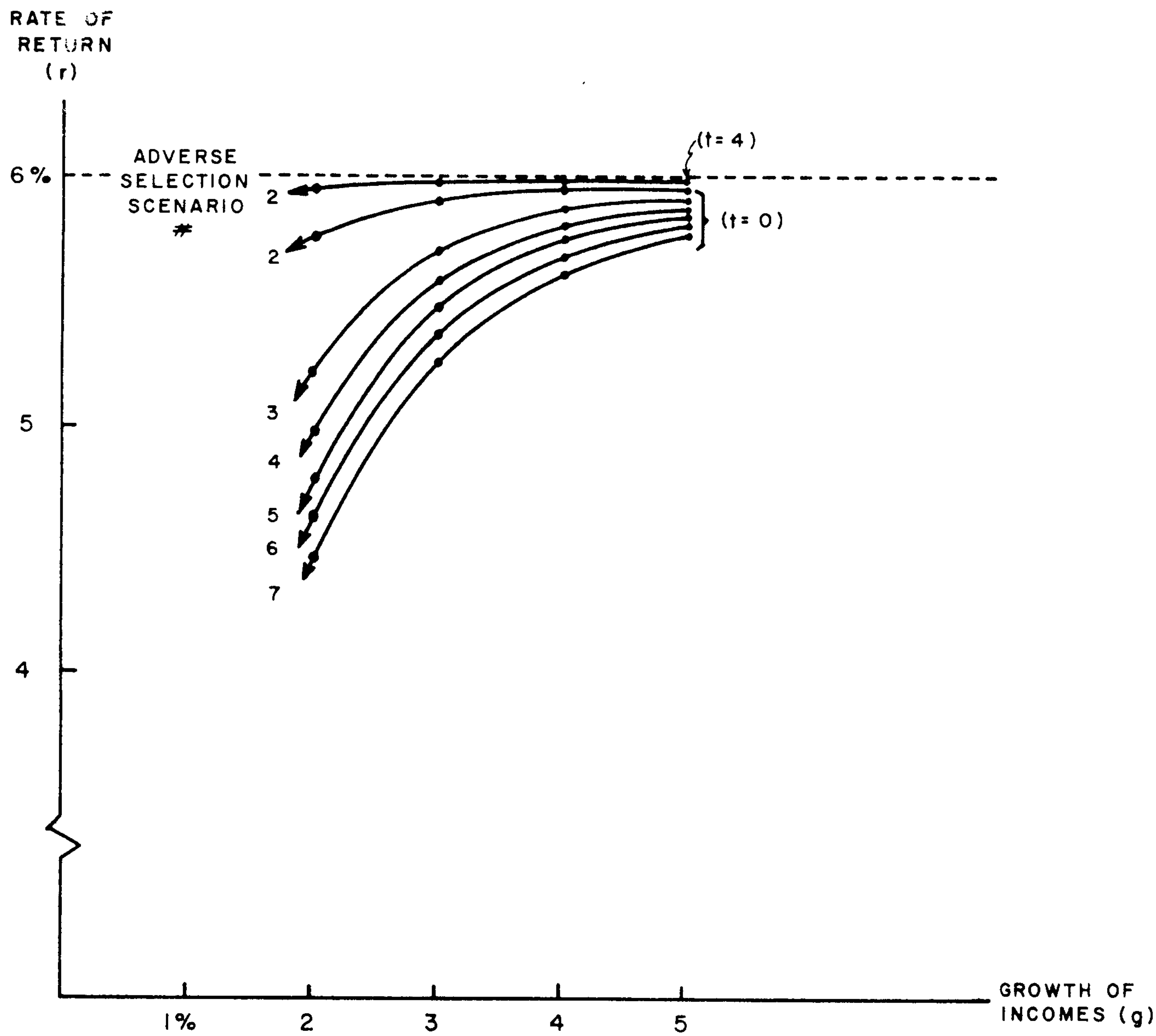
The low-earner's income insurance and the high-earner's payment insurance must then be compared by each group to see if the above "costs" are justified.

"Anticipated" adverse self-selection (i.e., what would r_c have to be to maintain the same r, given adverse selection) is explored in Table VIII and Figure IV. As expected, the coupon rate rises, but not substantially, as a result of the adverse selection. However, the variation of t and g exert a much more significant influence on r_c. This is illustrated by the family of curves in Figure IV (compare t = 0, 4 loci for adverse selection scenario = 2). As Table VIII corroborates, the sensitivity of the program to anticipated adverse selection increases dramatically when g, the growth rate of incomes, drops. In Figure IV we see that when g = 5%, increasing the severity of the adverse selection scenario has a negligible effect on the r_c required by the program. When g = 3%, however, adverse selection can make the program infeasible with the given τ. A grace period reduces this sensitivity by shifting these loci to the southwest, but the program with such a τ is still sensitive to low g's. Policy conclusion: higher τ's are needed if such adverse selection scenarios are anticipated.

The reverse exercise involves unanticipated adverse selection, or, given r_c and τ, what r would result under the same adverse selection scenarios as above, r_c and τ being chosen from the (r = 6%, g = 5%, no adverse selection) simulations. The results are set out in Table IX, and depicted in Figure V. The same pattern which emerged with anticipated adverse selection with low income growth can drop r substantially. A grace period of four years will guard against effects of unanticipated adverse selection by flattening out and raising the iso - r_c loci in (r,g) space, but dropping g still has significant effects with severe adverse self-selection. (See Figure V and Table IX.) Note that when

Figure V

Partially Contingent Program - Unanticipated Adverse Selection Coupon rate, r_c, (=6.17% for t=0, 6.51% for t=4) set to Yield Rate of Return, r=6%, with expected income growth rate, g=5%, and with no expected adverse selection when tax rate τ=.2%. Figure shows actual rate of return, r, as a function of the actual (not anticipated) growth of incomes, g, for various unanticipated adverse selection scenarios.



one combines scenario 7 (severe adverse self-selection) with g = 5%, the rate of return is higher than it is when g = 2% and only a little adverse selection occurs (scenario 2). Hence, the rate of return is more sensitive to poor (too high) income forecasting than to unanticipated adverse self-selection with good income forecasting. Note, too, that scenario 1 (no adverse selection) always produces a 6% return here since coupon rate has been chosen to "anticipate" lower income growth; i.e., it has been chosen as the r_c from the partially contingent scheme with the same parameters, including g, but with no adverse selection.

In summary, adverse self-selection *per se* does not hurt the program. Poor forecasting of income growth and low τ's will damage its financial viability. This can be mitigated somewhat by allowing for a grace period. The caveat regarding our income data for these interpretations is as applicable here as above; interns are now earning much more relative to their expected lifetime earnings than they did during the 1960 census period. The best policy can be inferred immediately from Figure III - set τ high enough to ensure viability. Even τ = .40% is not unattractive from the "insurance" point of view.

III. Evaluation of the Three Programs:

We cannot offer any simple evidence that one program is to be preferred over another. A semi conventional loan scheme such as we have outlined is preferable to a normal mortgage loan because its payments grow with the borrowers' ability to pay. We know from the simple arithmetic of compound interest, however, that the total amount paid back under a 25 year growing repayments plan will be significantly larger than that paid under a five year equal payments plan.

As we have stressed, the income contingent feature of the fully contingent scheme in some sense provides maximum insurance to the borrower, but the reduction of risk to the lender and the reduction of administrative costs offered by the partially contingent variant is of prime importance for small-scale applications. How might we compare the variants more precisely?

We know that the semi-conventional variant is the limiting case of the partially contingent variant in which $r_c = r$, τ is sufficiently large that in no period does any borrower elect the contingency option, and the rate of growth of repayments, γ , is the same for the partially contingent coupon as for the semi-conventional program. The semi-conventional variant is much like - but not necessarily identical to - the fully contingent variant in which τ is sufficiently high so that $r = R$. It should be stressed that at some point τ is sufficiently large to equate r to R, but if τ is increased further the pattern of repayments will be speeded up even though neither r nor R are affected by these further increases in τ.

Income distribution effects are certainly among the major reasons for proposing more flexible plans. The fully contingent plan favors lower income earners at the expense of higher income MD's. The early burden which a high opt-out rate puts on a rich MD, in spite of the fact that the high rate of return on his educational investment may justify it, could lead to adverse self-selection in these upper deciles. While this may not severely damage the program, as we have shown, the partially contingent program shifts the burden on these physicians to a later, higher income period. Certainly, the degree to which the early forced payments are a burden (especially for rich MD's) under the fully contingent scheme depends on the doctor's rate of time preference. In absolute terms, as already mentioned, the potential opt-out MD pays more under the partially contingent plan, due to interest compounding. Rather than expending a lot of effort trying to find tax loopholes to reduce his adjusted gross income, he can opt for the coupon, which is exactly what we want to keep administrative costs down.

Referring back to Figure II, we judge the area to the northwest of the region labelled "attractive" as such because too much "contingence" is being exercised; i.e., the τY_t^i option is selected by richer MD's. In other words, for the partially contingent plan, the administrators must set a relatively high τ and low coupon rate to make all but those in the lowest two or three deciles choose the tax repayment scheme. By "choose," of course, we mean year by year, since in each year, the choice between the two repayment options is open. Hence, a doctor starting out on his career may opt for τY_t^i for three or four years, and then stay with the coupon rate until the very end, when the γ% growth in repayments under the coupon scheme makes the tax more attractive. (See Table VIII (e) for example of this pattern.) Exercise of the "contingency" option will also be influenced by the grace period, since a low-income intern would obviously opt for the tax. Thus, extending the grace period shifts exercise of the contingency option from the early to the later years.

The "attractive region" also provides a margin of safety against unanticipated adverse self-selection combined with unanticipated low income growth. A more sophisticated way of projecting physicians' incomes seems desirable in view of the sensitivity of the latter two programs to changes in growth of incomes. Research on the elasticity of demand for education with respect to financing arrangements has yet to be done. More particularly, since this program is voluntary, we would like to know, given the investment decision, what is the elasticity of substitution between these and other means of financing that investment.

IV. The Pure Economic Theory Of The Ideal Contingent Repayment Loan Program

The major concerns of this study are largely for immediate policy implementation. We study the operating characteristics and stability properties of these variants. No plan strictly dominates any other. There is always a trade-off; e.g., greater stability and ease of administration is purchased at the price of reduced mutualization of borrower risk.

What program is best? There is no clear answer although we strongly suggest consideration of the so-called "fully contingent" EOB for national application in conjunction with the IRS and suggest consideration of the well-designed partially contingent EOB (PCEOB) for smaller scale application. In order to properly pose the question as to which contingent loan program is optional, we must consider partial and general equilibrium models of *intertemporal* decision-making under *uncertainty*. To construct a convincing but tractable model that allows for *choices among work*, *education*, *leisure*, *consumption*, *and saving in an uncertain environment* would be no mean feat in itself. Our problem is even more difficult: Since government taxation powers are of limited potency, in general the ideal CRLP would be only a "second-best" solution. Choosing an optimal EOB schedule is thus a problem in the barely developed field of optimal adverse-risk selection. Furthermore, transaction, enforcement, and administrative costs, as we have seen, play an essential role in selection of a "best" CRLP scheme. Here too, modeling is not likely to be easy. The general economic equilibrium theory with costly transactions is barely in its infancy; nonconvexities due to set-up costs abound and current mathematical techniques are not fully adequate.

It is outside the scope of this particular project to attempt to build a "definitive" model for the Ideal EOB. (The subject, however, fascinates us and we plan to make it an important part of future research effort.) Here we content ourselves with stretching some very simple models which illustrate the ideas of their section.

There is a further theoretical question which relates to the theory of the Ideal CRLP - the role of the institution of bankruptcy. Bankruptcy is obviously very important to any CRLP discussion. While the bankruptcy institution protects individual freedom from de facto slavery contracts, the same institution limits private investment in human capital by limiting lender security. The study of this special institution, which is obviously very important to the study of the Ideal CRLP, would take us so far afield into the theory of legal and economic arrangements, that we do not even attempt to sketch a "bankruptcy" model at this time.

A. Simple Aspects of Decision-making Under Uncertainty in the CRLP

For purposes of this subsection, we abstract from the choice of the student borrower as to quantity and quality of education, consumption and saving, and work and leisure. For simplicity the representative man is assumed to purchase college education and must (or chooses to) repay through the EOB arrangement. To keep things very simple, it is assumed that future pretax income is a single random variable unaffected by any decision of the borrower. In this very special and simple case, we have assumed away all incentive effects (thus assuming away all "moral hazards"). Thus, the EOB should be designed to provide insurance against lower-than-average earned income while supporting overall educational expenses.

Utility of the representative borrower is

$$U[(1-t)\ (Y_o+\tilde{Y}_e)]\ ,$$

where U[.] is the utility function, $\tilde{Y}_e$ is the random variable of earned income, Y_o is other income, and $t \in [0,1]$ is the average rate of income taxation. Following von Neuman and Morgenstern, we postulate that the individual desires to maximize expected utility,

$$E\{U[(1-t)\ (Y_o + \tilde{Y}_e\ )]\}$$

In the case of this subsection, the borrower has no decision variable at his own disposal - giving his probability belief EV is given after the government specifies the tax rate, t . We assume that the representative borrower is risk-averse, that is, the second derivative of his utility function is negative, $U'' < 0$.

The government must balance its education budget,

$$B = \sum_{i=1}^{i=\tau} y^i\ t\ (y^i)$$

where $y^i = Y_o^i + Y_e^i$ is income of borrower i , $t(y^i)$ is the average tax rate of borrower with income y^i , and B is total cohort borrowings including interest charges. If you like, the sum in the above may be approximated by integral of densities, so that

$$B = \int t(y)yf(y)dy ,$$

where f(y) is the density of individuals with income y . Following Bentham, we may wish to maximize the simple integral of expected utilities

$$\int E\{U[(1-t(y))y]\}f(y)dy$$

subject to the balanced-budget constraint. (Of course, the balanced-budget constraint can be easily modified to allow for government subsidy of education.)

The government's policy is the function, t(y), the full tax schedule. Lump-sum taxes are disallowed; t depends solely on y. By solving the Euler equation to the above isoparametric problem, the optamizing tax schedule is found. In the degenerate case where each individual has the same utility function, the same belief about the random variable $\tilde{Y}_e^i$, and the same Y_o^i , then since $U''< 0$, optimal tax is to confiscate all above-mean income and give subsidies to all others to bring each individual to the mean income. (All of the above implicitly assumes that a very strong law of large members applies to government tax revenue; the probability limit of average revenue (revenue per taxpayer) is equal to the expectation of average revenue.)

B. The Education Quantity and Quality Decision and Adverse Self-Selection.

Here we focus on the effect of taxes (or repayment-taxes) on the individual's educational effort and expenditure decisions. For simplicity, at this stage, we abstract from the intertemporal aspects of investment in human capital, the consumption aspects of higher education and the riskiness of return to investment in educational capital. The simple model will be of some use in studying the question of adverse self-selection.

The model studied is based on one exposited by E. S. Phelps.[1] The Phelps paper in turn employs the explicit educational choice model put forward by E. Sheskinski.[2] The very recent resurgence of interest in optimal income taxation which provides a theoretical framework for models of this type is due to J. A. Mirrlees.[3]

Assume that individuals - potential student borrowers all - have identical preferences, but they differ in ability to earn wage and salary income according to differences in a parameter n, $n \in [0,\infty)$. Let $F(n)$ be the cumulative distribution of individuals with ability n, so that $f(n)$ can denote the density of individuals of ability n.

$$F(n)=F(0)+\int_0^n f(s)ds \ ,$$

so that

$$F'(n)=f(n)>0$$

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1 E. S. Phelps, "Taxation of Wage Income for Economic Justice," Department of Economics, Columbia University, New York, New York, 10027. August 1972.

2 Reference [12].

3 Reference [7].

with

$$F(0) \geq 0 \quad \text{and} \quad F(N)=1 ,$$

where N is the highest ability.

Let x be an index of time and resources spent in education. Assume that ability and education interact in a multiplicative way so that

$$y = nx ,$$

where y is pretax income for an individual with ability n and education x. The problem for society is to choose an optimal system of taxation and transfers to redistribute income while not neglecting costs of interfering with educational incentives.

Let the net tax function be $h(y)$ so that after-tax disposable incomes are given by $z(y)=y-h(y)$. To bring out the redistribution-efficiency tradeoff most clearly, replace the Benthamite social welfare function of the previous subsection with the Rahlsian criterion of maximizing the utility of the worst-off individuals (in this case those with zero productive ability, n=0). Notice that the Rahlsian criterion does not call for confiscatory taxes. The energy of the ablest needs to be harvested for the least able even with this extreme social welfare function.

For analytic convenience we can follow Phelps in writing

$$z(y)=y+g-t(y) ,$$

where

$$h(y)=t(y)-g ,$$

so that the constant g has the interpretation of minimum-disposable-income and $t(0)=0$.

The repayment-tax schedule t(y) must be chosen to maximize minimum utility, u(g) subject to

$$g=\int_0^N t[y(n)]f(n)dn - \gamma-\sigma$$

where γ is government expenditure and σ is the desired government budgetary surplus, and subject to individual responses to the tax schedule which will be discussed next.

Each individual maximizes his utility of consumption, u(c). The cost of an education of type x is j(x), so by individual budget balance,

$$c+j(x)=y-t(y)+g \ .$$

Simple utility-maximization yields

$$\partial c/\partial x = n(1-t'(nx)) - j'(x) = 0$$

for interior maximum.

We have set the stage for a detailed derivation of an optimal repayment tax rate t(y). While interesting properties can be derived, this is not the place to do so given the extreme simplicity of the model. The intention here - as it is throughout Section IV - is to discuss the elements of a theory of ideal student finance for higher education.

C. Theoretical Aspects of Transactions Costs in Alternative Student Financing Schemes.

Traditional general equilibrium economic models assume the absence of transactions costs including costs of marketing, government costs of taxing and individual transactions costs imposed on individuals as a function of alternative legal and administrative arrangements. The very recent economic literature has attempted to incorporate such costs. See e.g. [4] and [6]. One notable difficulty in extending the traditional models is the obviously non-convex nature of transactions sets: Transactions costs functions are typically of the set-up cost type (with zero marginal costs) or at least exhibit sharply increasing returns-to-scale.

As with all industries characterized by increasing returns to scale, there is a strong argument for a government role in setting up markets and in designing legal and institutional arrangements. The important technical lesson is that the non-convexity can be expected to require digital (or integer) programming techniques to choose the socially optimal subset of feasible social-institutional-market arrangements.

In terms of the social financing of students in higher education, this suggests that there may be strong efficiency losses from retaining a diversity of federal financing programs which, of course, must be weighed against the ovbious gains to the student borrower of the existence of choice among financing schemes.

The reader of this report will note that in evaluating the particular EOB plans great emphasis was placed on relative transactions costs. While we hope that our arguments are persuasive, <u>we keenly feel the lack of quantitative basis for transactions enforcement-administrative costs in this study</u>. The failure to theoretically and quantitatively account formally for such costs is a subject of general concern in modern economic theory and econometric practice. (We plan in future research to address ourselves to these important theoretical questions and to apply the results to the area of educational finance.)

A New Variant of the Educational Opportunity Bank Designed for Stability and Ease of Administration in "Small-Scale" Application

Richard Berner
Michael B. Johnson
Karl Shell

October 30, 1972

APPENDIX A - E