STUDENT DISCOUNT RATES AND SUBSIDIES TO PROFESSIONAL EDUCATION

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The market for medical care is heavily subsidized by every level of government and at virtually every stage of production. More than 90 percent of the medical research done in this country is government sponsored. More than 40 percent of the direct educational costs of physicians are government financed. And roughly a quarter of the expenditures for physician care are made by government. Taken together the net effect of all these subsidies is a reduction in the price of medical services by more than 50 percent.[1/] Various arguments have been put forward in defense of these subsidies: that they internalize externalities for medical care consumption, that medical care is itself a merit good which would be underconsumed in a laissez faire environment or that the subsidies merely compensate for other market imperfections such as imperfect information about the expected productivity of physicians.[2/]

One argument frequently made in this context is that the market for consumption loans is "imperfect."[3/] The cash flow problem presented by medical education is particularly severe. Students must forego most of their earnings for a minimum of four years during which time they must somehow finance their consumption, school tuition and any other associated costs of training. These cash requirements clearly surpass the available liquid resources of many otherwise qualified potential applicants. Recourse to the capital market is the obvious alternative source of funds, and if this market operated without

transactions costs, there would be no problem. In the absence of other barriers, borrowing by impecunious students would continue until the capital value of this training fell to zero. This would result, in turn, in the efficient number of physicians being trained.

Friedman (1962) and more recently Nerlove (1972) have developed arguments which suggest that such markets do not function perfectly, and that purely private financing of educational investment will lead to underinvestment in this sort of training. As the capital created in these investments is human capital, it may not be used to secure the loan. A person to whom such a loan is granted may flee, declare bankruptcy, or simply refuse to use the capital to earn sufficient income to repay the loan. Borrowers aware of this risk will demand an interest premium on these loans to cover this possibility of default and loss. However, this private risk of default is not related to the social risk associated with the real productivity of the capital. An additional doctor is trained regardless of whether he repays or defaults on any loans he has outstanding. The riskiness of such loans is, in other words, greater than the riskiness of the investment in medical training, and it is the latter alone which governs the economic value of this investment.

Borrowers in the market for medical training must pay the higher rate inclusive of such a risk premium, hence underinvestment in this training may occur. As excessively high borrowing rates make a career in medicine unattractive, an efficient policy for government could be to take some offsetting action to improve the attractiveness of this career. In other words, inappropriately high discount rates faced by prospective medical students will diminish the rate of entry into medicine causing less than the socially efficient quantity of medical services to be supplied. The government may enhance the attractiveness of this career (and thereby the demand for this type of training)

by offering tax deductions or direct subsidies to the purchase of care, by offering subsidies to medical schools which allow them to lower fees, subsidies (scholarships) to students, or subsidies to the lenders themselves (so that they may offer loans at lower interest rates). The various levels of government employ all of these subsidy forms. It is therefore worthwhile to determine how large a subsidy may be rationalized in terms of this interest rate "imperfection."[4/]

This paper therefore attempts three things. In section I we calculate the level of the subsidy warranted on the basis of such capital market imperfections for a range of socially efficient and market rates of discount. In section II we develop a methodology for estimating the discount rates utilized by medical school applicants and calculate these rates. Finally in Section III actual subsidy rates for medical education are compared with the warranted subsidies of Section I in light of the market discount rates identified in Section II. In the market for physician training, we find a surprising correspondence between the actual and efficient subsidy levels.

I

Making the standard assumption that occupational choosers are strict wealth maximizers, and thus are not influenced by the nonpecuniary attractiveness of occupations or of schooling itself, the annual earnings of physicians Y_i will in equilibrium be determined by the earnings available in alternative occupations Y_{cg}, direct costs of education T, the length of both the training period j, and the annual adult working life t, and the discount rate r_i as shown below:

$$Y_i = \frac{Y_{cg}\int_o^t e^{-r_i t} + T\int_o^j e^{-r_i t}}{\int_j^t e^{-r_i t}}$$

If T reflects all costs of educating medical students other than foregone earnings, and the interest rate reflects only the riskiness of investments in medical training, such an equilibrium will result in the efficient quantity of physicians being trained. If, however, the market discount rate r_1 exceeds the socially appropriate rate r_2, then physicians' equilibrium actual earnings Y_1 (and hence fees) will be higher than they otherwise would be. This higher price will cause less than the efficient quantity of physicians' services to be purchased. A subsidy or subsidies at various points in the production process may offset the effect of the inefficiently high market discount rate. Such a subsidy should have the effect of lowering the supply price to the level which would exist at the lower discount rate r_2. Assuming that supply prices will be proportional to the earnings at the two discount rates, the efficient subsidy rate will be given by

$$\frac{Y_1 - Y_2}{Y_1} = 1 - \frac{\int_j^t e^{-r_1 t}(Y_{cg}\int_o^t e^{-r_2 t} + T\int_o^j e^{-r_2 t}}{\int_j^t e^{-r_2 t}(Y_{cg}\int_o^t e^{-r_1 t} + T\int_o^j e^{-r_1 t})}.$$

This is the proportion by which fees themselves should be reduced by all forms of subsidy motivated by capital market imperfections.

Values of this optimal subsidy rate for a range of parameter values are shown in Table 1. These have been calculated for varying values of the student borrowing rate and the socially appropriate discount rate. A length of student training equal to four was used throughout, and as the calculations were reasonably insensitive to changes in alternative earning Y_{cg}, and training costs T, these are reported only for Y_{cg} equal to \$15,503, which equals median college graduate earnings for the year 1973 and T equal to \$21,580, which is the total educational expenditure per student per year for American medical schools in that year. The latter value is assumed to approximate the tuition

TABLE 1

OPTIMAL SUBSIDY RATES IN THE MEDICAL CARE MARKET

FOR VARIOUS APPROPRIATE AND MARKET DISCOUNT RATES: 1973

	Market Rate						
Socially Appropriate Rate	.08	.09	.10	.11	.12	.13	.14
.01	.343	.384	.422	.457	.490	.521	.548
.02	.308	.352	.392	.429	.463	.495	.524
.03	.269	.315	.357	.396	.432	.466	.497
.04	.224	.273	.318	.359	.398	.433	.466
.05	.175	.226	.274	.318	.359	.397	.432
.06	.121	.176	.227	.274	.317	.358	.395

which would be charged by medical schools in a situation in which there were no subsidies to the schools.

One must be impressed by the magnitude of these warranted subsidy rates. Even for an interest rate premium of only two percent over the appropriate rate, the optimal subsidy rate is 12 percent. As we shall see in the next section, evidence suggests that the difference in the market and the appropriate discount rates are substantially greater than this.

II

For most investments the market discount rate is an observable variable. We need simply find the interest rate paid by borrowers in capital markets for investments with the same risk characteristics as the investment under question. If investors in physician training utilized capital markets to convert the high potential future earnings into present consumption, we would use the interest rate charged by lenders on these loans. Unfortunately we do not observe medical training costs being financed extensively by access to conventional capital markets. The impoverished student is all too familiar a picture, indicating that training is financed chiefly by reductions in current consumption. According to Altenderfer and West (1965), less than twenty percent of the out-of-pocket expenses of medical students are offset by loans and nearly all these loans are federally insured. In such a "thin" market it is desirable to have some other measure of the prospective students' marginal rates of time preference. We might employ as an alternative estimate of the actual discount rates used by prospective students, the internal rates of return which physicians earn on their investments in training. In equilibrium these internal rates of return should fall to the point where they equal the marginal rate of time preference of students assessing the attractiveness of such an investment.

This marginal rate of time preference will be less than or equal to the borrowing rate faced by students (Hirshleifer 1970). It is widely argued, however, that supply into this market is restrained. Under these circumstances positive profits would be earned on such investment, and the internal rates of return would exceed the relevant discount rates. Internal rates of return on medical training may therefore be unreliable as indicators of the discount rates faced by these students.

Lindsay (1973) and Hansen (1964) have suggested that we may infer the relevant rate of time preference from the returns earned in similar investments made by similar individuals. If we assume undergraduate college education is competitively supplied and in equilibrium over the long run, then the internal rate of return to college training may proxy the relevant discount rate for investors in medical training.

Many estimates of the internal rate of return to college education are available. Table 2 shows some of these estimates. Hanoch (1967) calculated the internal rate of return for undergraduate education to be 9.6 percent for northern whites and 10.1 percent for southern whites, using data from the 1960 census. Chiswick (1974) has estimated rates of return to schooling for the same data set be regressing the natural logarithm of earnings on years of schooling completed and other variables. Chiswick estimates an 8 percent rate of return from college education. Chiswick points out his regression estimates are biased downward due to negative correlation between schooling and earnings in his census sample. Other estimates are consistent with these findings falling around 10 percent.

Using the internal rate of return to undergraduate education to imply medical students' rate of time preference entails at least one predictable bias. Assuming only that preferences with respect to current and future income are

convex, we know that as the quantity of current consumption sacrificed increases, proportionally greater additions in future income would be demanded. That is, in the absence of a capital market, the equilibrium internal rate of return for a one year investment program would be less than for a two year program. Medical training involves a five to eight year investment program. The relative size of the investment in foregone earnings and direct costs is large. We might, therefore, expect equilibrium at an internal rate of return greater than in college education. Other problems including the effect of age and wealth on time preferences, and the level of non-pecuniary rewards across occupations make any estimation of the equilibrium rate of return in the absence of a clearly defined capital market most difficult.

In summary, the borrowing rate of prospective medical students must be equal to or greater than their marginal rate of time preference. We have reason to believe that this rate in turn will be higher than rates of return on undergraduate education which themselves range from about 8 to 13 percent. While such a range is useful, it is naturally desirable to narrow it to a point if possible. We may do this by inferring a discount rate from the behavior of applicants to medical schools.

The rate of applications for admission to medical school should vary with the attractiveness of a medical career, and this attractiveness itself will be influenced by the rate at which expected future earnings in alternative careers are discounted. More explicitly, we hypothesize the following relationship:

$$(1) \qquad APPL = f(PROF, CGM)$$

where APPL is the number of applicants to American medical schools, PROF is the expected pecuniary attractiveness of a medical career, and CGM is the pool of individuals qualified to make applications to medical schools. This last term

TABLE 2

Internal Rates of Return to

College Education

Author	Estimated Internal Rate of Return
Chiswick (1974)	8.0
Hanoch (1967)	9.6
Becker (1964)	13.0
Hansen (1963)	10.2

is included to allow for possible differences in taste for alternative occupations in the population. It assumes, in other words, a constant distribution of tastes over time as the relevant pool of potential applicants varies in size. PROF, as noted will depend upon the rate of time preference used by individuals to make this evaluation of career attractiveness.

The expected pecuniary attractiveness of a career is conceptually simply the present value of the difference in the earnings stream of this career and its next most attractive alternative. This is represented below for investment in physician training:

$$(2) \qquad PROF = \sum_{i=i}^{N} (EPE_i - EAE_i)(1 + R)^{-i}$$

where EPE_i is the expected physician earnings in the i^{th} year after investment,

EAE_i is the expected earnings in the alternative career in the i^{th} year after investment,

R is the discount rate, and

N is the expected career length.

In practice, however, its measurement is subject to serious ambiguity. In addition to R which we hope to estimate, neither EPE_i nor EAE_i are actually observed, but must themselves be inferred from other observed variables. Complicating the process further is the fact that there is no homogeneous "physician" population, but rather numerous specialties and subspecialties requiring different training programs and periods. We therefore restrict our analysis to the "basic" physician, the general practitioner. The GP generally receives the minimal formal training, consisting of four years of in-school training after undergraudate college and one year of internship. We thus treat the decision to specialize (involving more training) as a distinct and separable investment decision.[5/]

Conventional practice is to employ current earnings by age as the best estimate of both expected future earnings in the chosen and the alternative career. This is subject to question on the following grounds. Unlike markets in securities and some commodities there is good reason to suspect that current prices are not the best estimate of future prices. Interperiod arbitrage in physician services is too costly to have much of an equalizing effect on expected prices at different dates. As Freeman (1975) has shown, economists can forecast with reasonable accuracy future earnings movements on the basis of predicted demand and supply shifts. Elsewhere we (1977) explore whether potential applicants also use information on future market conditions to improve their predictions of the expected economic attractiveness of medicine as a career. Here, however, we employ the conventional assumption that current earnings by age are extrapolated forward by potential applicants to medical schools.

Values for expected physician earnings EPE_i were developed from a series of median earnings of general practitioners taken from quadrennial surveys of physician earnings from 1947 to 1959 and annual surveys from 1961 to 1973 published in Medical Economics. Between surveys, earnings were assumed to increase at a constant growth rate. This series is presented in Table 3. These Medical Economics surveys periodically reported experience-earning profiles. From these, age-earnings to median earnings ratios were calculated for the purpose of introducing life-cycle variability into our estimates. These ratios were also shown in Table 3.

The costs of medical school training includes tuition, scholarships, veterans' benefits and summer earnings. Interns' earnings are available for 1958-1973 from the Journal of the American Medical Association. From 1947 to 1957, intern earnings were assumed equal to real 1958 earnings.

TABLE 3

A. MEDIAN GENERAL PRACTIONER EARNINGS, 1947-1973

1947	8,088	1961	21,115
1948	8,957	1962	21,700
1949	9,920	1963	22,250
1950	10,986	1964	24,420
1951	12,164	1965	25,090
1952	12,778	1966	27,720
1953	13,423	1967	31,370
1954	14,101	1968	32,430
1955	14,817	1969	35,149
1956	15,972	1970	37,135
1957	17,218	1971	37,400
1958	18,561	1972	37,065
1959	20,000	1973	38,357
1960	20,550		

B. RATIO OF AGE-SPECIFIC EARNINGS TO MEDIAN EARNINGS

Age	
27 - 32	.840
33 - 37	1.094
38 - 47	1.072
48 - 57	1.030
57 - 70	.810

Median earnings of male college graduates were assumed to be the relevant alternative earnings. Age-earnings profiles were available from Census data and were used to estimate expected life-cycle earnings in each year.

Incomes of both physicians and nonphysicians were adjusted for taxes. Marginal tax rates were estimated from Individual Income Tax Returns, IRS, 1947 to 1973. All post-tax incomes were deflated by the consumer price index (1956-58 = 100).

These earnings are not expected with certainty; each career entails various risks which should be incorporated into the analysis. For example there is the risk of earning a high or low income in the chosen career. Census data reveal that earnings of individuals with only four years of college have greater coefficient of variation than earnings of physicians. No adjustment is made to our calculations for the lesser riskiness of a medical career, but we note that calculated returns to medical training may be understated for this reason. Another risk that should be incorporated into such calculations is the risk of death. An investor's risk of death may or may not influence his investment decision. This depends upon the investor's taste for leaving bequests. The value of human capital falls to zero when the "investment" dies, a risk not born by physical capital. Human capital should therefore earn a premium reflecting this probability, if such investors do have an estate motive. No adjustment is made in our calculations for this risk factor either, though ideally these two risks may to a certain extent offset either.

One aspect of the risk of death which is incorporated into our analysis is the effect which mortality during the earning years has on the capital value of the alternative earnings streams themselves. Previous studies (Sloan, (1970); Fein and Weber, (1971)) have treated such career earnings as expected with certainty; this significantly overstates the attractiveness of a medical career. Since by

investing in medical training physicians effectively trade-off early years earnings (when probability of death is low) for higher earnings in later years (with a higher mortality rate), calculations of returns which fail to adjust earnings in each career for expected mortality will contain an upward bias. We have adjusted the alternative income streams for expected mortality as reported in U.S. Vital Statistics.

Two other adjustments have been made in the alternative earnings streams. The first reflects the differential probability of being drafted faced by medical graduates and those whose education terminated with college. The second reflects the probable ability differences of the two pools whose earnings were used to form the alternative career streams.

Up to the year 1973 when the draft was abolished, physicians faced an average probability of 0.80 of induction into the Armed Services. Nonphysicians, however, faced only a 0.25 probability of being drafted.[6/] Our figures therefore contain a weighted average of military and nonmilitary earnings during the relevant years.

The use of median college graduates' earnings implies that those graduates considering medical training are average graduates. This is not likely to be the case with respect to either ability or motivation. For example, the grade point averages of medical college applicants have consistently been above a B average. Fein and Weber (1971) suggest college graduates earnings should be increased 10 percent to account for the greater than average abilities of medical school applicants. Our calculations include an upward adjustment of college graduate earnings of 5 percent.

Finally, expression (2) may not perfectly mirror the attractiveness of a medical career because individuals may expect to work with different intensities in different careers. As Lindsay (1971) has shown, the present value of

differences in expected earnings will yield an excessively sanguine measure of the profitability of investment in training for a career. As investment in human capital typically is associated with an increase in the cost of leisure, part of the higher earnings of individuals with greater training represents a pure substitution effect of pecuniary income for leisure at the new relative prices. Earnings differences standardized at either the physician or alternative employment work level identify a preferred measure of the real pecuniary attractiveness of investment in human capital. Lindsay (1971) has shown that it is possible to bracket the actual value of returns to such investment by standardizing earnings at both the physician and nonphysician earnings work-level. Medical Economics surveys consistently report physician work weeks in excess of sixty hours. More recent studies, surveyed by Sloan (1975), suggest a more reasonable estimate to be between 52 and 55 hours. In our calculations we assumed a conservative physician work week of 50 hours.

Table 4, A-B, summarizes the results of our estimations of the profitability of physician training. Table 4, A, shows the effects of the adjustments due to ability and hours differentials for five year intervals at a ten percent discount rate. The ability adjustment causes an average decrease in the estimated profitability of approximately $3,000. The adjustment for differential work hours causes a further decrease of $9,644 to $15,437 for 1950 and 1970, respectively. Column 6 of Table 4, A, shows the profitability found by averaging the under and over differential hour adjustments estimates. Table 4, B, shows the estimates employing the method of column 6, for various discount rates for the period 1947-1973.

Table 4, B, highlights the importance of the discount rate to these calculations. If the appropriate discount rate was as low as 5 percent in real terms, then medicine as a career has been extremely attractive in economic terms

TABLE 4, A

PHYSICIAN PROFITABILITY: VARIOUS ADJUSTMENTS, DISCOUNT RATE EQUAL TEN PERCENT[a]

Estimate	1	2	3	4	5	6
Adjustments						
Ability[b]	No	Yes	No	Yes	Yes	Yes
Hours[c]	No	No	Physician Earnings Down	Physician Earnings Down	College Graduates Earnings Up	Average of 4 & 5
Year						
1950	$11,306	8,897	724	-1,684	-747	-1,216
1955	$15,036	12,440	2,967	371	1,681	1,026
1960	$21,192	18,243	6,769	3,820	6,161	4,991
1965	$26,562	23,180	9,817	6,435	9,309	7,872
1970	$40,537	36,882	21,046	17,391	21,445	19,418

[a]All estimates in constant (1956 - 1958 = 1.00) dollars.

[b]Adjusting college graduates' earnings up by five percent.

[c]Adjusting physician earnings down by twenty percent (40/50) or college graduates' earnings up by twenty-five percent (50/40).

TABLE 4, B

PHYSICIAN PROFITABILITY: VARIOUS DISCOUNT RATES[a]

	DISCOUNT RATE				
Year	5	8	10	12	15
1947	6202	-2687	-5873	-7855	-9497
1948	11057	- 575	-4743	-7349	-9538
1949	20384	4458	-1279	-4908	-8044
1950	22758	5108	-1216	-5204	-8647
1951	25599	7739	1343	-2693	-6192
1952	23270	5795	- 492	-4464	-7891
1953	23871	6278	- 13	-3974	-7378
1954	28557	8277	982	-3638	-7661
1955	29622	8607	1026	-3791	-8005
1956	31668	9540	1556	-3518	-7963
1957	34180	10765	2328	-3033	-7735
1958	36150	12423	3717	-1902	-6935
1959	34765	11040	2327	-3273	-8237
1960	42316	14948	4991	-1399	-7086
1961	40071	13315	3594	-2630	-8147
1962	40894	13885	4071	-2215	-7794
1963	41943	14995	4989	-1521	-7409
1964	50683	19906	8471	1010	-5776
1965	51083	19504	7872	316	-6531
1966	54577	21116	8846	917	-6213
1967	72198	31699	16706	6906	-2085
1968	66461	28541	14462	5257	-3173
1969	67054	29142	15056	5827	-2657
1970	74786	34453	19418	9514	314
1971	71751	33904	19656	10183	1268
1972	56228	25175	13340	5424	-2048
1973	58293	27603	15748	7730	48

[a]Constant (1956 - 1958 = 100) dollars. Ability adjusted, average of estimates from adjusting physician earnings down and college graduates earnings up for differential hours.

throughout the postwar period. Expected profits on investment in this training never fall below $20,000 after 1948. On the other hand, if the appropriate discount rate is as high as 15 percent, then physicians can be seen consistently to experience actual economic sacrifice in choosing medicine as a career. We are now in a position to attempt to resolve this discount rate uncertainty using a proxy for career attractiveness revealed in the behavior of potential applicants themselves, namely, the rate of applications for medical school admission.

The absolute number of students who apply for medical school has varied considerably over the twenty-seven years investigated as shown in Table 5. There were 24,434 applicants for admission to the 1949 class. This number declined to 14,381 for the 1961 class, and climbed to over forty thousand for the 1973 class. During this period there were large changes in the size of the population from which most medical students come. The number of male college graduates fell from 329,819 in 1950 to 183,602 by 1955, rising to over a half a million by 1973. In 1947, 17 percent of male college graduates applied to medical school. This fell to only about 5 percent in 1968.

Considerable variation thus remains to be explained in the rate of application to medical school. We hypothesize that a significant part of that variance is explained by the economic attractiveness of medical school, and that measures of that attractiveness which employ the discount rate actually used by potential applicants will perform better than measures which employ discount rates which are either too high or too low. In essence we select the discount rate by regressing measures of profitability of medical training on the applicant rate using different discount rates and selecting that which fits best. This amounts to a maximum likelihood search on the discount rate in which our criteria for selection is that value which minimizes the summed squared residuals.

TABLE 5

MEDICAL SCHOOL APPLICANTS, ACCEPTANCES AND COLLEGE GRADUATES, 1947-1973

Year	Applicants[1]	Accepted Applicants[1]	Ratio of Applicants to Acceptances	College Graduates[2]	Ratio of Applicants to College Graduates	Male College Graduates[2]	Ratio of Applicants to Male College Graduates
1947	18029	6512	2.8	204242	.092	110086	.170
1948	24242	6973	3.4	272511	.089	176292	.130
1949	24434	7150	3.4	366098	.066	264168	.092
1950	22279	7254	3.0	433734	.051	329819	.067
1951	19920	7663	2.5	384352	.051	279343	.071
1952	16763	7778	2.1	331924	.050	227029	.073
1953	14678	7756	1.8	304857	.048	200820	.073
1954	14538	7878	1.8	292880	.049	187500	.077
1955	14937	7969	1.8	287401	.051	183602	.081
1956	15917	8263	1.9	311298	.051	199571	.079
1957	15791	8302	1.9	340347	.046	222738	.070
1958	15170	8366	1.8	365748	.041	242948	.062
1959	14952	8512	1.7	385151	.038	254868	.058
1960	14397	8550	1.6	394369	.036	255504	.056
1961	14381	8682	1.6	401784	.035	255599	.056
1962	15647	8959	1.7	420485	.037	262015	.060
1963	17608	9063	1.9	450592	.039	274750	.064
1964	19168	9043	2.1	502104	.038	299813	.063
1965	16703	9012	2.0	536930	.034	319670	.058
1966	16250	9123	2.0	553755	.032	330647	.055
1967	18724	9702	1.9	593955	.031	354709	.052
1968	21117	10092	2.0	671591	.031	392850	.053
1969	24465	10514	2.3	764000	.032	434000	.056
1970	24981	11500	2.1	827000	.030	444000	.056
1971	29172	12335	2.3	877676	.033	511138	.057
1972	36135	13757	2.6	921000	.039	535000	.067
1973	40506	14336	2.8	991000	.040	572000	.070

1. From Journal of the American Medical Association, Education Number, 1948-1974.

2. From Earned Degrees Conferred, U.S. Office of Education, 1948-1974. Includes first professional degrees which constitutes about 8 percent of the total.

Expression 3 below illustrates the actual form of this relationship employed:

$$(3) \quad \text{Log}(\text{Appl}_t) = \alpha_0 F_{t-5}(R) + \alpha_1 \text{CGM}_t + \alpha_2 + E_t$$

where F_{t-5} is the profitability estimating equation (2) lagged five years

R is the discount rate

E_t is a random error term.

The profitability variable is expected to affect applicants with a lag. First of all, information on salaries is not immediately available to applicants; published data are reported with at least a two year lag. Most applicants clearly do not explicitly compute profitability, and the information used to assess the changing attractiveness of medical training appears gradually in piecemeat fashion.[7/] Secondly, the decision to apply to medical school is made relatively early in the college career. A survey of college freshmen by Astin (1972) shows that of those surveyed who applied to medical school in 1968, ninety-two percent made the decision in or by their freshman year. A study by Davis (1965) found over ninety-percent of seniors planning medical careers had made that decision by their freshman year. The tight prerequisite requirements of medical schools is one reason for this. Experimentation suggests that a five year lag is appropriate.

Estimation by ordinary least squares produced severe serial correlation. The data were therefore transformed using the Cochrane-Orcutt technique. In all cases the sample size is twenty observations. Table 6 shows the results of estimating rho (the serial correlation adjusting coefficient), α_0, α_1, and α_2 of equation 3. A grid search of one unit increments on R reveals that the summed squared residuals are minimized at a discount rate of 12 percent. The values of these residuals are plotted in Figure 1.

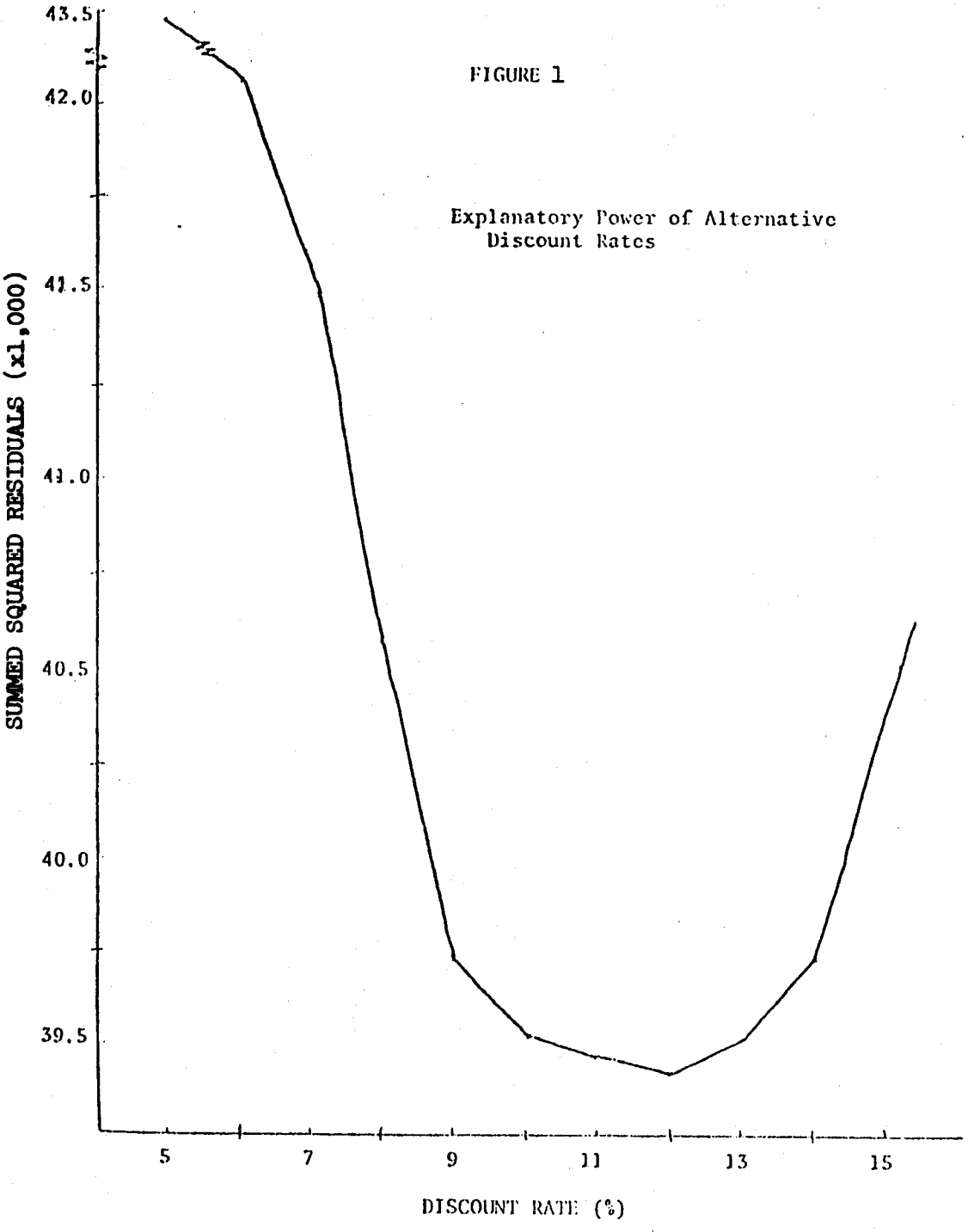
TABLE 6

Estimation of Medical Students Rate of Time Preference

Number	Discount Rate (%)	Profitability Coefficient (x100,000)	O.L.S. S.E.	"Pool" Coefficient (x100,000)	O.L.S. S.E.	Constant	Rho	Summed Squared Residuals	R^2
1	5	.618	.245	.227	.0378	8.85	.80	.04343	.9761
2	6	.771	.292	.226	.0371	8.88	.79	.04236	.9767
3	7	.945	.345	.225	.0361	8.91	.79	.04141	.9772
4	8	1.14	.403	.225	.0352	8.95	.78	.04061	.9776
5	9	1.34	.465	.226	.0342	8.99	.78	.03998	.9780
6	10	1.56	.533	.227	.0330	9.04	.77	.03955	.9782
7	11	1.78	.603	.230	.0321	9.08	.76	.03932	.9783
8	12	2.01	.679	.233	.310	9.12	.75	.03929	.9784
9	13	2.22	.757	.236	.030	9.17	.75	.03949	.9782
10	14	2.42	.837	.240	.0288	9.20	.74	.03989	.9780
11	15	2.60	.918	.245	.0280	9.23	.73	.04048	.9777

FIGURE 1

Explanatory Power of Alternative Discount Rates



Our results suggest that applicants to medical school act as if they discount future earnings at twelve percent. Applicant behavior is best explained when that discount rate is used to calculate economic attractiveness. The standardized standard error of the profitability coefficient is also smallest at 12 percent. We also note that this estimate is consistent with the evidence on internal rates of return to undergraduate college education discussed above.

III

In section I above we calculated optimal subsidy rates which will just offset the capital market "imperfections" for persons who must borrow to finance their investment in physician training. These rates varied depending upon the actual discount rates faced by such investors. We now have a point estimate of that discount rate and may choose from the array of subsidies presented in Table 1. This optimal subsidy results from a disparity in the discount rate faced by human capital investors on the one hand the the "appropriate rate" reflecting only the real economic risk implicit in such investment. In section II above we estimated that the discount rate employed by students to discount future earnings is 12 percent. We have no similar estimate of the appropriate rate but are confident that it lies somewhere in the range shown in Table 1. An unexceptional point estimate might be 3 percent. We are thus led to conclude that the optimal subsidy rate resulting from the capital market imperfection alone is in the neighborhood of 43 percent. That is, a set of subsidies which effectively lower the market price of medical care by 43 percent should just offset the inefficiency caused by inappropriately high discount rates.

In Lindsay, Hall, and Leffler (1976) the effect of all government subsidies on the price of physician services is estimated. Direct subsidies in the market for care together with "tax expenditures" resulting from the deductability of

care expenditures were estimated to reduce the demand price by 27 percent. Indirect subsidies to the care market through grants to medical schools and students were estimated to have lowered the demand price for physician services by another 26 percent. The combined effect of all subsidies to the medical care market taken together is thus a net reduction of 53 percent in the price of these services. This figure lies somewhat above the range of our estimates, though this capital market imperfection explains a considerable share of the existing subsidies. Our analysis nevertheless suggests that either excessive resources are being devoted to training physicians or that this subsidy is being undertaken for reasons in addition to capital market imperfections.

In closing we note one final conclusion of this analysis which has some policy significance. We mentioned in the introduction that the government commitments in the health area are quite substantial. Let us assume that the chief objective of this involvement is to lower the price of physician services and thus increase public access. The government may do this alternatively by subsidizing demand via National Health Insurance or some such program, or it may subsidize medical schools and physician training. Both ultimately make a medical career more attractive and thus should eventually increase the supply of practitioners, lowering the price of medical care. The first by supplementing demand would drive up supply prices, hence earnings. The second would presumably make it possible for medical schools to lower fees, also increasing the profitability of a medical career.

From the results discussed above, we can categorically state that in the absence of distributional considerations, subsidies to medical schools are preferred to subsidies in the care market. This occurs because applicants to medical school face a cost of transferring purchasing power from the future into the present which exceeds 10 percent. Estimates of the government social rate of discount are considerably less than this.[8/] The relative attractiveness

to prospective applicants of a subsidy while in school versus a subsidy later during active practice differs substantially from the government's relative cost of making these two forms of subsidy. Using our regression results from section II, we may estimate the extent of this advantage.

Assuming an applicant discount rate of 12 percent and a social discount rate of five percent, we can calculate the savings from increased school aid (or scholarships) vis a vis subsidies to demanders of care. In 1973, for example, an increase in aid to schools of $1,000 per student per year would have cost the government in present value terms $3,546 per student. This would have increased expected profitability to prospective medical students by $3,037 and increased total applicants by 2,549. For the same cost, the government could have subsidized physicians over their lifetimes by $252 per year. This, however, would increase profitability by only $1,186 and increase applicants by 977. The cost per additional applicant more than doubles by giving subsidies in the care market rather than in the training market. This is a general conclusion applicable to all human capital markets facing "high" borrowing costs. Subsidies to trainees will be more efficient than subsidies to the practitioners during their working careers.

FOOTNOTES

1/ See Lindsay, Hall and Leffler (1976), Chapter Four, for the development of these statistics.

2/ See Arrow (1963) or Pauly (1971) for full discussions of these arguments.

3/ We follow the conventional and misleading use of the phrase "imperfect market" to describe a market functioning well in that lenders are charging appropriate premiums for risky loans. See Stigler (1967) for an extended discussion of the senses in which capital markets can be perfect or imperfect.

4/ Stan Liebowitz has called our attention to an ambiguity in this argument. He points out that where bankruptcy is a possibility, individuals may borrow with the express purpose of defaulting on their loans. If attendance at medical school is a condition for the granting of such loans, the result may be efficient or even excessive levels of demand for training -- even at high discount rates. Investment in training becomes, in effect, a license to steal. The high discount rates have little deterrent effect on borrowing and studying medicine since these borrowers do not intend to pay the high rates anyway.

In the limiting case such an argument leads to the conclusion that no market will exist at any discount rate, for no lenders will supply a market where there are no qualifications for bankruptcy. Such markets do exist, however, possibly indicating either that most people are honest or that the policing of such fraud is reasonably effective (See Darby and Karni, (1973)). As long as bankruptcy is allowed in cases where human capital creation is unimpaired, the market rates are nevertheless inefficiently high and too little training will be demanded.

5/ Sloan (1970) has shown that general practitioners typically earn far greater profits on their investment in training than do most specialists. As we are here less concerned with the level than the variation of PROF over time, this will hopefully pose little difficulty.

6/ Physician draft probabilities are reported in The Report of the President's Commission on an All Volunteer Army (1973). College graduate draft probabilities are estimated as equal to the number drafted divided by the male population age 21. Military earnings for physicians were assumed equal to the pay of a captain (O-3) with two years service. College graduate earnings were assumed equal to the pay of a corporal (E-4) with one year of service.

7/ Such things as the cars physicians drive, the country clubs they belong to, reports in newspapers, and job offers of friends would all tend to indicate the general level of returns to continued training as a physician.

8/ Harberger (1969) places the real social discount rate at between 3 and 6 percent.

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