COSTS AND BENEFITS OF VETERINARY MEDICAL VERSUS FOUR YEAR COLLEGE GRADUATES

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I. Introduction

Historically much attention has been given by the private human capial investors(students and/or their parents) to expect higher lifetime earnings of veterinarians relative to comparable alternatives in general. Moreover, there has been a tendency that as observed earning differentials between the veterinary educational investors and those of other fields become larger, the application and enrollments in veterinary medical education increase. For example, from 1960 to 1980 the number of graduates from veterinary medical schools increased by more than 10 percent annually in USA. New schools of veterinary medicine have been established, and schools already operating have expanded their enrollment. In 1960, veterinary medical degrees were awarded by 18 schools in USA. By 1983, 9 additional schools were in operation, and several other schools were in the development or planning stages.

A number of studies have identified the costs and returns associated with specialized higher educational programs (Lindsay 1973; Sloan 1970 & 1976). However, such techniques have not been applied to veterinary medical education in a systematic fashion. For meaningful decisions, both costs and benefits of the veterinary medical education should be combined because of the large investment (both out of pocket money and opportunity costs) and interrelationships between educational investment and labor market conditions for those with veterinary medical training. The adjustment of college enrollments to changes in the returns to education in not always smooth or rapid - particularly in specialized highly technical field such as veterinary medical science. This inability to respond immediately to changed market conditions may cause boom-and-bust cycles in the market for veterinarians. This phenomenon has been observed in other highly skilled professionals. Policies that fail to incorporate these interrelationships adequately may seek to stimulate(or reduce) enrollments in veterinary medical education at a time when they should be doing exactly the opposite. As a conseqnence they may re-

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quire continual updating and revision. In addition, unnecessarily high adjustment costs may occur. Considering a large amount of private educational expenditures in this field, more systematic research about the private rate of returns to human capital investment in veterinary medical education in warranted.

The present paper estimates the private costs, benefits and investment rate of return for human capital investment in veterinary medicine. In the first section, a relatively simple model of human capital investment, and some issues which are considered as important in veterinary human capital investment are reviewed. The results of empirical analysis are included in the second section. Finally, implications and conclusions of the study are made.

II. Theoretical Consideration of Human Capital Investment in Veterinary Medical Education

Many labor-supply choices usually require a substantial investment on the part of the worker. Training to be a veterinary medical doctor is regarded as investment in human capital. This investment yields a lifetime income stream-earnings of the veterinary medical doctor. The cost of this investment consists of whatever direct costs are incurred during training period plus whatever lifetime earnings are foregone as a result of the decision to become a veterinary medical doctor. Direct costs during the training period consist of tuition, supplies and equipment, and books. Also on the return side of the investment are the veterinary medical student's summer earnings, his earnings during the school year, and whatever scholarship aid he receives

A criterion for a person to invest veterinary medical education may be developed from the present value of the benefits (monetary and non-monetary) and the cost of the education. An investment of veterinary medical schooling is worthwhile if the present value of the benefits are at least as large as the present value of the costs. In mathematical terms, this criterion can be expressed as equation (1):

$$(1) \qquad \sum_{T=1}^{n} \frac{B_T}{(1+r)^T} \geq \sum_{T=1}^{n} \frac{C_T}{(1+r)^T}$$

where r=discount rate

T=expected working period including investment period $(T=1, \ldots, n)$

B_T=differences in earnings between the veterinary human capital investors and other alternative human capital investors at year T

C_T=costs at year T

As evaluation criteria, net present value (NPV), benefit-cost ratio (B/C ratio), and internal rate of return (IRR) are common measures in educational investment analysis.

Since the decision criterion of educational investment is determined by three basic elements, B_T, C_T, and T in equation (1), they should be specified in detail.

Private Returns to Veterinary Schooling *(B_T)*

Private returns accruing to a veterinary school graduate may be defined as follows:

(2) $B_T = B_T^M + B_T^{NM}$

where B_T=private returns accruing to a graduate at time T
B_T^M=monetary returns,
B_T^{NM}=non-monetary returns

From a veterinary school graduate's point of view, the appropriate measure of returns is given by the additional monetary and non-monetary returns which one is able to get during a working life after completion of veterinary school over and above what one would have earned in an alternative occupation. An important facet of the non-monetary component is the enhanced social status associated with the professional degree. The veterinary school graduate's monetary returns can be expressed as follows:

(3) $B_T^M = GB_T - (AB_T + T_T)$

where B_T^M=net earning differential of veterinary school graduate in year T
GB_T=gross earnings of veterinary school graduate in year T
AB_T=alternative gross earnings which would have accrued to one in year T had one not attended veterinary school
T_T=marginal income tax on amount of $(GB_T - AB_T)$.

Since GB_T and AB_T affect B_T^M in equation (3), any changes in labor markets (both for veterinary and non-veterinary school graduates) such as changes in wage rate and unemployment rates will change the private money returns.

Private Costs *(C_T)*

The major veterinary educational costs consist of two parts: direct costs and indirect costs. Direct costs include tuition fees, books, and other incidental expenses arising out of veterinary educational programs. Indirect costs include earnings foregone by the student during the period of his veterinary school education.

It is well-known that the estimated foregone earnings are more than half of the total private costs in the higher education (Becker 1964). Therefore, this foregone earnings is particularly important for older people. Because older people command higher wages (on average), their opportunity costs of veterinary school education are higher than those for younger students. Older people are, thus, doubly discouraged from attending veterinary school; their foregone earnings are relatively high and the period over which they can capture benefits is

comparatively short.

Expected Working Period *(T)*

Given similar yearly benefits of a veterinary educational investment, younger people have a larger present value of total benefits than older people simply because they have a longer remaining working life ahead of them. Other factors that affect expected working period are investor's health and stage of household life cycle (especially for female investors in their household production).

Market Labor Supply and Human Capital

Hours of work may differ among educated classes for a variety of reasons: some persons retire earlier, have the opportunity to work more hours during any week, and some prefer leisure to work (take longer vacations, etc.). Although many empirical studies of labor supply include education as an independent variable, there is no theoretical justification.

The crux of argument is that in order to obtain a higher wage, one must forego wealth (potential earnings), i. e., make expenditures on education (Keeley 1981). If we assume that wage rates are positively related to the level of education, its increasing rate of wage is relatively higher than that of the productivity of non-work activities induced by education, and that education does not affect individual's work-leisure preferences, then education can increase market working hours. As a result the earnings differentials between educated and less educated not only come from wage differentials associated with productivity levels, but also from the defferences of working hours. Consequently, the currently pervasive "earnings difference" measure has an upward bias as the size of the investment increase. This upward bias can be reduced by using standardized (hours working) earning differentials (Lindsay 1971).

III. Data and Analytical Procedures

Data

Like many empirical researches, research on human capital is limited by available data. Virtually two types of data have been used in empirical human capital research -- aggregated cross-sectional data (census) and disaggregated cross-sectional sample survey data. In this study three types of data were used : (a) cross-sectional sample survey data for veterinarians ; (b) cross-sectional sample survey data for control group (college graduates) ; and (C) whole sample survey data of veterinary medical schools for determining veterinary schooling direct costs.

To estimate gross private returns to, and lifetime earning function of veterinary medical school graduates, data on individual earnings and other socio-economic characteristics are necessary. Such data were provided by the AVMA Economic Survey, conducted in January 1978 and 1981 by the American Veterinary Medical Association (AVMA), Office of Economic Research.

A primary objective of the survey was to collect information on income from professional veterinary medical activity and about other related socio-economic characteristies of the veterinary population (Wise 1978). The sample of veterinarians (sample consisted of both private practice and those not in private practice) consisted of 7,349 veterinarians chosen with a stratified random sample method from AVMA's commputerized listing of 31,229 member and non-member veterinarians. Survey forms were mailed in January 1978, with a reminder mailing six weeks later (see Wise 1978, for more details). A total number of 5,165 samples were identified in the computerized data tape prepared by the AVMA, Office of Economic Branch. Among these, some questionnaires were eliminated from the analysis because of missing values for some variables. A total number of 5,115 questionaires were used in the 1977 veterinarian earnings analysis. For the 1980 veterinary earnings analysis, the AVMA Surey of Veterinarians, 1981 were used. Among 4,617 identified observations recorded in the computerized tape, a total number of 4,500 questionnaires were used.

A control group (4 year college graduates) was required for comparative purposes, i.e., if students had not attended veterinary medical schools, what would likely be their earnings. Data from the Nationwide Food Consumption Survey 1977-78(NFCS) were used. This survey was conducted by the USDA during 1977 and 1978. Data on food consumption as well as other socio-economic variables were collected by interviewers in over 14,000 house keeping households, drawn from a stratified probability sample in the 48 conterminous States. Information on individual household members were also available in this survey (see Consumer Nutrition Division, 1983, for more details).

A total of 7,393 housekeeping households were identified in the Spring and Fall for the 1977 NFCS data tapes (3,322 and 4,071 households in the Spring and Fall surveys, respectively). Only those individuals who completed four years of college (or university) and were wage earners were selected from the 7,392 household data files. Also, samples with missing values for some variables were eliminated during sample selection procedures. A total number of 538 individuals met sample selection criteria required to specify the control group.

For estimating direct educational investment costs, comparative data summary reports for two academic periods (1977-78 and 1981-82) were utilized. Each all the schools / colleges of veterinary medicine complete a questionnaire which is collected and compiled by the Washington Office of the Association of American Veterinary Medical Colleges. The Comparative Data Summary Report is a compilation of data collected by survey method from all schools/colleges of veterinary medicine within the United States and Canada (Washington Office of the Association of American Veterinary Medical Colleges 1982).

From these two summary reports, data on direct private schooling costs and scholarship information of the veterinary medical schools located in the United States were identified. A total number of 22 veterinary schools for 1977-78 academic period and 27 veterinary schools for 1981-82 academic period were

used to determine average veterinary schooling costs in the United States.

In addition, secondary data on the general sate of the economy (unemployment rates, etc.) and mortality rate of each age group were collected and used as adjustment factors to compute expected earnings from educational investment.

Analytical Procedures

To estimate gross private benefits (salary differences) and foregone earnings of veterinary schooling, lifetime earnings functions were estimated using income data of two groups (veterinarian and counterpart control groups). Since the veterinary and the comparison groups were not being drawn from the same population it is thus necessary to adequately control statistically for differences between them. Multiple regression methods with veterinary education graduate specified as a dummy variable set was the major statistical technique for isolating veterinary educational effects.

Ordinary least squares (OLS) was the major statistical tool used in this analysis. The estimated equation had the form:

$$(2) \qquad Y = b_o + \sum_{j=1}^{n} b_j \cdot X_j + \sum_{k=1}^{2} c_k \ (DEd \cdot X_k)$$

where Y represents annual wage or salary earnings measured in dollars (for the private practice veterinarian group, the wage earnings were the adjusted wage earnings derived from their yearly net practitioner income by deducting 4% of capital invested in their private practice).[1] The independent variables (X_j) included age (X_1), age squared (X_2), annual hours worked (X_5), and 10 dummy variables for gender, educational background, geographical location, and occupation. The two interaction terms, DEd $\cdot X_1$ and DEd $\cdot X_2$, representing the veterinary educational dummy variable times age and age square respectively, were included to be consistent with the assumptions that the lifetime earning profiles are different between the two groups. This means that to the control group the estimated regression coefficients for the age (X_1) and age square (X_2) variables are b_1 and b_2, whereas to the veterinarian group they are $(b_1 + c_1)$ and $(b_2 + c_2)$ respectively.

To estimate the direct costs of veterinary medical education, scholarships, tuition and other direct costs in veterinary medical schooling were calculated directly from secondary data. Two investment analysis criteria (net present

[1] The survey form asked for income before personal taxes. Therefore, interest expenses for debt capital had been deducted from income. Deducting 4 percent of the capital investment as a partial return to capital increases the return attributed to capital still further. As an example, assume a practice has $100,000 invested in facilities and equipment, and that the owner(s) have 50 percent equity in the business. The $50,000 debt capital is financed at 13 percent interest. Therefore, $4,000 plus $4,500 gives $9,500 return to capital, or a 9.5 percent return to the $100,000 capital investment.

value and internal rate of return) were used to determine the degree of profitability associated with veterinary medical schooling investment. Both the before- and after-income tax approaches were applied to the investment analysis.

IV. The Results

The analysis is divided into three sections. In the first, gross benefits of veterinary medical education is estimated from the regression analysis of age/earnings profiles. Net benefit of veterinary medical education is estimated with use of selected income adjustment factors. In the second, direct and indirect private costs of veterinary medical education are calculated. Finnally, costs and benefits are combined to estimate the rate of return on private investments in veterinary medical training. Also a comparison between the results of this and previous studies on the higher professional training are attempted.

Earnings Functions and Benefits of Veterinary Medical Education

Table 1 shows the mean and standard deviation of all variables used in the earnings function estimation. The average yearly wage earnings of veterinarians are almost two times larger than that of 4-year college graduates. Mean ages do not differ significantly between the two groups. However, the annual working hours are significantly different between the two groups (statistical tests will follow).

Some variables have relatively large standard deviations in comparison with their means, and some relatively small. The standard deviations of wage earnings, practitioner earnings and investment in private practice are relatively large. However, age and working hours are relatively small in comparison with their means.

Noting the veterinarian exclusive variables, one observes that 78.3 percent of total veterinarians didn't have advanced degrees beyond four years of veterinary medical schooling. Also Table 2 shows that 6 percent of total veterinarians had board certification in specialty areas, and that the average capital investment in private practices is $64,721.

Table 2 shows the results of statistical estimation of working hours function. This estimation is conducted to test whether differences exist in working hours between the veterinarian and the 4-year college groups. This working hour difference between two groups has an important implication for measuring returns to human capital investment.

As mentioned, the point of argument on hours of working and mesauring human capital returns is that the currently pervasive earning difference measure without considering hours of working of two comparison groups has a severe upward bias of returns as the size of human capital investment increases (Lindsay 1971). Consequently the earnings differentials as the result of more working hours by the higher educated group should be adjusted in order to estimate less biased returns to human capital. The loss of leisure due to more working hours

TABLE 1 **Means and Standard Deviations(S.D.) of the Variables: Veterinarians and Control Group**

Variable	Veterinarian		4-Year college graduate	
	Mean or fraction in sample	S.D.	Mean or fraction in sample	S.D.
Yearly wage earnings($)(Enw)	25,392[a]	12,187	13,323	9,410
Log wage earnings(LgEnw)	10.00	0.61	9.26	0.771
Age(age years in 1977)	41	11	37	12
Sex : Male(%)(DSex = 1)	94.7		67.5	-
Female(%)(DSex = 0)	5.3		32.5	-
Residential location : NE(North East : DLoc1)	17.4		29.6	-
NC(North Central : DLoc2)	32.1		27.0	-
S(South : DLoc3)	28.2		20.1	-
W(West : DLoc4)	19.9		23.4	-
Others[c]	2.4		0	-
Occupation :				
Private vet practice(Doc 1 = 1)	59.6		72.8	-
Professional[d]	40.4		20.1	-
Clerical or Sales	-		7.1	-
Others	-		-	-
Working hours(annual working hours : HWrk)	2,562	686	2,092	633
Log working hours(LgHwrk)	7.79	0.497	7.58	0.438
Veterinarian exclusive variables :				
Advanced degree : None	78.3	-	-	-
M.S.(Dadv 2 = 1)	15.5	-	-	-
Ph.D.(Dadv 3 = 1)	5.4	-	-	-
Special board certification :				
Holder	9.0			
Non-holder(DSbod = 1)	91.0	-	-	-
Investment in private practice($)	64,721	76,776	-	-

Note: a)Estimated wage earnings from practitioner.
b)Sample proportion to the total sample(total N = 5,516)
c)Hawaii, Alaska and others.
d)Non-private veterinary practitioners(Doc 2 = 1) are included.

by a higher educated group must be considered in human capital returns. In order to reduce this upward biased estimation of human capital returns, Lindsay suggested that the working hours of the more educated group be used to standardize for working hour differences.

In Table 2, the first column represents the results of hours of working function for the whole sample. Second and third columns represent the results of the separate estimation for the male and female groups. In the three equations, all estimated regression coefficients are statistically significant at 1% level, except the coefficients of age and age squared variables in female group. All signs of estimated coefficients are consistent with expectations.

Results show veterinarians worked more hours than the 4-year college graduate group as a whole. Also male and female veterinarians worked more hours than that of their counterpart groups. This means that part of earnings

differentials between veterinarians and 4-year college graduates are due to added working hours.

For preliminary the average yearly earnings of veterinarians and their counterpart group were compared. Table 3 summarizes the average yearly earnings of veterinarians and 4-year college graduates by their sex and types of employment. On the average, male veterinarians earn $25,948 per year whereas their counterpart 4-year college graduates earn $15,789 in a year. For female groups, the average yearly earnings for veterinarians and college graduates are $15,393 and $8,208, respectively. In short, the earnings gap between veterinarians and 4-year college graduates are much larger in male groups than in female groups. Lower relative earnings of female veterinarians may, in part, be explained by fewer working hours by choice. An investigation of this phenomena is beyond the scope of this research.

TABLE 2 **Regression Results of Hours Worked Regressed on Selected Independent Variables by Sex for Veterinarians and Control Group, 1977**

Independent	Whole sample		Male group		Female group	
variable	b	T-value	b	T-value	b	T-value
Intercept	7.02	79.1***	7.22	76.4***	7.97	23.8***
DSex	0.26	9.96***	-	-	-	-
DEd	0.15	6.67***	0.13	4.8***	0.26	4.9***
Age	0.02	5.60***	0.03	6.3***	-0.03	-1.9**
SQAge	-0.0003	-6.96***	-0.0004	-7.7***	-0.0004	1.8*
F-value		32.0	59.7		9.2	
N		5,515	5,078		436	

Notes : Dependent varialbe : log(natural) yearly working hours.

DSex and DEd : dummy variables for sexual status(male = 1) and educational background(veterinarian = 1) respectively.

Age and SQAge : actual age and squared of the respondents, respectively.

*** 1% significant level.

** 5% significant level.

* 10% significant level.

TABLE 3 **Average Yearly Earnings of Male and Female by Their Educational Backgrounds, 1977**

	Veterinarian			4-Year college	
Sex	Private practice	Non-Private practice	Overall (A)	graduate (B)	Diff. (A−B)
Male	$25,900[a] (13,375)[b]	$26,041 (9,216)	$25,948 (12,019)	$15,789 (10,133)	$10,159
Female	14,738 (8,706)	17,087 (8,871)	15,393 (8,799)	8,208 (4,542)	7,185
Overall weighted average	25,258 (13,405)	25,655 (9,378)	25,392 (12,187)	13,323 (9,410)	12,069

Notes: a)Average earnings with 4 percent of investment capital deducted as return on capital. This rate approximates the rate obtained when value of practice investment was regressed on total earnings.

b)Standard deviations(S.D.).

To estimate the lifetime earnings function several model specifications were tried. For example, natural logarithm of yearly earnings and working hours were used instead of real values in earnings functions. For the whole pooled sample a simple specification (non-logarithm form) fits better than logarithm form even though many previous human capital studies tell that the logarithm of yearly earnings is appropriate. However, in separate estimations, the logarithm fit better than non-logarithm.

Table 4 shows the results of the earnings function estimation for the whole pooled sample group. All estimated regression coefficients are significantly different from zero at the 1% level, except the locational and occupatioal dummy variables. Also the signs of the coefficients are consistent with the theory. Especially, the negative signs of regression coefficients of SQAge and (DEd·SQAge) explain the inverted U-shape lifetime earnings profiles in both the 4-year college graduates and veterinarian groups. From these estimation results, peak earnings of lifetime earnings profiles for both groups were derived. For the veterinarian the peak earning age is 49.2 whereas it is 49.5 for the 4-year college graduate.

As a measure of goodness of fit, R-square can be used. The model explained about 28 percent of the variance in earnings. This finding is consistent with most other cross-sectional studies (most other studies ranged from 0.2 to 0.3).

TABLE 4 **Statistical Estimates of Earnings Function and Related Statistics(Total Sample), 1977**

Independent variables	*b*	T- value
Intercept	-17,534.3	-3.31***
Age	901.8	3.26***
SQAge(age squared)	-9.1	-2.72***
DSex(1 = male)	5,123.0	9.00***
DEd(1 = veterinary, 0 if 4 yr college)	-29,357.1	-5.09***
HWrk(annual hours worked)	3.4	15.27***
DEd · Age(interaction term)	1,666.5	5.67***
DEd · SQAge(interaction term)	-17.0	-4.8***
(Location)		
DLoc1(North East)	356.8	0.46
DLoc2(North Central)	-672.3	-1.68*
DLoc3(South)	-1,383.1	-1.78*
DLoc4(West)	-1,625.2	-1.98**
(Occupation)		
DOc1(private vet.)	1,910.9	2.18**
DOc2(non-private vet., Prof., Mgr.)	1,750.3	2.10**
DOc3(clerical, sales, craftsman, service workers, farmers)	-3,415.4	-1.80*
R^2	0.284	
F-ratio	155.0	
N	5,505	

Note : a) Dependent variable : yearly wage earnings.
b) * Statistically significant at 0.10 level.
** Statistically significant at 0.05 level.
*** Statistically significant at 0.01 level.

Tables 5 and 6 show the results of separate estimation of earnings function for the veterinarians (private and non-private practice veterinarians) and 4-year college groups. For private veterinary practice, being board certified is not significantly correlated with earnings, whereas board certification increases earnings for individuals in nonprivate veterinary practices. Holding of advanced degrees (M.S. and Ph.D.) contributes positively to earnings for the non-private veterinary practitioners. But, they decrease (M.S. degree) or do not influence (Ph.D. degree) earnings for those employed as private veterinary practitioners. Also, there are some earning differences among types of private practices and types of non-private practitioner jobs.

From the estimated earnings function in Table 4, the gross and net benefits of veterinary medical education were derived. The gross benefits (expected salary over working life) of veterinary medical education were calculated with use of two different age/earnings profiles for the veterinarians and the counterpart

TABLE 5 **Results of Veterinarian's Earnings(natural log), Private Practice and Non-Private Practice, Regressed on Selected Independent Variables, 1977**

Independent variable	Private		Non-Private	
	b	T-value	*b*	T-value
Intercept	4.971	20.26**	6.185	37.04**
Age	0.126	15.00**	0.098	14.68**
SQAge	-0.0013	-13.79**	-0.0009	-12.78**
DSex	0.299	6.04**	0.216	5.21**
LgHwrk	0.450	13.56**	0.339	12.20**
DSbod	0.074	0.54	-0.145	-6.39**
DStatus	0.051	1.61	-	-
$Dadv^2$	-0.181	-3.93**	0.118	5.86**
$Dadv^3$	0.136	0.61	0.166	4.81**
DPrct2	0.031	0.68	-	-
DPrct3	-0.068	-1.64+	-	-
DPrct4	0.090	2.02*	-	-
DPrct5	0.264	6.20**	-	-
DPrct6	0.223	4.64**	-	-
DPrct7	0.228	1.36	-	-
DNPrct2	-	-	0.187	7.09**
DNPrct3	-	-	0.036	1.28
DNPrct4	-	-	0.016	0.65
DNPrct5	-	-	0.333	10.39**
DNPrct6	-	-	0.233	4.96**
R^2	0.225		0.487	
F - ratio	61.07		127.59	
N	2962		1623	

Notes : a) Dependent variable : natural log of yearly earnings.
b) Adjusted yearly earnings were used.
c) + significant at 0.10 level.
* significant at 0.05 level.
** significant at 0.01 level.

4-year college graduates. To calculate the two age/earnings profiles, mean values of independent variables were applied for all variable other than age. For veterinarian group it was assumed that they start to work at age 27 because their average pre-vet school years were 4 years. It was also assumed that both veterinarians and their counterpart group retire at age 65. Figure 1 shows the age/earnings profiles for both groups.

TABLE 6 **Results of Earnings for 4-Year College Graduates Regressed on Selected Independent Variables, 1977**

Independent variable	*b*	T-value
Intercept	1.381	2.71**
Age	0.0715	4.64**
SQAge	-0.00078	-4.21**
LgSWrk	0.724	11.53**
DSex	0.424	7.19**
DLOC1[b]	-0.029	-0.42
DLOC2	0.022	0.31
DLOC3	-0.061	-0.79
(Occupational dummy variables)		
Professional or technical	0.724	5.52**
Manager, officer or proprietor	0.773	5.46**
Farmer	0.217	0.938
Clerical or sales worker	0.599	4.28**
Craftman or foreman	0.455	2.51*
Operatives	0.004	0.012
R^2	0.45	
F-ratio	34.35	
N	538	

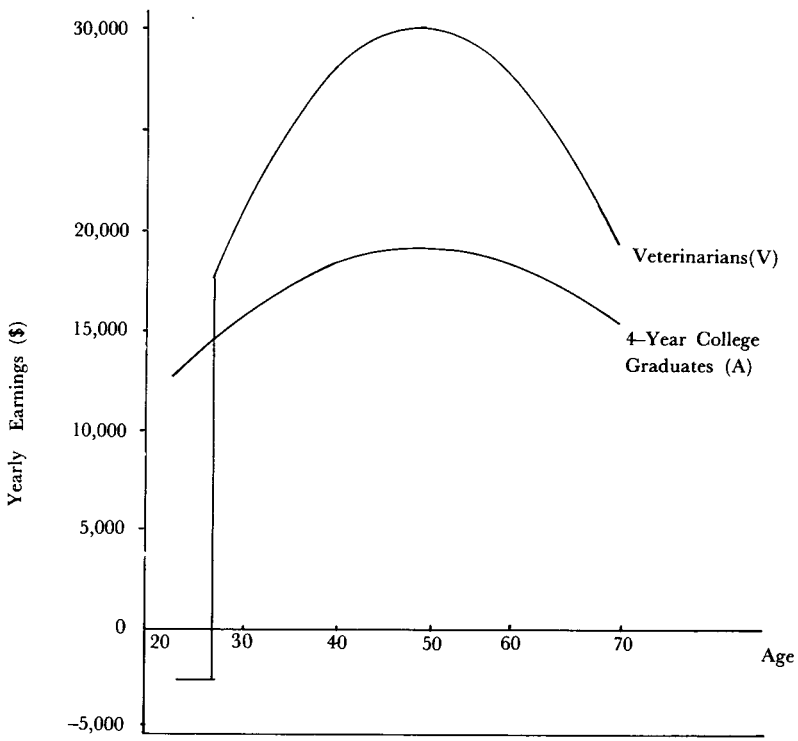
Notes : a) Dependent variable : natural log of yearly earnings.
b) The control group is the people who are living in West (DLOC4).
c) The control group is the people who are working in service or similar jobs.
d) + statistically significant at 0.10 level.
* statistically significant at 0.05 level.
** statistically significant at 0.01 level.

TABLE 7 **Estimated Benefits of Veterinary Medical Education(Pooled Sample)**

Age	Gross benefits	Net Benefits	
		Before income tax	After income tax
27 - 30	$17,236*	$19,268*	$15,166*
31 - 35	35,454	43,249	34,079
36 - 40	46,941	63,048	49,274
41 - 45	54,179	80,254	58,639
46 - 50	58,266	94,842	68,197
51 - 55	55,904	100,250	66,280
56 - 60	50,391	98,860	64,467
61 - 65	40,629	87,895	55,439
Total	359,000	587,666	412,541

* Nondiscounted value.

FIGURE 1 **The Estimated Lifetime Earnings Profiles (not Discounted) for Verterinarians and 4–Year College Graduates**



To calculate expected salaries and subsequent net benefits (salary differences) for veterinary medical education graduates, some income adjustment factors were applied to both lifetime earnings of veterinarians and their counterpart group. The adjustment factors used are as follows:

(a) An unemployment rate of 2% assumed for both veterinarians and their counterparts because the average unemployment rate for experienced professional workers (managers and administrators) was about 2% during 1970 and 1979(U.S. Department of Labor 1980). (b) Real wages were assumed to increase 2% per year for both groups. So in the final lifetime earnings estimation, 2% of compound rate was applied from age 23. (c) Different mortality rates were applied for each age bracket in sex group. The mortality rates used in this anslysis were adapted from mortality statistics published by U.S. National Center for Health Statistics (U.S.National Center for Health Statistics 1983). (d) Finally, to estimate net benefits on an after-income tax basis, different income tax rates were applied to each income bracket for both groups. The income tax rate in the 1980 Income Tax Rate Table published by the Internal Revenue Service were used for this purpose (Internal Revenue Service 1982).

The nondiscounted lifetime benefits are shown on Table 7. The estimated total gross benefits for veterinary medical education is $359,000 from age 27 to 65. Net benefits with before- and after-income tax payments are $587,666 and $412,541 respectively.

Direct Costs in Veterinary Medical Education

In principle, the direct private cost of veterinary medical education includes tuition fees, outlays on books and supplies, and any living expenses beyond what would be incurred when not in four years of veterinary medical education. In addition, direct private costs must be adjusted for students receiving scholarships and grants from colleges and other sources.

Table 8 summarizes the average costs of four years of schooling in veterinary medical education. An annual average increasing rate of 13.6 percent schooling costs were assumed to estimate average direct costs per student for four years of veterinary schooling. This figure was derived from observing tuition/fee increases from 1977 and 1981. The net total direct costs (nondiscounted) of four years of veterinary medical education averaged $10,494 per student. Of this net total direct schooling expenses, 81 percent, or $8,510, were tuition and fees: whereas, books and equipment, and scholarships were 25 percent ($2,562) and 6 percent ($578) respectively.

Estimates of average schooling costs per student in four years of veterinary medical education are included in Table 10. Foregone earnings were derived from the lifetime earnings function of whole sample in Table 4. Among the total of $62,949 of schooling costs (nondiscounted) foregone earnings are the largest part. Over $50,000 was incurred by students, which amounted to 83 percent of the total costs.

TABLE 8 **Estimated Average Private Cost per Student in Veterinary Schooling(Direct Cost) : 1977 - 80**

	Academic year[a]				
Expenses	1977	1978	1979	1980	Total
Tuition/Fees($)	1,767	2,007[b]	2,248[b]	2,488[b]	8,510
Books and equipment allowances($)	532[c]	604[c]	677[c]	749	2,562
Total expenses(A)	2,299	2,611	2,925	3,237	11,072
Scholarships, grants, and gifts(B)	120[d]	136[d]	153[d]	169[d]	578
Total net expenses (A — B)	2,179	2,475	2,772	3,068	10,494

Note : a) Based on beginning semester month.
b) Estimates from 1977 data(annual increasing rates of 13.6% were applied).
c) Estimates from 1980 data.
d) Estimates from 1981 data(annual increasing rates of 13.6% were applied).

TABLE 9 **Estimated Average Foregone Earnings per Student in Veterinary Schooling, 1977 - 80**

Expenses*	Academic Year 1977	1978	1979	1980	Total
Foregone earnings (A)	$12,569	$13,047	$13,507	$13,950	$53,073
Earnings from college work study(CWS) program (B)	122	144	165	187	618
Net foregone earnings (A − B)	12,447	12,903	13,342	13,763	52,455

* Nondiscounted value.

TABLE 10 **Estimates of Average Schooling Costs per Student in Four Years of Veterinary Medical Education**

Expenses*	Academic Year 1977	1978	1979	1980	Total
Direct costs	$2,179	$2,475	$2,772	$3,068	$10,494 (16.7)
Indirect costs	12,447	12,903	13,342	13,763	52,455 (83.3)
Total	14,626	15,378	16,114	16,831	62,949 (100.0)

* Nondiscounted value.

Investment Analysis

The estimates of the rate of return on private investment in veterinary medical training are presented in Table 11. In the estimation, retirement at age 65 was assumed for both groups.

The internal rate of return to veterinary medical human capital investment is 11.0 percent (based on after-tax income) as a whole. The net present value, at a discount rate of 9 percent, was $14,199. The estimates of internal rate of return differ in veterinarian's job status. In case of before-tax income, the internal rate of return of private practice veterinarians is 9.7 percent whereas that of the non-private practice veterinarians is 13.5 percent. Net present values, at 9% discount rate, on the human capital investment of these two groups are $5,232 and $43,275 respectively. The differences in internal rate of return or net present value between two groups may come from the fact that the private practice veterinarian group invest substainally to their private businesses early in their lifetime and that their net lifetime incomes are not always guaranteed like the non-private practice veterinarian group.

The internal rate of return and net present value are substantially reduced when income tax is considered in lifetime earnings of veterinarians. In case of the private practice veterinarian group a negative net present value(−$2,875) is found. But the net present value of the non-private practice veterinarian group is $25,450.

TABLE 11 **Investment Analysis of Veterinary Education : Internal Rate of Return and Net Present Value, U.S.A., 1978**

Unit : %, US dollar

	Private practice vet.		Non-private practice vet.		All vet.
	Before-tax	After-tax	Before-tax	After-tax	After-tax
Internal rate of return(%)	9.7	8.6	13.5	12.2	11.0
Net present value (at 9% discount rate)	5,232	-2,875	43,275	25,450	14,199

Table 12 presents the net present values of medical education studied by other researchers. The net profitability of medical training at 10 percent discount rate varies across the researches. The sources of these differences mainly come from the methodology applied to the work-hours adjustment. When the work-hours adjustment is considered the net present values of the veterinarian group and the medical doctor group are quite comparable.

TABLE 12 **Net Profitability of Medical Training at 10 Percent Discount Rate**

Unit : US dollar

	1955	1959	1966
Sloan(no hours adjustment)	33,542	39,841	-
Fein and Weber(no hours adjustment)	-	-	24,376
Lindsay(with Paasche hours adjustment)	6,740	11,720	4,660
Leffler(with smaller Paasche hours adjustment and adjusted for mortality differences)	-3,939	964	12,409
Leffler(annual earnings equivalent)	-397	103	1,327

Source : Cotton M. Lindsay, *The Journal of Human Resources*, 11, no. 1(Winter 1976) : 127-130.

V. Summary and Conclusions

This study concerns the profitability of the human capital investment in veterinary medical education. Net present value and internal rate of return to veterinary medical human capital investment were estimated using cross-sectional observations on annual income of veterinarians and 4-year college graduates. The estimated results are quite comparable to those of previous estimates.

The important results found in this study are: the veterinarian group work more hours in a year than their counterpart 4-year college graduate group. This means that the observed earnings differential between veterinary educational investors and the control group may come from, in part, differences in working hours; and a relatively normal private rate of return on veterinary medical human capital investment is observed. When the adjustment of work-hours and income tax(i.e., after-tax income) is considered, 11.0 percent of internal rate of return on veterinary medical human capital investment are found. This means the observed large amounts of private educational expenditures in veterinary medical schooling may not be an overinvestment to an individual student.

The results of present study have some limitations. Since nonmonetary returns to veterinarians and the innate of veterinarians were not incorporated in the study, the calculated figures might be over- or under-estimated. The estimates of internal rate of return might be bigger if non-monetary returns to veterinary medical education are considered. The enhanced social status associated with the professional degree is a good example of the non-monetary returns. On the other hand, the estimated figure does not reflect the innate abilities of veterinarians. It is well-known that the average grade points of veterinary medical students is higher than that of general college students. Unfortunately such factors were not considered in the present analysis due to limitations on data and measurement problems.

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