Evaluating the Economic Impacts of Veterinary Research and Education*

by

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Abstract

Results are presented from estimating the value of research, clinical practice, and education for a college of veterinary medicine. Short-run impacts are estimated using input-output analysis. Long-run benefits are estimated using a combination of economic surplus analysis, travel cost analysis and demand estimation, animal-owner willingness-to-pay based on a survey of practicing veterinarians, and earnings differentials.

Evaluating the Economic Impacts of Veterinary Research and Education

Colleges of veterinary medicine increasingly are asked to provide evidence of the economic impacts of their publicly-supported activities. Public funds are scarce and veterinary colleges compete with roads, prisons, other forms of education, and many other public services for those funds. Some of the impacts of the colleges arise from productivity-enhancing research and clinical services, but others stem from the difficult-to-measure value that individuals place on the health of their companion animals and other species, and from the value that society places on veterinary education. Whatever assessment approaches are applied must be capable of handling diverse programs that encompass teaching, research, extension, and clinical services. This paper presents the methods used for and results from estimating the economic impacts of the Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM)[1]. Results are compared to those from two previous studies that attempted such an evaluation (KPMG, Spears). The study was a collaborative effort by veterinary scientists and economists.

Colleges of veterinary medicine can have both short-run impacts on income and employment as well as longer-run economic benefits. Short-run impacts emanate from direct employment opportunities provided by the College, from its direct purchases of goods and

[1] The Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM) has three campuses: the main campus at Virginia Tech in Blacksburg, Virginia, a second campus at the University of Maryland - College Park, and the Marion duPont Scott Medical Center in Leesburg, Virginia. The third facility focuses exclusively on equine medicine and surgery.

services, and from induced or indirect economic activity that results from industries supplying goods and services to the College. Longer-run benefits result from (1) agricultural productivity effects of veterinary research and extension programs (2) reduced mortality and morbidity of companion and other non-agricultural animals, and (3) the economic value of veterinary education to individuals and to society, above its private and public costs.

The longer-run benefits are the important benefits from society's standpoint and unfortunately the more difficult to measure, because some of them are not fully valued directly in the market; in particular, the value placed on healthier companion animals and the societal value of veterinary education. To the extent that fees paid by veterinary customers to the hospitals or the fees paid by students do not reflect the complete cost of the treatments or education, a non-market benefit exists that needs to be estimated in valuing the outputs of the veterinary college.

In this study, short-run and long-run impacts of the veterinary college were assessed using a combination of approaches, specifically: input-output analysis to measure short-run direct and indirect impacts of College expenditures, economic surplus analysis to measure the longer-run benefits of veterinary research on livestock, an indirect contingent valuation survey to value research on companion animals, a travel cost method to value clinical services, and a human capital approach to value veterinary education. A brief description of these methods and how they were used is provided below.

Methods

Measuring short-run impacts

Short-run impacts of the College on output, employment, and income as a result of college expenditures, were assessed using input-output (I/O) analysis (Ciaschini). Multipliers were derived for outputs, employment, value-added, and income, and were used to measure (1) the direct effects of expenditures by the veterinary college, (2) the indirect effects of those expenditures, representing changes in the purchases of inputs by industries (other sectors) to meet the change in demand for their output, and (3) induced effects resulting from changes in household spending due to changes in economic activity caused by the College.

The IMPLAN I/O model was chosen for the analysis (USDA). The model includes 458 sectors for Virginia. A vector of changes in final demand, calculated from expenditures of the College, was used with the multipliers to solve for the changes in total output. Total operating expenditures for the College in Blacksburg and Leesburg were $13.6 million and $1.5 million, respectively in 1991-92. In addition, the students spent another $0.68 million on goods and services that were obtained from sources other than the College. The expenditures were broken down into salaries and wages paid to faculty and staff, assistantships and wages paid to students, and the purchase of goods and services such as surgical supplies and equipment, communications, and equipment rental and leasing. A 1992 survey on spending patterns of faculty, staff, and students was used to break down their expenditures into categories such as housing, food, transportation, medical, retail merchandise, and so forth (Johnson and Kambhampathy). All expenditures were deflated to 1990, the base year for the IMPLAN data.

Valuing veterinary research and extension

The long-run value of the benefits of veterinary research and extension were estimated using two separate applications of economic surplus analysis: the first for estimating the benefits of research affecting agriculturally valuable animals and the second for estimating benefits of research on companion animals. To estimate the extent of the supply shift, interview questionnaires were developed to obtain information from scientists and extension specialists about specific research projects. A stratified random sample of research projects was selected, with a total of 82 out of 466 projects being selected. Eighteen scientists were interviewed and asked about realized or expected change in off-take (eggs, milk, etc) or reduction in losses if the research is or was successful; level of confidence in achieving the estimated off-take; when results were or will be available to animal owners; and extent and timing of adoption. Additional questions about the nature of basic research were asked. Of the 82 projects surveyed, 11 were selected for in-depth quantitative evaluation.

Some of the research projects were aimed at companion animals, specifically dogs. Because the value of canine companionship is not valued in the market, a modified a modified contingent valuation approach was used in which a sample of practicing veterinarians was asked how much dog owners were willing to pay for a treatment, rather than euthanize their dogs. It was felt that veterinarians would provide the best estimate of the value of dogs because of their frequent dealings with pet owners on this issue.

Thirty veterinarians were surveyed, weighted by the geographical location of their practice and the percentage of the state's population in the region. The veterinarians were asked the range that dog owners are willing to pay and the percentage of owners willing to pay different amounts within the range. The results of the survey were used to value research that

increased the life span of dogs. If the research reduced the cost of the treatment, the net benefit of the new treatment was estimated as the difference between the cost of the old and the new treatments. Total economic surplus was calculated as the product of the net change in treatment cost (or value of increased life-span), probability of research success, adoption rate, and number of dogs suffering from the problem.

The net benefits of each project were calculated by subtracting the cost of the research project, with costs and benefits discounted at five percent. A range of net benefits was calculated. The most conservative assumption was that only the 11 projects evaluated had any benefits and the costs for all 466 projects were charged against them. A less conservative result was obtained by assuming that the other projects were half as productive as those evaluated, and therefore half the level of benefits found for the 11 projects were assumed for the remaining projects. The most liberal assumption was that the other projects were as productive as the 11 projects evaluated.

Valuing clinical services

The approach used to value clinical services of the veterinary hospitals was a travel-cost method (Clawson and Knetsch). Time to visit the hospital was valued at the household's wage rate; costs of travel to the hospital was valued at $.25 per mile; and fees charged by the hospital were obtained. The visit rate to the veterinary hospitals depends on fees, travel costs, the value of time, and on the income and other socio-economic characteristics of the household. Using these variables, a demand function for hospital visits was estimated from which economic benefits were derived. The equation estimated was Q = f (f, tc, Y, H, D, ed), where: Q = the visit rate to the hospital by households in the county, f = hospital fees, tc = travel cost, Y = household

income, H = total households in the county, D = percent of households with income above $50,000 in the county, and ed = percent of households with at least a high school education.

Economic (consumer) surplus was calculated using the demand estimates to obtain the benefits of the clinical services. Data for seventy counties on hospital visits, clients' residences, and fees were obtained from VMRCVM records. Travel time and mileage were calculated from the client's residence. Data for Y, H, D, and ed were obtained from 1992 census records.

Valuing veterinary education

The benefits of the educational component of the VMRCVM contain both public and private components. Public benefits are reflected in part in increased livestock productivity, but measuring this productivity change is difficult. Therefore the benefits calculated in this study only reflect *private* benefits. As such, they underestimate total benefits. One measure of the return on this human capital investment is the income differential between the student's earnings with and without a veterinary education. Total economic benefits of the school's graduates in year i are: Benefits = $N_i \Sigma_t Y_t/(1 + R)^t$, where N_i is the number of graduates in year i, Y_t is the average income differential for a veterinary graduate in year t, and R is the discount rate. Data on average starting salary for veterinary students were obtained from the College and an average graduating age of 29 was used or a 36-year career. Costs of the education, including foregone earnings while in school, were subtracted. The earnings without the education were based on average starting salaries of animal science and biology majors who did not go to veterinary school.

Results

Direct effects, indirect effects on industry, and induced effects on households are presented in table 1. The Blacksburg component of the College created 707 jobs (direct/indirect/induced), $43.3 million in output, $27.8 million in value-added (GDP), and $25.9 million in income with its $4.26 million in operating costs, $8.66 million in faculty salaries, and $0.69 million in student wages in 1991-92. The Equine Center in Leesburg created 94 jobs, $4.6 million in output, $2.6 million in value-added, and $2.5 million in income with its $0.70 million in operating costs and $0.80 million in faculty and staff salaries. Therefore the total short-run impact was more than 800 jobs and $30 million in state GDP. This contribution compares favorably with many large industrial employers.

Table 1. Direct, Indirect, and Induced Effects of the Blacksburg and Leesburg Components of the Virginia-Maryland Regional College of Veterinary Medicine

	Employment	Output	Income	Value-added
Blacksburg		(million $)	(million $)	(million $)
Direct	188	13.88	10.04	10.04
Indirect	296	17.15	9.07	10.12
Induced	223	12.29	6.79	7.65
Total	707	43.32	25.90	27.81
Leesburg				
Direct	34	1.50	0.81	0.81
Indirect	37	1.84	0.95	1.05
Induced	23	1.29	0.71	0.80
Total	94	4.63	2.47	2.66
Grand Total	801	47.95	28.37	30.47

Value of veterinary research and extension

The net economic benefits of the 11 research projects quantitatively assessed in this study are presented in table 2. Benefits that could be easily measured totaled approximately $12 million. Total costs of all 82 sampled projects equaled $3.9 million, resulting in a benefit cost ratio of 3:1. If the remaining 384 projects, which cost $11.6 million, were just as productive as the 82 that were sampled, their benefits would total $36 million, resulting in a total of $48 million for all 466 projects. Even if a more conservative assumption is made that the non-sampled projects were only half as productive as the sampled projects, those projects would generate $18 million, resulting in aggregate benefits of $30 million.

Table 2. Estimated Economic Benefits of Selected Veterinary College Research Projects

Project (with summarized title)	$ million
Role of selenium in cell mediated and humoral immunity in beef cattle	1.34
Ultrasound techniques for detecting pregnancy in ewes	0.20
Pathology and pathogenesis of hemorrhagic enteritis in turkeys	1.30
Genetically improved vaccine against colibacillus	0.44
Parasite control in stocker cattle	0.17
Parasite control for cow-calf operations	2.78
Increase reproductive efficiency in beef cattle	1.19
Assess risk factors associated with Gastric Dilatation Volvulus in dogs	0.1
Develop external fixator for broken bones in dogs	1.1
New method for testing for Giardia in dogs	1.82
Test kits for predicting foaling in horses	1.48
Total	11.92

Value of clinical services

The results of estimating the demand equations in double log form for hospital visits to Blacksburg and Leesburg are presented in Table 3. The two most significant variables were travel cost and number of households.

Table 3. Estimated demand equations for hospital visits to Blacksburg and Leesburg

Variable	Blacksburg	Leesburg
	Coefficient and (t-ratio)	Coefficient and (t-ratio)
Constant	13.06 (1.185)	4.754 (0.365)
f	0.096 (0.740)	-1.169 (-7.606)*
tc	-0.619 (-2.822)*	-
Y	-1.324 (-1.074)	-0.820 (-0.455)
H	-0.924 (-6.980)*	-0.909 (-7.802)*
D	0.696 (1.369)	0.147 (0.160)
edu	0.432 (0.542)	1.909 (0.762)
R^2	.64	.86
F value	18.478	33.411
No. of obs.	69	33

* Significant at the 5 percent or greater level

The results of these equations were used to calculate gross and net economic benefits per hospital visit and the total benefits per hospital per year (table 4). Assuming the benefits were received in proportion to fees charged in the hospitals, benefits were also calculated for a Production Management Medicine unit that provides field service and herd and flock health programs throughout the state. Total net benefits to society from the clinical portion of the Veterinary College were $5.65 million per year.

Table 4. Gross and net benefits of the clinical part of the of the VMRCVM in Virginia

	Blacksburg	Leesburg	Production Mgt. Medicine Unit
Gross benefits per visit, $	1757	1125	
Net benefits per visit, $	1383	215	
Annual total gross benefits, $	5,695,422	1,674,917	1,138,723
Annual total net benefits, $	4,466,462	320,584	862,334

Value of veterinary education

The AVMA annual survey of graduates in veterinary medicine listed the average starting salary for 1994 graduates at $30,694 (JAVMA, 1995), while Virginia Tech listed the annual mean salary of new biology and animal science graduates at $19,855 in 1995. The calculated gross economic benefits for one graduate in 1995 were $188,319. There were 78 graduates in 1995, resulting in a total gross benefit of $14,688,882.

Other adjustments were made to obtain net benefits per student for the 1995 class of graduates. Tuition and fees of $6954 per year for four years were subtracted, as were foregone earnings of $19,855 per year that would have been earned by veterinary students if they had not been in school for four years. Added to the benefits were $3856 per year in federal and state taxes that the students did not have to pay and income earned while in veterinary school of $2295 per year. The total adjustment per student was $82,596 for a net benefit per student of $188,319 minus $82,596, which equals $105,723. The total net economic benefits for the 78 students are estimated at $8,246,394 for the 1995 class.

Discussion

The results indicate that the VMRCVM has had substantial short-run and long-run economic impacts on the Commonwealth of Virginia. Total long-run benefits are estimated of almost $18 million per year, not including non-quantifiable benefits from basic research or public benefits from the teaching component. Annual state appropriated funds for the instruction and academic support, hospitals, and research projects totaled of $8.1 million. Therefore the long-term annual benefits of the VMRCVM had a benefit/state funding ratio of more than 2.2 to 1, not including indirect benefits or short-term impacts. In addition, this benefit/funding ratio is conservative

because the research benefits component of the numerator was already net of costs. Adding short-term income impacts to the long-term benefits, a benefits-to-state-funding ratio of 5.6 to 1 is obtained.

The results of this study may be compared to two other studies that have attempted to estimate the economic value of colleges of veterinary medicine. The first of these studies undertaken by KPMG Peat Marwick in 1992 for the University of Pennsylvania. That study found short-term impacts of $94 million in income and 1913 jobs, or roughly three times the income and 2.5 times the jobs estimated for the VMRCVM. However, the Pennsylvania budget was roughly three times as large the VMRCVM budget. KPMG also estimated the value of the research and clinical components of the College. A $714 million impact was reported that represented the annual loss in productivity due to diseases in food producing animals, and a $158 million impact that represented the value of food animals and horses treated and returned to production and performance. It does not seem reasonable to count either impact as a direct benefit to the Pennsylvania veterinary research and clinical activities. Neither takes into account the success of the veterinary research and clinical programs in solving disease problems, and the total value of the animals represents benefits only if all the animals would have died without treatment. Therefore the Pennsylvania and the VMRCVM figures for research and clinical impacts can not be compared.

Both studies calculated teaching benefits in a similar manner. KPMG found a $30,692 benefit per student per year compared to $105,723 per lifetime for VMRCVM graduates. The VMRCVM study used more conservative assumptions about income differentials, and it assumed that income differences in early years were maintained at the same level over a lifetime,

when it is possible that they may grow over time. Also, earnings in future years were discounted to account for opportunity costs.

The second study that can be compared to the current study is one by Spears for the Atlantic Veterinary College of the University of Prince Edward Island. That study focused only on the short-run impacts. It found that the $22.6 million annual expenditures for the College generated $39.1 million in annual income and 575 jobs. The income-to-expenditure ratio of roughly 2:1 estimated by Spears was almost the same as ratio for the VMCVM. Fewer jobs were produced as a result of expenditures by the Atlantic Veterinary College, perhaps due to the smaller local economy on Prince Edward Island.

Calculation of economic benefits of a college of veterinary medicine is a complex task because of the diverse nature of the research, teaching, and clinical care missions. The task is further complicated by the non-market nature of some of the benefits such as those accruing to companion animals. The results of this study demonstrate that it is possible to quantitatively account for at least a portion of those benefits, recognizing that other benefits remain outside the quantification. Such quantification can be useful for documenting impacts for funding agencies and other interested parties.

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