Economic Impacts of the College of Veterinary Medicine

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Agricultural Competitiveness

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ABSTRACT

Colleges of veterinary medicine are often asked to provide evidence of the economic impacts of their activities. This report presents methods for evaluating a veterinary college and applies them to the Virginia-Maryland Regional College of Veterinary Medicine. Short-run impacts on income and employment are assessed as well as the long-run benefits of the research, extension, teaching, and clinical services of the college.

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INTRODUCTION

Colleges of veterinary medicine are increasingly 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. Other impacts stem from the difficult-to-measure value that individuals place on the health of companion animals and other species and from the value that society places on veterinary medical education. Whatever assessment approaches are applied must be capable of handling diverse programs that encompass teaching, research, extension, and clinical services. This report presents the methods used for and results from estimating the economic impacts of the Virginia-Maryland Regional College of Veterinary Medicine.

The Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM) was founded in 1978 and 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 (Leesburg Equine Center). The third facility focuses exclusively on equine medicine and surgery. Each year 50 Virginians and 30 students from Maryland (and, since 1996, 10 out-of-state students) are admitted to the VMRCVM professional degree program. The College has graduated more than 1,000 veterinarians, and its hospitals treat more than 40,000 animals annually. The total annual budget of those two facilities is more than $15 million, roughly half funded by state appropriations. The study, focusing on the two campuses located in Virginia, was a collaborative effort by veterinary scientists and economists and describes an assessment approach that other colleges may find useful.

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 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 nonagricultural 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 returns from society's standpoint and, unfortunately, the more difficult to measure because some of them are not fully valued in the marketplace: 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, both 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.

HOW THE STUDY WAS DONE

Measuring Short-Run Impacts

Short-run impacts of the College on output, employment, and income as a result of college expenditures, were assessed using the IMPLAN input-output (I/O) model (USDA, 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 (Box 1);
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 that result from changes in household spending due to changes in economic activity caused by the veterinary college.

Box 1. Impact Analysis Definitions

Direct effect: a change in output, employment, income, and value-added by the veterinary college.

Indirect effect: additional economic impact caused by additional rounds of spending by directly impacted firms purchasing from still other firms in the region. These expenditures would include the medicines veterinarians use, the cost of transporting animals to the veterinarian, and so on.

Induced effect: additional economic impact caused by the spending of wages and salaries by households in the directly and indirectly impacted. These expenditures include the wages and salaries earned by students, faculty, and other employees in grocery stores, general merchandise stores, and the like.

The IMPLAN model includes 458 sectors for Virginia. All expenditures were deflated to 1990, the base year for the IMPLAN database. Total operating expenditures for the College in Blacksburg and Leesburg were $13.5 million and $1.5 million, respectively, in 1991-92 (Table 1). In addition, the students spent another $0.7 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).

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 (Box 2): 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 shift in the supply of output, interview questionnaires were developed to obtain information from scientists and extension specialists about 82 specific research projects from a total of 466 projects. Eighteen scientists were interviewed and asked about realized or expected change in production (eggs, milk, etc.) or reduction in animal losses if the research is or was successful; their level of confidence in achieving the expected production; when results were or will be available to animal owners; and the extent and timing of adoption. Additional questions about the nature of basic research were asked. (A copy of the questionnaire is available from the authors). Of the 82 projects surveyed, 11 were selected for in-depth quantitative evaluation.

Table 1. Sources of Income and Expenditures for the Virginia portion of the VMCVM

	Expenditure					
Income	Faculty and Staff	Students	Blacksburg College	Leesburg Facility	Goods & Services	**Total Expenditure**
	million dollars					
Faculty & Staff					9.4	**9.4**
Students					1.4	**1.4**
Blacksburg College	8.6	0.7			4.2	**13.5**
Leesburg Facility	0.8				0.7	**1.5**
Other		0.7	13.5	1.5		**15.7**
Total Income	**9.4**	**1.4**	**13.5**	**1.5**	**15.7**	**41.5**

Box 2. Economic surplus

Economic surplus or consumer surplus is the willingness of consumers to pay more for an item than the market price. It is viewed as a benefit to society.

Some of the research projects were aimed at companion animals, specifically dogs. Because the value of canine companionship is not priced in the market and lifetime expenditures on the animal would be an underestimate, an indirect contingent valuation (Box 3) 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. Veterinarians were asked to provide the best estimate of the value of dogs because of their frequent dealings with pet owners on this issue.

Box 3. Indirect Contingent Valuation

Contingent Valuation is a method to measure benefits for which no market value exists. The method used in this research is indirect because the veterinarians, not dog owners, were asked to value the life of dogs based on the amount that they have observed dog owners are willing to pay to treat the animals rather than euthanizing them.

Thirty veterinarians were surveyed, based on 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 available 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 the cost of treatment (or value of increased life-span), probability of research success, adoption rate, and the number of dogs suffering from the particular problem.

The net benefits of each project were calculated by subtracting the cost of the research project, and discounting the costs and benefits at 5 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 being conducted were charged against them. A less conservative result was obtained by assuming that the other projects were half as productive as those evaluated; 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 two veterinary hospitals was a travel-cost method (Clawson and Knetch). Time to visit the hospital was valued at the household's wage rate; costs to travel to the hospital were valued at $0.25 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 socioeconomic characteristics of the household. Using these variables, a demand function (see Appendix for details) for hospital visits was estimated from which economic benefits could be derived. The equation used to estimate the demand function is

$$Q = f (f, tc, Y, H, D, ed)$$

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
ed = percent of households with at least a high school education.

Data on hospital visits, clients' residences, and fees were obtained from records of the VMRCVM. Travel time and mileage were calculated from the client's residence. Data for Y, H, D, and ed were obtained from 1992 census records. Seventy counties were in the data set. Montgomery County, where Blacksburg is located, was excluded because many of the cases from that county are not referral cases to VMRCVM as are cases from the other counties.

Valuing Veterinary Education

The educational component (human capital) of the VMRCVM contains benefits with 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 the *private* benefits. As such, they are an underestimate of 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, which was calculated as

$$Benefits = \frac{N_i \sum Y_t}{(1+R)^t}$$

where N_i = the number of graduates in year i
Y = the average income differential for a veterinary graduate in year t of his/her career
R^t = the discount rate.

Data on the average starting salary for veterinary students were obtained from VMRCVM, and an average graduating age of 29 or a 36-year career was used. Costs of the education, including earnings foregone while in veterinary 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

Short-Run Impacts

Direct effects, indirect effects on industry, and induced effects on households represent the multiplier effects of the College as it ripples its way through the local economy (Table 2). The Blacksburg component of the College created 707 jobs (direct/indirect/induced), $43.3 million in output, $27.8 million in value-added (Virginia Gross Domestic Product: GDP), and $25.9 million in income with its $4.3 million in operating costs, $8.7 million in faculty salaries, and $0.7 million in student wages in 1991-92. The Leesburg Equine Center created 94 jobs, $4.6 million in output, $2.6 million in value-added, and $2.5 million in income with its $0.7 million in operating costs and $0.8 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 2. Direct, Indirect, and Induced Effects of the Blacksburg and Leesburg Components of the VMRCVM

	Employment	Output	Income	Value-added
Blacksburg		----------$ 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

Veterinary research and extension increases the productivity and competitiveness of livestock agriculture and lengthens and improves the lives of companion animals. Several of the 466 research projects undertaken by the College since the early 1980s produced basic research results with potentially large impacts on human as well as animal health as the results are used in more applied

research. Other projects are yielding more immediate payoffs. The net economic benefits of the 11 projects quantitatively assessed in this study are presented in Table 3.

Table 3. 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 E coli	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	0.10
Develop external fixator for broken bones in dogs	1.10
New method for testing for Giardia in dogs	1.82
Test kits for predicting foaling in horses	1.48
Total	**11.92**

The benefits of individual research projects depend on estimated gains minus the cost of the research, which is adjusted for the likelihood of adoption of the results for those projects with results not yet adopted. In projects such as those that prevent sickness and loss due to parasites, cost savings were used to calculate project benefits. In other cases, the value of production increases per animal was used. For companion animals, the willingness to pay for a procedure to save the animal was used.

Benefits that could be easily measured for 11 of the 82 sampled projects totaled approximately $12 million. Total costs of the 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.

Value of Clinical Services

The two variables most significant in the demand equation were the travel cost and population (number of households). The results from the demand equation were used to calculate the gross and net economic benefits (economic surplus) per hospital visit and the total benefits per hospital per year (Table 4). Assuming the benefits were received in the same proportion to fees charged in the hospitals, gross and net 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 College were $5.7 million per year.

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

	Blacksburg	Leesburg	Production Management Medicine Unit
	----------$----------		
Gross benefits per visit	1,757	1,125	Not applicable
Net benefits per visit	1,383	215	Not applicable
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 American Veterinary Medicinal Association (AVMA) annual survey of graduates in veterinary medicine listed the average starting salary for 1994 graduates at $30,694, while Virginia Tech listed the annual mean salary of new biology and animal science graduates at $19,855 in 1995. Using the annual salary difference of $10,839, a 36-year working life, and a 5 percent discount rate, the calculated gross economic benefits for one graduate in 1995 were $188,319. In 1995, 78 students graduated, resulting in a total gross benefit of $14.7 million.

Other adjustments were made to the gross benefits to obtain net benefits per student for the 1995 class of graduates. Tuition and fees of $6,954 per year (for four years) were subtracted, as were the foregone earnings of $19,855 per year that would have been earned by the veterinary students if they had not been in Veterinary School for four years. Added to the benefits were $3,856 per year in federal and state taxes that the students did not have to pay and average income earned by them while in veterinary school of $2,295 per year. The total adjustment per student was $82,596. The net benefit per student equals $105,723 ($188,319 - $82,596). The total net economic benefits for the 78 students are estimated at $8.2 million for the class of 1995.

CONCLUSIONS

The preceding analysis illustrates that it is possible to estimate quantitatively at least some of the benefits of a college of veterinary medicine. The results for VMRCVM indicate that the college has had substantial short-run and long-run economic impacts on the Commonwealth of Virginia. The short-run impacts of its expenditures total 805 jobs and more than $30 million in state value added (Virginia GDP). If the $48 million in quantifiable research and extension benefits are converted to an annual basis, they would result in approximately $4 million in benefits per year to research and education (the projects were undertaken over 12 years). Annual benefits from the clinical portion of the College are estimated at $5.65 million per year. Private benefits from the teaching portion of the College are estimated at $8.25 million per year. Therefore, total benefits are estimated at almost $18 million per year, not including any non-quantifiable benefits from basic research or public benefits from the teaching component.

Annual state appropriated funds for the instruction and academic support component were $6.4 million per year; for the teaching hospitals, $0.4 million per year; and for the research projects, $1.3 million per year: a total annual state cost of $8.1 million. Therefore, the long-term annual benefits of the VMRCVM have a benefit/state funding ratio of more than 2.2 to 1, not including indirect benefits or the short-term impacts described above. In addition, this benefit/funding ratio is conservatively calculated because the research benefits component of the numerator was already

net of costs. Adding the 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 was undertaken in 1992 by KPMG Peat Marwick (KPGM) for the University of Pennsylvania. That study found short-term impacts of $94 million in income and 1,913 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. To count either impact as a direct benefit to the Pennsylvania veterinary research and clinical activities does not seem reasonable. 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. Hence, the "impacts" are only "potential" benefits. Therefore, the Pennsylvania and the VMRCVM figures for research and clinical impacts cannot 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 they may possibly grow over time. Also, earnings in future years were discounted to account for opportunity costs (Box 4).

Box. 4. Opportunity Cost

Opportunity cost is the forgone income from choosing one economic activity over another. The opportunity cost of attending veterinary college is the income that would have been earned in alternative employment if the person had not chosen veterinary school.

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 VMRCVM. 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 teaching, research, and clinical care missions. The task is further complicated by the non-market nature of some of the benefits such those accruing to companion animals. The results of this study demonstrate that quantitatively accounting for at least a portion of those benefits is possible, 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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APPENDIX

Four different functional forms (linear, quadratic, semi-log, and double-log) were tested with the demand equation, and economic (consumer) surplus was calculated using these demand estimates to obtain the economic benefits of the clinical services. A summary of the mean values for each variable for both the Blacksburg and Leesburg hospitals is presented in Table A1.

Table A1. Mean values for variables used in demand equations for hospital visits

Variable	Units	Blacksburg	Leesburg
Q	visits/household	6.13	13.88
f	hospital fees, $	213.53	-
tc	travel costs, $	160.66	39.78
Y	Household income, $	34,231	36,203
H	No. of households/Co.	29,103	93,971
D	Percent over $50,000	19.62	31.01
ed	Percent H.S. graduates	71.84	75.10

The results of estimating the demand equations in double-log form for hospital visits to Blacksburg and Leesburg are presented in Table A2. This functional form gave calculated benefits similar to and within the range of the estimated benefits for the three other functional forms tested.

Table A2. Estimated demand equations for hospital visits to Blacksburg and Leesburg

Variable	Blacksburg	Leesburg
	----------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)*	Not applicable
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