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Evaluating the Short- and Long-run Economic Impacts of the Virginia-Maryland Regional College of Veterinary Medicine

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ABSTRACT

Colleges of veterinary medicine are often asked to provide evidence of the economic impacts of their activities. This paper presents methods for evaluating a veterinary college and applies them to the Virginia-Maryland Regional College of Veterinary Medicine. It assesses short-run impacts on income and employment 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.

Key Words: *economic impact assessment, economic surplus, input-output, returns to veterinary education, travel cost method.*

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, but others 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 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 the results of estimating the economic impacts of the Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM).[1] The study was a collaborative

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[1] 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. The third facility focuses exclusively on equine medicine and surgery. Each year 50 Virginians and 30 stu-

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 long-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. Long-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 long-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 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 long-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 description of each of these methods and how they were applied 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 an input-output (I/O) model (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 that result from changes in household spending due to changes in economic activity caused by the veterinary college.

The IMPLAN I/O model was chosen for the analysis (Micro IMPLAN Group). The model includes 458 sectors for Virginia. A vector of changes in final demand, calculated from expenditures of the Virgina-Maryland Regional 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-base.

dents from Maryland (and, since 1996, 10 out-of-state students) are admitted to the VMRCVM professional degree program. The College has graduated more than 1000 veterinarians, and its hospitals treat more than 40,000 animals annually. This study focuses on the impacts of the two campuses located in Virginia. The total annual budget of those two facilities is more than $15 million, roughly half of which is funded by state appropriations.

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 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.[2] Of the 82 projects surveyed, 11 were selected for in-depth quantitative evaluation based on ease of quantification.

Seven of 11 projects involved livestock research, and changes in economic surplus were calculated in a spreadsheet using the standard graph and formula for a research-induced change in economic surplus in a small open economy (Alston, Norton, and Pardey, p. 227). 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, 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 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. Additional details on calculations of benefits for all the projects are available from the authors.

The net benefits of each project were calculated by subtracting the cost of the research project from the benefits (change in economic surplus), 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 Knetch). Time to visit the hospital was valued at the household's wage rate, costs to travel to the hospital were valued at $.25 per mile, and fees charged by the hospital were obtained. The demand for veterinary services should also depend on socioeconomic characteristics of the households. Therefore it is hypothesized that the visit rate

[2] A copy of the questionnaire is available from the authors.

Table 1. Mean Values for Variables Used in Demand Equations for Hospital Visits

Variable[1]	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	households/County	29,103	93,971
D	percent over $50,000	19.62	31.01
ed	percent H.S. graduates[2]	71.84	75.10

[1] Variable definitions: 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.

[2] Percent high school graduates.

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 could be derived. The equation estimated was:

$$(1) \quad Q = f(f, tc, Y, H, D, ed),$$

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. It is expected that hospital visits per household should be negatively related to f, tc, and H, and positively related to Y, D, and ed. The expected sign of the relationship to H is less obvious than the signs on the other variables. While more households per county should imply more pets, less densely populated rural households may have more pets per household as well as more farm animals and horses. Therefore the visit rate per household is expected to be greater for counties with fewer households.

Four 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. 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 and Montgomery County, where Blacksburg is located, was excluded because many of the cases from that county are not referral cases as they are from the other counties. A summary of the mean values for each variable for both the Blacksburg and Leesburg hospitals is presented in Table 1.

Valuing Veterinary Education

The benefits of the educational component of the VMRCVM contain both public and private components. Public benefits are manifested in part through increased productivity in the livestock sector, but measuring this productivity change is difficult. Therefore the benefits calculated in this study only reflect the *private* benefits as measured by the income differential between the student's earnings with and without a veterinary education. This return on human capital investment is an underestimate of total benefits of VMRCVM. Total economic benefits of the school's graduates in year i are:

$$(2) \quad \text{Benefits} = N_i \sum_t Y_t/(1 + R)^t$$

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

Table 2. Direct, Indirect, and Induced Effects of the Blacksburg and Leesburg Components of the Virginia-Maryland Regional College of Veterinary Medicine

	Employment	Output (million $)[1]	Income (million $)[1]	Value-Added (million $)[1]
Blacksburg				
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

[1] In 1990 dollars.

College and an average graduating age of 29 was used or a 36-year career. 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 are presented in Table 2. These effects represent the multiplier effects of the College as it ripples through the local economy. 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-term impact was more than 800 jobs and $30 million in state GDP. This contribution compares favorably with many large industrial employers.

Table 3. Estimated Economic Benefits of Selected Veterinary College Research Projects

Project (with summarized title)	$ Million (1990$)
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 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 resulted in 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.

The benefits of individual research projects depend on estimated gains minus the cost of

Table 4. Estimated Demand Equations for Hospital Visits to Blacksburg and Leesburg

Variable[1]	Blacksburg Coefficient and (Standard Error)	Leesburg Coefficient and (Standard Error)
Constant	13.06 (11.021)	4.754 (13.025)
f	0.096 (0.130)	—
tc	−0.619 (0.219)*	−1.169 (0.154)*
Y	−1.324 (1.233)	−0.820 (1.802)
H	−0.924 (0.132)*	−0.909 (0.117)*
D	0.696 (0.508)	0.147 (0.919)
edu	0.432 (0.797)	1.909 (2.505)
R^2	.64	.86
F value	18.478	33.411
No. of obs.[2]	69	33

* Significant at the 5 percent or greater level.

[1] Variable definitions: 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.

[2] No. of obs. = number of observations.

the research 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 (shifts in the supply curve). 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 results of estimating the demand equations in double-log form for hospital visits to Blacksburg and Leesburg are presented in Table 4. This functional form gave calculated benefits similar to and within the range of the estimated benefits for the three other functional forms tested. It also had the highest F-value, consistent with earlier studies on recreation demand that also found the double-log form to be the most appropriate functional form (Strong, 1983; Hanley, 1993).

The two variables most significant in the equations were the travel cost and population (number of households) variables. One would expect that the cost of traveling to the hospitals would be important. It appears that counties with greater populations make fewer visits per household, perhaps for reasons mentioned above. Surprisingly, the income-per-household variables were not significant and even had negative signs. Education had the expected sign, but was not significant at the 5-percent level, implying the veterinary hospital visit rate is little influenced by education.

The results of these equations were used to calculate the gross and net economic benefits (economic surplus) per hospital visit and the total benefits per hospital per year (Table 5). 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

Table 5. Gross and Net Benefits of the Clinical Part of the VMRCVM[1] in Virginia (1995$)

	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

[1] Virginia-Maryland Regional College of Veterinary 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 in 1990 dollars.

Value Veterinary Education

The 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, 36-year working life, and a 5-percent discount rate, 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 the gross benefits 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 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 $3856 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 $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 class of 1995.

Discussion

The analysis above illustrates that it is possible to estimate quantitatively at least some of the benefits of a college of veterinary medicine. The results for The Virginia-Maryland Regional College of Veterinary Medicine 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. 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 of R&E (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. Converting all benefits to 1995 dollars, total benefits are estimated at approximately $18.5 million, 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, for 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 2.3 to 1 ($18.5 million divided by $8.1 million), 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 direct, indirect, and induced income impacts to the long-term productivity-related and consumer benefits (after converting them to 1995 dollars), a benefits-to-state-funding ratio of 6.3 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 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. 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 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 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 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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