



2014 Economic Impact of Purdue's College of Veterinary Medicine on the State of Indiana

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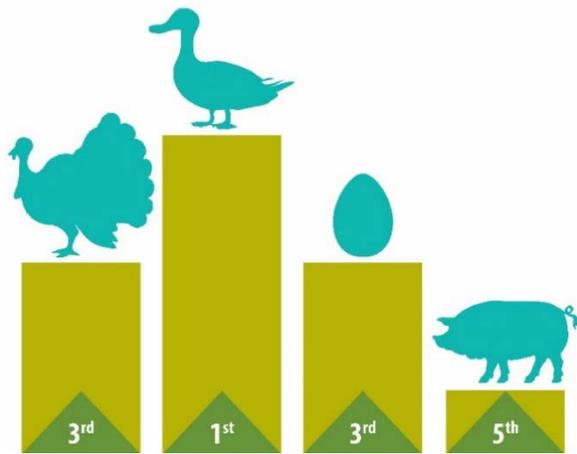
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Executive Summary

Figure 1: Indiana State Commodities Rankings



Veterinary medicine touches many lives – both human and animal. Society depends on veterinary healthcare professionals to keep animals healthy, pursue better treatments for diseases of animals and humans, and protect public health and food safety. As Indiana’s only veterinary school, the Purdue University College of Veterinary Medicine (PVM) not only serves as a vital veterinary healthcare resource for the state, but also produces an economic impact on the state valued at hundreds of millions of dollars. Using figures for 2014, the most recent available, this report documents the aggregate effect of the college on the Indiana economy.

Statistics on animal ownership in Indiana help set the stage for understanding the magnitude of Purdue Veterinary Medicine’s economic impact. More than half of all Indiana households own a pet and 40 percent of pet

owners visited a veterinarian at least once in the past year.¹ Beyond companion animals, the state has approximately 22,400 farms producing livestock, poultry and related products valued at \$3.68 billion.² Indiana ranks first in duck production, third in egg production, third in turkey production, and fifth in swine production. Indiana depends on the veterinary medical profession to care for the health needs of these animals, ensure a safe and secure food supply, and protect public health. More than 60 percent of Indiana’s veterinarians and 30 percent of the state’s registered veterinary technicians are Purdue alumni. Additionally, the Indiana State Veterinarian and 16 of 17 staff veterinarians at the Indiana State Board of Animal Health are graduates of the Purdue University College of Veterinary Medicine. Veterinary professionals also are essential to research that benefits both animals and humans. Since people and animals share common health conditions such as diabetes, asthma, and cancer, advances in veterinary medicine, such as new cancer treatments for animals developed at Purdue, are often used to advance human health.

The Purdue University College of Veterinary Medicine located on the university’s West Lafayette campus, is one of only 30 U.S. veterinary colleges supplying the workforce with accomplished veterinarians and veterinary technicians. Purdue Veterinary Medicine also is one of only four U.S. programs that trains the entire veterinary team. By educating both veterinarians and veterinary technicians (who are the nurses in the veterinary medical profession), the college graduates veterinary professionals who know first-hand how effective teamwork leads to excellence.

¹ Data came from ESRI’s Pets and Products Market Potential data for Indiana.

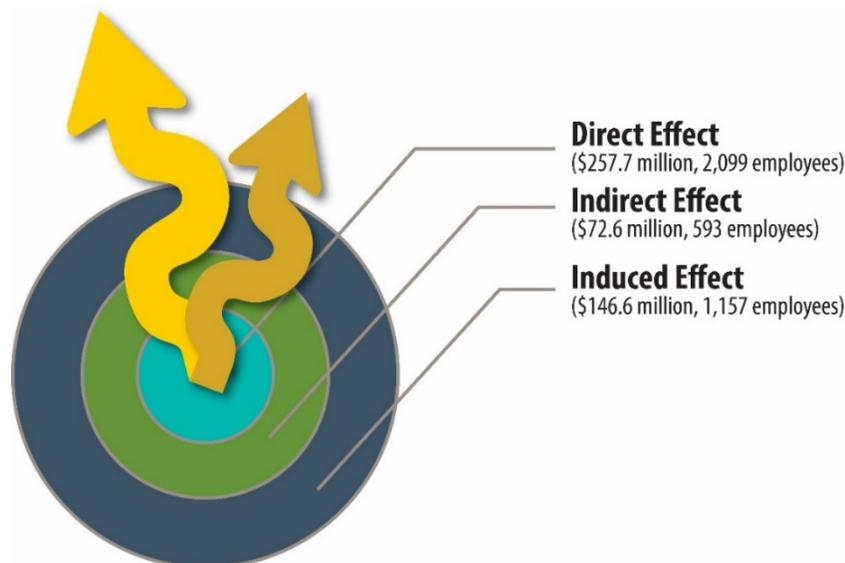
² Data came from the 2012 Census of Agriculture, United States Department of Agriculture.

Key Findings

The College of Veterinary Medicine and its alumni significantly impacted the Indiana economy through direct and indirect economic output and by generating good paying jobs.

- Collectively, the **Purdue College of Veterinary Medicine and its alumni had a total economic output of \$476.9 million**. Nearly half of the output (\$219.2 million) was derived from increased economic activity from the initial direct expenditures. PVM and its alumni contributed a net of \$311.4 million to the state's GDP.
- The **economic output of the college itself was \$220.2 million** in 2014, of which \$83.2 million was the result of the ripple effects from the initial direct effect. Slightly more than half of the college's total output contributed to the state's GDP.
- The college's **alumni who are veterinarians and veterinary technicians in Indiana spurred \$136.1 million in additional economic activity** in the state, thus producing an economic footprint of \$256.7 million, of which 76 percent contributed to the state's GDP. Purdue Veterinary Medicine has graduated 4,445 students with degrees in veterinary medicine or veterinary technology since 1959. Today Purdue alumni represent 63 percent of Indiana's veterinarians and 30 percent of the state's registered veterinary technicians.
- **An additional 1,749 jobs paying approximately \$52,400 per worker were supported** by the combined effects of the college and its alumni. .
- **Every 10 jobs directly related to PVM and its alumni supported an additional eight jobs** at other Indiana businesses in 2014. The employment multiplier, the ratio of total employment to direct employment effects, was 1.83.
- As the primary contributors of the PVM alumni's economic contribution to the state (80 percent), **veterinarians generated \$113.6 million in increased economic activity and supported 868 jobs** via indirect or induced effects.
- An estimated **\$28.6 million in state and local government tax revenues and \$46.7 million in federal government collections were produced** in 2014 as a result of the economic activity generated by PVM and its alumni.

Figure 2: Purdue University College of Veterinary Medicine Economic Contribution to Indiana, 2014



PVM Vision and Mission

The college's impact on Indiana reflects the common *vision* shared by the faculty, staff, students and alumni who make up the Purdue Veterinary Medicine family:

- PVM graduates will excel in their choice of veterinary/biomedical careers.
- PVM will advance global animal and human health and well-being through transformational and interdisciplinary research.
- PVM will be a recognized authority for animal and public health through collaborations in medical care, diagnostics, education and discovery.

The college's *mission* is to advance global animal and human health and well-being through excellence in learning, discovery and engagement. To fulfill this mission, the college promotes excellence by holding to the following core values:

- Promote a collegial work and learning environment enhanced by diversity.
- Emphasize innovation and delivery in PVM learning, discovery, and engagement programs.
- Actively support individual development of PVM faculty, staff, and students such that they can achieve their full potential as biomedical scientists, professionals, and individuals.
- Encourage collaborative, multidisciplinary discovery programs providing a continuum of basic science to applied research benefiting both animal and human health.
- Encourage participation in activities that enhance the veterinary profession and the reputation of the college.

Purdue educated veterinarians have experienced high employment rates (including internships) upon graduation, as evidenced most recently by the Class of 2015, which enjoyed a 100 percent employment rate. Nearly two-thirds of the DVM alumni are practicing in Indiana today. Concurrently, almost one-third of the state's registered veterinary technicians are Purdue graduates.

Figure 3: Components of Purdue University College of Veterinary Medicine, 2014



PVM has several components that work together to enrich the education of students, magnify the college's ability to serve the general public, and amplify the college's contributions to the advancement of the discipline (see **Figure 3**). With an employment level of more than 650 individuals, as of June 2015, the college's operating budget exceeds \$50 million. PVM includes two major operating units: the Veterinary Teaching Hospital (VTH) and the Indiana's Animal Disease Diagnostic Laboratory (ADDL).

The VTH has three missions: teaching students, facilitating clinical studies of animal diseases, and providing veterinary services to the animal-owning public. Most cases are referred to the VTH by veterinarians practicing in Indiana or the surrounding states. The VTH not only functions as a specialized animal hospital, but also enables clinical year veterinary students and veterinary technician students to gain practical, hands-on experiences. Specialty services are provided to both small and large animals including internal medicine, surgery and emergency critical care. In the 2013-2014 fiscal year, the hospital serviced nearly 8,700 clients of which half were new clients, for a total of 42,050 cases (including follow-up appointments). The quantity of clients served increased 50 percent between the 2008-2009 and the 2013-2014 fiscal years, due in part to the acquisition of a local small animal emergency service which currently sees around 3,700 cases a year.

The ADDL serves as Indiana's accredited full-service veterinary diagnostic laboratory with testing capabilities for all types of animal diseases in livestock, poultry, companion animals, and wildlife. ADDL services are offered both at the West Lafayette campus as well as at a satellite facility, called the Heeke Lab, in Dubois County, which is in proximity to much of Indiana's poultry industry as well as numerous cattle operations. The ADDL works in collaboration with PVM, the Purdue College of Agriculture, Indiana Board of Animal Health, state agencies, United States Department of Agriculture, local veterinarians, the livestock industry and animal owners to find, control and eradicate animal diseases. To complete this mission, the ADDL employs veterinary specialists in pathology, bacteriology, virology, toxicology, avian medicine and diagnostics. Additionally, a wide variety of tests for bacterial, fungal, viral, prion, parasite, neoplastic, immunological and chemically-induced diseases are available for clients. In fiscal year 2013 the ADDL received 22,706 cases, which involved performing 106,020 tests for 749 unique clients.

PVM and Alumni Promote Economic Health

Since the first class of veterinary students enrolled in 1959, the college's educational programs have prepared thousands of graduates for important careers in the veterinary medical profession. As of March 2014, PVM had graduated over 4,800 alumni with the majority receiving a Doctor of Veterinary Medicine (DVM) degree. Upon graduation, veterinarians have multiple employment opportunities including working in private practice (e.g. companion animal, food animal, mixed animal, equine), public practice (e.g. university, government, uniformed services), industry and non-profits. According to the American Veterinary Medical Association, in 2014, 81.4 percent of Purdue graduates were in private practices with the largest share treating small animals (see **Table 1**).

Data for all Indiana AVMA members show that the aggregate population of veterinarians in Indiana are engaged in activities that closely align with those of Purdue graduates.

Table 1: PVM Veterinarian Alumni Employment Distribution, 2014

	AVMA Members	
	Purdue Graduates	All Indiana DVMs
Private Practice	81.4%	79.2%
<i>Small Animal</i>	85.4%	85.6%
<i>Large Animal</i>	11.0%	10.9%
<i>Mixed Animal</i>	3.5%	3.5%
Public Practice	10.2%	11.6%
Industry	6.1%	7.2%
Other	2.3%	1.9%

Source: Purdue Extension using data from AVMA

While the information presented in **Table 1** is valuable, it does not paint the full story about PVM or its alumni. In particular, it does not capture the economic contribution of the college or its alumni to the state of Indiana. Many veterinarians operate their own business, thus their establishments have an impact on their local economy. Similarly, the college has an effect on the economy via its income and expenditures, including payroll. Every purchase by the college triggers a chain reaction of economic activity amongst the college’s suppliers and employees. As a result there are economic ripple effects throughout the state from PVM and its alumni.

The economic benefits provided by PVM and its alumni to the Indiana economy are summarized in this report. It must be noted that these numbers are conservative estimates since non-Purdue alumni veterinarians likely also utilize PVM’s services. Additionally, Indiana residents who live close to a state border may utilize a PVM veterinarian who practices in the neighboring state. Capturing these circumstances was beyond the current study’s intended scope. The full analysis can be found in the additional details that follow in this report on the “2014 Economic Impact of Purdue’s College of Veterinary Medicine on the State of Indiana.”

Veterinary Medicine in Indiana

Animals are a vital part of our society. Some animals provide companionship while others serve as sources of food, clothing and other value added goods. Slightly more than half of all Indiana households own a pet and 40 percent of pet owners visited a veterinarian at least once in the past year.³ Beyond companion animals the state has approximately 22,400 farms with livestock, poultry and their products valuing \$3.68 billion.⁴ Thus the need for the services of veterinarians as well as veterinary technicians is sizable.

Purdue University is one of 30 U.S. veterinary colleges in the nation and traces its origin back to 1874 when courses were first offered as part of the three-year agricultural curriculum. The College of Veterinary Medicine admitted its first class in 1959 and has since graduated 4,800 alumni including approximately 3,300 doctors of veterinary medicine (DVM), 340 veterinary technicians with a bachelor’s degree and 1,000 veterinary technicians with an associate degree. This report will focus on the veterinarians (DVMs) and registered veterinary technicians

³ Data came from ESRI’s Pets and Products Market Potential data for Indiana.

⁴ Data came from the 2012 Census of Agriculture, United States Department of Agriculture

The following three sections delve more deeply into the Purdue University College of Veterinary Medicine, including the employment types of its graduates and external factors affecting the veterinary profession.

Purdue University's College of Veterinary Medicine

The College of Veterinary Medicine is well known for its quality education due to its expert faculty, innovative research and hands-on learning opportunities as well as its engagement with the general public. The college not only educates the next generation of veterinarians and veterinary technicians, but also provides veterinary services to the public via its veterinary teaching hospital. Interdisciplinary research is a vital component of the college with numerous collaborations forged across the university. Strengthening the relationship between communities and the veterinary profession assists the college in recruiting future students as well as disseminating research-based education to Indiana citizens. The longstanding Indiana Animal Disease Diagnostic Laboratory (ADDL) recently became housed within PVM, thus continuing its service to the state. Therefore, Purdue University's College of Veterinary Medicine has many components by which their economic contribution to the state can be measured.

In the fall of 2013, the college had a total headcount of 683 individuals, with approximately 30 percent being students in various levels of study. The remainder served in faculty, staff or administrative capacities. Numerous faculty and staff members of the college serve in leadership roles of associations and specie groups at the state and national level. The College of Veterinary Medicine generated 23 patent applications in 2013 and was involved with five different start-up companies.

Veterinary Teaching Hospital

The veterinary teaching hospital has three missions: teaching students, research, and providing veterinary services to the animal-owning public, with most cases being referred by veterinarians practicing in Indiana or its surrounding states. It is viewed not only as a specialized animal hospital, but also as a laboratory for the fourth year veterinary students and veterinary technician students. Specialty services are provided to both small and large animals including internal medicine, surgery and emergency critical care.

In the 2013-2014 fiscal year, the hospital serviced nearly 8,700 clients of which half were new clients, for a total of 42,050 cases (including follow-up appointments). The quantity of clients served has increased 50 percent from the 2008-2009 to 2013-2014 fiscal years, due in part to the acquisition of a local small animal emergency service which currently sees around 3,700 cases a year.

Animal Disease Diagnostic Laboratory (ADDL)

Indiana's ADDL is a fully accredited full-service veterinary diagnostic laboratory with testing capabilities for all types of animal diseases in livestock, poultry, companion animals, and wildlife. Its services are completed both at the West Lafayette campus as well as in Dubois County, with this latter location being near poultry and numerous cattle operations. In collaboration with the PVM, Purdue's College of Agriculture, Indiana Board of Animal Health, state agencies, United States Department of Agriculture, local veterinarians, livestock industry and animal owners – ADDL works to find, control and eradicate animal diseases.

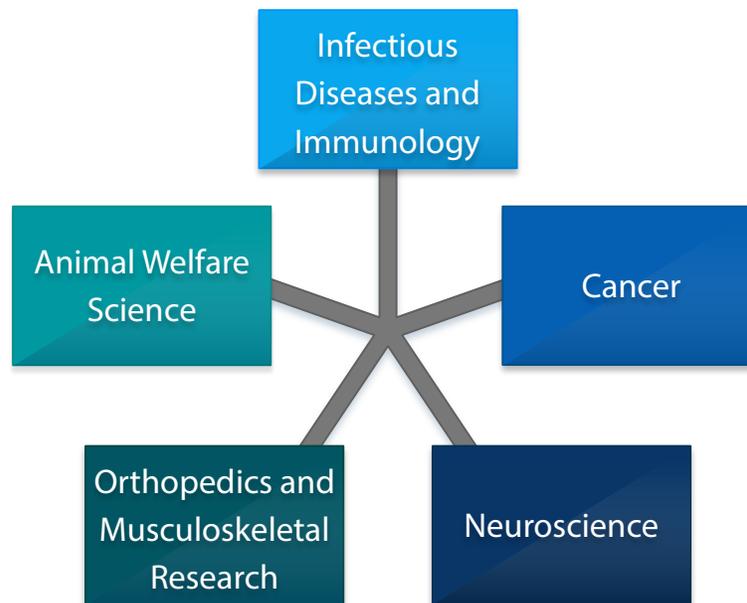
To complete this mission ADDL employs veterinary specialists in pathology, bacteriology, virology, toxicology, avian medicine and diagnostics. Additionally, a wide variety of tests for bacterial, fungal, viral, prion, parasite, neoplastic, immunological and chemically-induced diseases are available for clients. In fiscal year 2013 the ADDL received 22,706 cases involving 106,020 tests performed for 749 unique clients.

Research

Discovery is an integral part of the PVM’s mission and is aimed at enhancing the health and well-being of animals and people. The research is characterized by two overarching characteristics: comparative and translational. Comparative research involves investigating diseases in different animal species with the concept that discoveries made in one species can often be applied to others. Translational research involves adapting the advances in animal health into practical applications for treatment and prevention of diseases in people. This type of research is highly interdisciplinary and collaborative – not only within Purdue University, but also with other universities across the nation and abroad.

During the 2013-2014 period, PVM concentrated its resources in five focus areas (see **Figure 6**). Extramural funding provided for PVM research totaled \$10.3 million in the 2013-2014 fiscal year, an increase of 18 percent since 2008.

Figure 6: PVM Research Focus Areas, 2013-2014



Engagement

Fostering mutually-beneficial relationships that improve our communities and the veterinary profession is the goal of PVM’s Office of Engagement. Engagement entails the college reaching out to its community via educational programs for elementary, middle, high school, and college students; traveling exhibits for museums and science centers; study abroad trips; lifelong learning opportunities for veterinary professionals; and assisting Indiana’s livestock producer’s through the PVM Extension service.

Quantifying the contribution of Purdue University’s College of Veterinary Medicine to Indiana’s economy can quickly become quite complex. Therefore, this study will focus on a core set of factors, including contributions in the areas of alumni employment in the state, the college’s employment and expenditures as well as income generated from the veterinary teaching hospital. A more in-depth analysis of the contributions made by the remainder of PVM’s operations will be forthcoming.

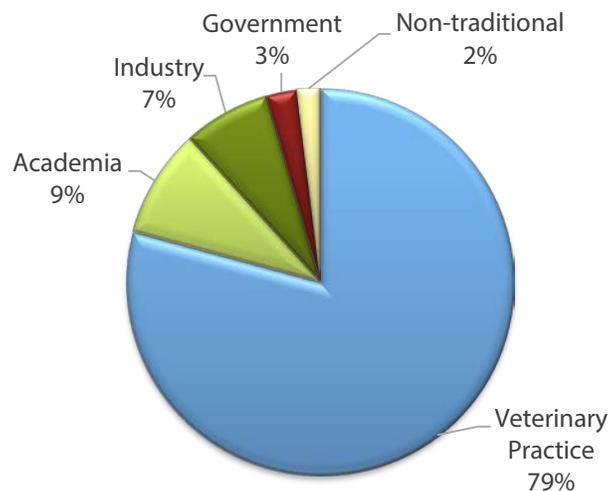
Alumni Employment Types

Obtaining data on PVM graduates by their employment type required utilizing two data sources – Indiana’s Professional Licensing Agency (PLA) and the American Veterinary Medical Association (AVMA) membership rolls. Both veterinarians and registered veterinary technicians are required to be licensed in the practicing state. Therefore, the PLA had information on the current list of practicing veterinarians and registered veterinary technicians, but no identifying information on industry of employment. Conversely, the AVMA has information on their members, including data on their education, employment type, as well as information on Indiana employed veterinarians. Unfortunately, for this study a cross-tabulation of Purdue graduates and Indiana employed veterinarians was not available.

Veterinarians

Membership data from AVMA shows approximately 80 percent of Purdue graduates as well as Indiana veterinarians primarily work in clinical veterinary practices. Of these veterinarians, some 80 percent practice exclusively or predominately on companion animals. Beyond clinical veterinary practices, the second largest employer of veterinarians is in academia settings followed by the private sector. It is known that of the licensed veterinarians in Indiana, nearly two-thirds are PVM alumni. Utilizing the AVMA membership rolls, the PLA records and the PVM alumni records, PVM graduates are distributed in five distinct categories (**see Figure 7**). The average starting salary of PVM veterinarians is \$ \$69,700, with the average wage of all veterinarians statewide being nearly \$81,000 (as of 2014).

Figure 7: Estimated Employment Type of Purdue DVM Alumni, 2014



Notes: Purdue alumni data only pertains to graduates through 2014. Estimates were derived from distribution of AVMA membership data for those whose preferred state was Indiana. Source: American Veterinary Medical Association, Professional Licensing Agency and Purdue Veterinary Medicine

Registered Veterinary Technicians

The Professional Licensing Agency (PLA) reports 1,249 registered veterinary technicians in Indiana during 2014. Of these technicians, 30 percent are Purdue graduates. It was estimated from a proprietary data source, an overwhelming number of these technicians likely work in clinical veterinary practices (94.1 percent) earning an average wage of \$30,000. As an example, among Purdue’s 2013-2014 graduating class, 78 percent are still working

in Indiana and all are employed by clinical veterinary practices. Slightly more than three-fourths of the graduates are employed at companion animal clinics with the remainder engaged in livestock/equine practices.

External Factors on Veterinary Medicine

The demand for veterinary services has been influenced historically by consumer's level of income, thus long-term changes to the economic conditions can serve as an important indicator of changes in demand for veterinary services. The 2014-2024 Congressional Budget Office (CBO) economic forecast predicts a period of stronger U.S. gross domestic growth (GDP) between 2014 and 2016, which in turn should cause veterinary services to continue to strengthen through 2017. In the past decade, growth in GDP has not translated into growth in median income of U.S. households. However, the CBO anticipates wage growth to outpace general prices' growth – thus a rise in real median household income through 2017.

Therefore, with the predicted increase in households combined with the anticipated increase in real median household income, an environment that results in an increased demand for goods and services is likely to exist. Bottom line, these predictions of strong GDP growth and increased median household incomes bodes well for providers of veterinary services. Conversely, rising interest rates will exacerbate the student debt problem and thus industry-wide costs. Under current interest rate projections, the average veterinary student's total cost of debt could rise by \$75,000 – or \$3,000 a year for a 25 year loan.⁵

The Economic Contributions of the Purdue University College of Veterinary Medicine

Purdue University's College of Veterinary Medicine in West Lafayette serves as the primary hub of activity, yet its economic benefits extend beyond the campus borders. The college, as well as businesses operated by Purdue alumni, purchase many inputs from suppliers both locally and nationally. The economic activity spurred by the purchase of these inputs—in addition to the household spending by PVM employees, alumni veterinarians and registered veterinary technicians—cascade throughout the state's economy. The Purdue Extension Community Development team used the IMPLAN economic modeling software in order to comprehensively account for the economic benefits associated with PVM and its alumni business spending.

Data inputted into the IMPLAN software, otherwise known as the direct effects, included the PVM's budget, payroll, veterinary teaching hospital revenue and the number of alumni by degree type working in Indiana. Utilizing this data, the IMPLAN model constructs Indiana's economic structure from secondary data sources, creating input – output relationships which depict the path of money circulation in the economy. For example, the model incorporates the fact that Indiana's veterinarians purchase nearly half of their inputs from other Indiana establishments. The estimated economic effects of these supply chain purchases are represented in the “indirect effects” results. Discretionary income expenditures by the veterinarians, as well as employees throughout the supply chain, on entertainment, food, health care, clothing, etc. are captured in the “induced effects”.⁶ These economic effects combined provide the total estimated economic contribution to the state.

⁵ Dicks, Michael R., Bain, Bridgette and Knippenberg, Ross. 2015. “2015 AVMA Report on Veterinary Markets.” American Veterinary Medical Association, Veterinary Economics Division.

⁶ See the appendix for a more detailed explanation of the key terms used in this report.

It must be noted that these numbers are conservative estimates as non-Purdue alumni veterinarians likely utilize PVM's services. Likewise, Indiana residents who live close to a state border may utilize a PVM veterinarian that actually practices in the bordering state. Capturing these circumstances would require a study measuring the impact on the state of all veterinary services, which was beyond this study's intended scope.

Summary of Economic Contributions

In 2014, Purdue University's College of Veterinary Medicine and its Indiana-employed alumni generated an estimated \$258 million in direct economic output – which is reflective of the expenditures made by the college and its alumni (see **Table 2**). In addition to these direct effects, the college and its alumni caused an estimated \$72.6 million in additional economic activity in the state by purchasing inputs from Indiana-based suppliers (indirect effects). The tertiary economic ripple from household spending of the PVM employees, PVM alumni and supply chain employees totaled \$146.6 million. Collectively, the total economic footprint of Purdue University's College of Veterinary Medicine and its alumni was nearly half a billion dollars (\$476.9 million) in 2014.

Multipliers assist in better understanding the ripple effects. The ratio of total effects to direct output yields a multiplier of 1.85, meaning that each dollar of output generated by PVM and its alumni stimulates another \$0.85 in economic activity in the state.

It is important to note that while economic output estimates are useful as they provide approximate values of sales or expenditures – a concept readily understood by most people – it truly serves as “headline numbers”. It could also be regarded as the “gross” economic activity as a result of the domino effect of economic transactions. In relation to the total output or total footprint, total value added would be the “net” economic activity as it eliminates transaction duplications. Total value added contributes to the official GDP figures reported at national or state levels, thus is a more accurate appraisal of the contribution of PVM and its alumni to the state's economy. As depicted in the second row of **Table 2**, PVM and its alumni combined to generate \$186.1 million in direct value added in 2014. This initial level of activity cascaded through the economy with nearly \$42 million indirect and \$83.4 million induced effects within Indiana, resulting in a total value added contribution of \$311.4 million. The multiplier shows that every dollar in expenditures supported \$0.67 in additional economic activity in the state.

Faculty and staff employed at PVM as well as the Indiana employed PVM alumni, comprised the majority of the estimated 2,099 direct jobs. An additional 1,657 jobs within the state were the byproducts of the ripple effects of PVM and its alumni. The purchase of production inputs from Indiana suppliers supported an estimated 500 additional jobs in the state (indirect). Household spending of these direct and indirect workers supported an additional 1,157 jobs locally (induced). This brings the total employment effect to an estimated 3,849 jobs. The ratio of total employment effects to direct employment results in a multiplier of 1.83, meaning that every 10 jobs directly related to PVM and its alumni resulted in the creation of eight additional jobs in the state in 2014. The compensation per job is highest in the direct effects at nearly \$67,600⁷, the ripple effects supported jobs in the \$30,000 salary range, leaving the average compensation per job to be \$52,400.

⁷ The high compensation per job would be reflective of the pay scale for professors and veterinarians in all sectors of employment.

Table 2: The Economic Contributions of PVM and PVM Alumni on Indiana's Economy, 2014

	Direct Effects	Indirect Effects	Induced Effects	Total	Multiplier
Output (\$ millions)	\$257.7	\$72.6	\$146.6	\$476.9	1.85
Total Value Added (\$ millions)	\$186.1	\$41.8	\$83.4	\$311.4	1.67
Employee Compensation (\$ millions)	\$141.8	\$19.0	\$40.9	\$201.8	1.42
Employment	2,099	593	1,157	3,849	1.83
Compensation per job	\$67,562	\$32,040	\$35,356	\$52,429	-

Note: Employee compensation includes wages and salaries as well as benefits and employer contributions to government social insurance. The estimated proprietors' incomes were included in employee compensation, despite it typically being reported separately. Source: Purdue Extension, using PVM, EMSI and the IMPLAN economic modeling software

Distribution of Economic Contributions

The PVM alumni – particularly the veterinarians – accounted for more than half of the total economic output (53.8 percent) and nearly two-thirds of total value added economic output in 2014 as shown in **Table 3**. The ripple effects of veterinarians spurred an estimated \$113.6 million in additional economic activity throughout the state, bringing the total economic footprint to \$206.3 million, or a value added impact of \$168.5 million. The combined effects of the college, which include its budget, employment and income, totaled more than \$114.1 million in 2014.

Table 3: The Economic Contribution of PVM by Component, 2014 (\$ millions)

Component	Direct Output	Indirect Output	Induced Output	Total Output	Total Value Added	Multiplier
College of PVM	\$137.1	\$32.7	\$50.5	\$220.2	\$114.1	1.61
Alumni	120.6	40.0	96.1	256.7	197.2	2.13
<i>Veterinarians</i>	92.7	30.8	82.8	206.3	168.5	2.23
<i>Registered Vet Technicians</i>	27.9	9.2	13.2	50.4	28.7	1.80
Total	\$257.7	\$72.6	\$146.6	\$476.9	\$311.4	1.85

Source: Purdue Extension, using PVM, EMSI and the IMPLAN economic modeling software

The direct employment volume of PVM alumni was more than double the college, thus PVM alumni generated a larger employment ripple effect (see **Table 4**). Once the supply chain purchases and household spending associated with PVM alumni and the college were considered, the total employment effects jumped to 2,451 and 1,398, respectively. Despite having a smaller employment footprint, the college had the largest multiplier effect with 2.05, meaning for every 100 jobs, the college supported another 105 jobs statewide.

Table 4: Number of Employees Supported within PVM and its Alumni by Component, 2014

Component	Direct Employment	Indirect Employment	Induced Employment	Total Employment	Multiplier
College of PVM	683	316	399	1,398	2.05
Alumni	1,416	277	758	2,451	1.73
<i>Veterinarians</i>	<i>1,052</i>	<i>214</i>	<i>654</i>	<i>1,919</i>	<i>1.82</i>
<i>Registered Vet Technicians</i>	<i>364</i>	<i>63</i>	<i>104</i>	<i>532</i>	<i>1.46</i>
Total	2,099	593	1,157	3,849	1.83

Notes: PVM Hospital direct employment figures are reflected in PVM payroll figures and subsequently a multiplier cannot be calculated. Due to payroll not needing to purchase from suppliers, indirect employment is not populated. Source: Purdue Extension, using PVM, EMSI and the IMPLAN economic modeling software

Tax Effects

The direct, indirect and induced economic activity created by PVM and its alumni generates federal, state and local government tax revenue. The IMPLAN model estimates the tax revenues from corporate profit taxes, indirect business taxes (e.g., sales, property and excise taxes), personal taxes (e.g., income and property taxes) as well as employer and employee contributions to social insurance. The largest share of federal revenue comes from contributions to social insurance. On the state and local level, direct business taxes are the largest source of government revenues. As **Table 5** shows, the economic activity related to all the activity associated with PVM and its alumni generated an estimated \$46.7 million in federal revenues and \$28.6 million in state and local collections.

Table 5: Tax Effects of PVM and its Alumni, 2014 (\$ millions)

Tax Effects	Direct Effects	Indirect Effects	Induced Effects	Total
State and Local	\$17.3	\$3.0	\$8.2	\$28.6
Federal	\$30.3	\$5.3	\$11.0	\$46.7

Source: Purdue Extension, using PVM, EMSI and the IMPLAN economic modeling software

Conclusion

Owners of pets and livestock depend on veterinarians and registered veterinary technicians to take care of their animals which in turn affects their livelihoods. Consequently, these veterinarians and technicians depend on the availability of high quality education and research, which Purdue University's College of Veterinary Medicine provides. The education at PVM extends beyond classroom learning via its hands on learning opportunities through its veterinary teaching hospital, clinical experiences and research opportunities. At the end of the program, students are prepared to pursue additional specialization or enter the workforce. In the past few years, over 90 percent of the graduates indicated having one of these commitments at graduation – evidence of a successful education program. Today, 63 percent of the state's veterinarians and 30 percent of registered veterinarians are Purdue graduates and fulfill various capacities – servicing the public via clinical practices, protecting the state's food supply via government positions, conducting research through jobs at private companies, or preparing future veterinary workers via education at Purdue University and much more.

As a result of PVM graduating a skilled workforce, the college and its alumni had a collective economic footprint of \$476.9 million, contributing \$311.4 million to the state's GDP in 2014. The ripple effects of this economic output supported an additional 1,656 jobs. Over half of the economic contributions of the PVM and its alumni were tied to its graduates – namely the veterinarians – with a net impact of \$168.5 million and every 10 veterinarians supporting eight additional jobs.

In the near future, pet ownership and livestock production will likely continue to expand. Coupled with the anticipated increase in discretionary income, the potential expanded demand for veterinary medicine services is real. To adequately satisfy the demand for services and protect our food sources, the education infrastructure needs to remain strong to fulfill its role in training and supporting the field veterinarians and registered veterinary technicians. The degree to which PVM can train future veterinarians, as well as disseminate veterinary knowledge to the public, will affect the level of economic contribution the veterinary discipline provides to the state of Indiana.

Appendix

About the Data

This study desired to quantify the economic contribution of the College of Veterinary Medicine at Purdue University including its outputs, known as graduates. The college provided the researcher with its budget expenditures, income from the veterinary teaching hospital, employment and payroll. The college's alumni database, as well as national membership and state licensing data were used to define the graduates and their locality. Economic Modeling Specialists International (EMSI), a proprietary database, was used to fill in staffing patterns as well as wage information.

The IMPLAN software model outlining the state government education inter-industry relationships was modified to reflect the PVM expenditures. Staffing patterns and membership data on Indiana's veterinarians and registered veterinary technicians allowed the researcher to utilize four industry spending patterns (veterinary services, federal government, scientific research and development services as well as museums, zoos, historical sites and parks). It is recognized that this study does not capture the full scope of the PVM impact and the next study will look more closely at the veterinary hospital, engagement, research and education benefits.

Key Terms

Direct Effects: Refers to the increase in final demand or employment in Indiana that can be attributed specifically to PVM and its alumni.

Employee Compensation: The total cost of labor to an employer. It includes wages and salaries as well as benefits and employer contributions to government social insurance. In this study, compensation includes both employee compensation and proprietor's income. However, these are typically reported separately.

Indirect Effects: A measure of the change in dollars or employment caused when PVM or its alumni increase their purchases of goods and services from suppliers and, in turn, those suppliers purchase more inputs and so on throughout the economy.

Induced Effects: The result from the household spending of employees at PVM and their alumni and their suppliers—whether in dollars or employment. Induced spending will react to changes in output along the economic supply chain. For example, as a veterinarian's production and sales increase, the output of its supply chain increases correspondingly. Those output changes also result in changes in household income and spending of suppliers' employees. Induced effects represent the change in overall economic output and employment resulting from such household spending changes.

Multiplier: The multiplier is the extent of the economic response in a particular geographic area associated with a change in the direct effects. For example, multiply every dollar of PVM expenditures in 2014 by 1.61 to find an estimate of the total contribution of this activity to Indiana's economy. Another way to look at it is that every dollar of output supports \$0.61 in additional economic activity in the state.

Tax Effects: The IMPLAN model tracks the federal, state and local government tax collection that would be associated with the direct and ripple effects' economic activity. For example, household spending at retailers generates state sales tax. In addition, those retailers also pay property taxes to local governments.

Total Effects: The sum of the direct, indirect and induced effects, otherwise known as the size of the economic contribution to the economy. Term used interchangeably with ripple effects or economic footprint.

About the IMPLAN Software

IMPLAN is built on a mathematical input-output (I-O) model that expresses relationships between sectors of the economy in a chosen geographic location. Using a traditional input-output analysis, IMPLAN can measure the economic effects of an event, such as construction of a new plant or expanded sales at a business, or the economic contribution of an existing entity such as an industry, university or business. The input-output model defines the flow of dollars through the economy contingent on the assumption of fixed relationships between producers and their suppliers. Dollars spent outside of the defined economy are omitted, which would include imported items, purchased goods originating from the defined economy or commuting employees who conduct household spending elsewhere.

The concept of input-output modeling is the inter-industry relationships within the defined geographic area will estimate an economy's response to economic changes. Thus, a demand increase for a certain product or service causes a chain reaction of results, captured via the multiplier effect. Impacted parties would include the producer of the product, its employees, suppliers, the supplier's employees and beyond – showcasing the total effect of change is greater than the original demand. The multiplier, the ratio of total effect to direct effect, helps quantify in simple terms the estimated effect resulting from the change in original demand. Each industry has a unique output multiplier due to different inter-industry relationships with firms within and outside the defined economy.

The multiplier is a great tool, but often does not answer all the desired questions. Most want answers in regards to quantity of jobs impacted, effects on the economy due to the change (increase or decrease) as well as the anticipated compensation per job resulting from the impact on jobs. The IMPLAN software allows the user to construct models measuring the flow of dollars from purchasers to producers within the defined economy. Data within the models will set up the precise equations which answers questions about the impact of a new company, a plant closing or greater product demand.

Local, regional and national production, employment and trade data sources are used by IMPLAN to construct its input-output model. Examples of such data sources include U.S. Census Bureau's annual *County Business Patterns* report and the U.S. Bureau of Labor Statistics' annual *Covered Employment and Wages* report. Despite gathering large quantities of data from government sources, the company behind IMPLAN also estimates unavailable data, such as county-level production data or suppressed data due to confidentiality of easily identifiable individual companies.

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