

Scotland's Rural College

A preliminary economic assessment of the veterinary profession's value to Scotland

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A preliminary economic assessment of the veterinary profession's value to Scotland



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A preliminary economic assessment of the veterinary profession's value to Scotland

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Executive Summary

- The role of veterinarians in Scotland goes beyond private farming or general household clients, reaching into government, food processing industries, pet organisations, wildlife organisations, sporting animal organisations, animal welfare organisations, policing, etc.
- Six central categories of impacts for the veterinary profession were identified namely: 1) farm animal productivity and related industries; 2) companion animals and related industries; 3) horse and equine industry; 4) public health, hygiene and surveillance activities; 5) tourism; 6) other impacts such as environment, wild life, education, research and policy.
- In 2016 there were 2,134 registered veterinary surgeons in Scotland and 948 registered veterinary nurses operating in 474 registered practices (246 of which were part of the RCVS Practice Standards Scheme). Additionally, in 2017 there were 197 approved veterinary training practices (TPs) in Scotland offering clinical training and work experience to 426 student veterinary nurses.
- Despite increased corporatisation of the veterinary landscape the sector in 2016 was dominated by micro businesses. At the UK level, one in ten veterinary businesses had a turnover of less than £50,000 per annum with just over a quarter of businesses in the under £100,000 category. Nearly 60% of veterinary businesses generated £500,000 turnover with one-in-five having turnovers of over £1 million. Over 40% of the UK veterinary businesses have fewer than 5 staff, with 62% having less than 20 employees, reiterating how it is a sector dominated by micro businesses.
- In 2015, Scottish veterinary businesses were estimated to be generating £308 million in turnover, generating £186 million in Gross Value Added and spending £134 million on goods and services and spending £83 million on wages. However, veterinarians have impact beyond this, particularly into education, research, and official government food hygiene and public health services.
- Whilst there are very high levels of job satisfaction, over 90% of veterinarians reported that their work was stressful. There has been a long term increase in the proportion of veterinarian work focusing on small companion animals, whilst the proportion of veterinarians working on large/farm animals falls. A “spiral of disillusionment” has been identified in the large animal sector that leads to a drift by newly qualified veterinarians to small animal medicine, even where that is not their original intention. Another longer term trend is greater veterinary research activity and reduced government veterinarians.
- In 2016, the Scottish universities accounted for 30% (£159) of the UK's veterinary graduates and it is estimated that their net additional lifetime earnings (i.e. after studying costs) was £165,000 for men and £128,000 for women. Veterinary earnings five years after graduating are second to only medicine and dentistry, with average earnings of around £36,000. There is, however evidence of a gender pay gap in new graduates with the starting salary of women estimated to be 7.2% lower than their male counterparts.
- The veterinary sector is now dominated by women (59% veterinary surgeons and 98% veterinary nurses), but the smaller proportion of women in the older cohort of veterinary surgeons reflects the historic male dominance within the industry. With proportionately fewer women in the older age group it means women in the industry are less likely to have a senior position within veterinary businesses (i.e. owners, partners, directors) that affects average salaries across the sector. Average earnings in the profession were £41,152 for women and £46,921 for men in

2016/17 meaning a 12% gender pay gap (which is up to 20% for those with more than 11 years' experience). Care should, however, be taken when considering the gender pay as the differences are largely driven by the unequal distribution of women in senior position that in turn is driven by age structures, which are gradually changing.

- Veterinary, and related, research is of significant social and economic benefit, but it is challenging to attribute these impacts fully to the veterinary profession, as RCVS acknowledge: *“Veterinary research is carried out by individuals with a range of scientific backgrounds, including veterinarians, at research institutes and universities, by industry, including pharmaceutical companies, and in privately-owned veterinary practices.”*
- The farming sector places a great deal of trust in the advice and support they receive from veterinarians. The veterinary profession support the £1.77bn output generated annually from livestock in Scotland, and safeguard the £1bn of breeding livestock and £1bn of trading livestock in the country. It is estimated that farmers spend about £64m a year on veterinary services across Scotland. The impacts of veterinary profession on farm animals in relation to improve health and productivity are categorised under three groups: i) prevention, control and treatment of diseases and improving animal welfare conditions; ii) other health and farm management supports; and iii) contribution to feed, pharmaceutical and other related industries.
- Whilst the avoided costs from endemic and exotic diseases of farm animals, and the size of the sectors were estimated but it must be noted that it is (a) difficult to assess the contribution of vets and (b) as the avoided costs are highly probabilistic and difficult to assess, they should not be added to provide accumulated impacts. They do however provide indicative figures for the significant role to be played in monitoring, preventing and controlling animal diseases in Scotland and the scales of potential costs of outbreaks. With those caveats, it is estimated that veterinary interventions have significant economic impact through avoidable costs to the industry and taxpayer. The avoided costs attributable to veterinary services in Scotland for 30 endemic diseases of farm animals were estimated to be between £100m and £154m per annum. The avoided costs due to veterinary control measures stopping exotic disease outbreaks (FMD, Bluetongue and AI) were estimated at £135m per annum. Likewise, avoided costs from controlling and minimising outbreaks of BSE, salmonella, campylobacter and *E.coli* O157 were estimated at £96m per annum.
- The value of the UK veterinary medicine market in 2017 was estimated at £700m, with 42% percent of the sales are relating to farm animals. It is estimated that the Scottish veterinary pharmaceutical market is worth £59m for farmed animals and £33m for pets.
- The contribution of veterinary profession to the economy of Scotland through companion animals/pets can be viewed under three main categories namely: i) health and well-being of pet animals, ii) impact on health and well-being of pet owners, and iii) direct and indirect contributions to the related industries such as pet food, pharmaceuticals, accessories and insurance. In the UK the pet population stands at around 57 million, with an estimated 40% of households owning a pet. It was estimated that through reduced doctor visits and other healthcare expense the total health benefit of pets for the economy in Scotland is £209m.
- It is estimated that the pet insurance premiums paid by Scottish households in 2016 amounted to £71 million, with claims of £57 million paid out in 2016 (£44 million on dogs). The UK pet insurance market is expected to continue to expand with some estimates suggesting it will grow from £976 million in 2015 to £1.6 billion by 2021. The full cost of insurance claims cannot be attributed to the veterinary profession, as insurance also covers non-veterinary expenses such as

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third party liability, replacement cost, advertising costs, pet care in case of hospitalisation, holiday cancellation, etc.

- It is estimated that 10% of the UK veterinarians are equine specialists, servicing 1 million horses and ponies in and an industry that has an economic impact of over £7 billion and employs about 250,000 people (half the employment is in horse racing). It was estimated that the total value of the horse industry in Scotland is £1.2 billion with £554 million generated from racing, and £90 million generated from other events.
- The veterinary profession play pivotal role in Scottish meat processing sector, acting as Official Veterinarians and overseeing meat hygiene inspections. In 2016, the direct cost to the meat industry for this role was £5.9m.
- In addition to their familiar roles, veterinarians are increasingly contributing to the “One Health” concept, covering areas such as bioterrorism, antimicrobial resistance, climate change, transboundary disease, ecosystem health and sustainability, and zoonotic disease. As veterinarians routinely observe and treat these diseases in a wide variety of animal species they have often adopted diagnostic methods and treatments that may be applicable to human disease interventions, thereby improving the effectiveness and cost of human treatments.
- The Scottish Government spends approximately £4 million per year on its Veterinary Services Programme (VSP), delivered by SRUC, to support livestock disease surveillance and animal health planning and welfare activities. In 2016/17 through the VSP diagnostic tests were carried out on 5,475 farmed animal carcasses and over 93,000 submissions of blood, faeces, swabs and other materials. Farmers and veterinarians in Scotland also pay privately for diagnostic services undertaken by SAC Consulting and the Moredun Research Institute.

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1. Introduction

1.1 Context of the study

The steering group of Veterinary Delivery Landscape project (VDLP) has indicated that a significant evidence gap existed on the economic value of the veterinary profession in Scotland. Through the Scottish Government's Strategic Research Programme 2016 to 2021, SRUC, Scotland's Rural College asked to investigate the socio-economic value of the veterinary profession in Scotland. However, determining an economy-wide impact of veterinary profession requires a comprehensive economic impact assessment that is out-with the scope of this study's budget. This short preliminary study is considered a first step in providing a framework, and initial estimates, for a more rigorous economic impact assessment for the veterinary profession in Scotland.

1.2 Identifying impacts, data sources and methods

The first step in determining the economic value of the veterinary profession in Scotland was to identify different impact categories. Using the research call from the Veterinary Delivery Landscape project (VDLP) and expertise of the authors, six central categories of impacts for the veterinary profession were considered as the main focus. These were impact on: 1) farm animal productivity and related industries; 2) companion animals and related industries; 3) horse and equine industry; 4) public health, hygiene and surveillance activities; 5) tourism; 6) other impacts such as environment, wild life, education, research and policy.

From the outset of the research it was envisaged that possible evidence of the impact of veterinary profession could be classified under two class of "quantitative" and "qualitative" evidence. Therefore, relevant quantitative and qualitative data and information for each of the six impact categories were collected using rapid evidence assessment (REA). REA that is more rigorous than *ad hoc* searching was performed using both academic and non-academic search engines namely: Google and Goole Scholar. The initial key search word and combinations used were: "value of veterinary profession", "costs and benefits of veterinary", "economics of veterinary profession", "value of veterinary profession", "costs of animal health", "economics of animal health", and "cost of animal diseases". Identified quantitative evidence and figures were used to estimate costs and benefits of the identified impacts of the veterinary profession.

Regarding animal disease, the estimated values for each category of potential cost avoidance (or value of production loss) attributed to veterinary profession interventions were adjusted by a "contribution" factor. The presented figures in this report are based on assuming a triangular distribution for the probability that the impact can be attributed to the vet profession – using hypothetical values of: minimum 10%, most likely 20% and maximum 60% likelihood of veterinary impact attribution. A similar approach was used to modelling the probability of outbreaks of FMD, BSE, AI and salmonellosis, using probabilities of: minimum 2% (one in 50 years), most likely 5% (one in 20 years) and maximum 10% (one in 10 years). The values of the triangular distribution for BTV were assumed to be: minimum 5%, most likely 10% and maximum 20%. The model was run for 10,000 iterations to generate a distribution of the avoided costs.

2. Veterinarians in Scotland

The role of vets in Scotland goes beyond private farming or general household clients, reaching into government, food processing industries, pet organisations, wildlife organisations, sporting animal organisations, animal welfare organisations, policing, etc. As such, their activities are considered by a wide ranging audience as being beneficial to society, a society who places animal welfare high on their social conscience – Eurobarometer (2015) revealed that 98% of UK population believe it is important to protect the welfare of farmed animals (European Commission, 2015).

2.1 Changing Veterinary Profession

2.1.1 Number of veterinarians and veterinary nurses

RCVS data (RCVS, 2017) reveals that in 2016 there were **2,134 registered veterinary surgeons** in Scotland (0.04% of Scottish population) and **948 registered veterinary nurses** operating in **474 registered practices** (246 of which were part of the RCVS Practice Standards Scheme). This equates to 9.4% of the UK veterinary surgeons, 7% of the UK veterinary nurses and 8.6% of the UK registered practices. In addition the RCVS (RCVS, 2017) revealed that in 2017 there **were 197 approved veterinary training practices (TPs)** in Scotland offering clinical **training and work experience to 426 student veterinary nurses** in Scotland.

2.1.2 Changing profile of veterinary work

Data from reported by Lowe (2009) and a RCVS 2104 survey (Buzzeo et al. 2014) of the veterinary profession reveal that the profile of veterinarians in the UK has been changing. In particular it is noticeable that the proportion of Governmental veterinarians diminished between 1996 and 2014, whilst the proportion of research veterinarians increased to account for an estimated 1 in 10 UK veterinarians. Veterinary research was identified by RCVS (2013) as helping society: *“address inefficiencies in the food-chain, national food security, prevent or minimise the devastating financial losses brought about by animal disease, improve food animal welfare and help tackle climate change, contribute to the conservation of wildlife, and improve companion animal and equine health and welfare”*.

Figure 1. The changing profile of the veterinary profession in the UK; data related to 1966, 2006 and 2014. RCVS survey of veterinary profession 2014.

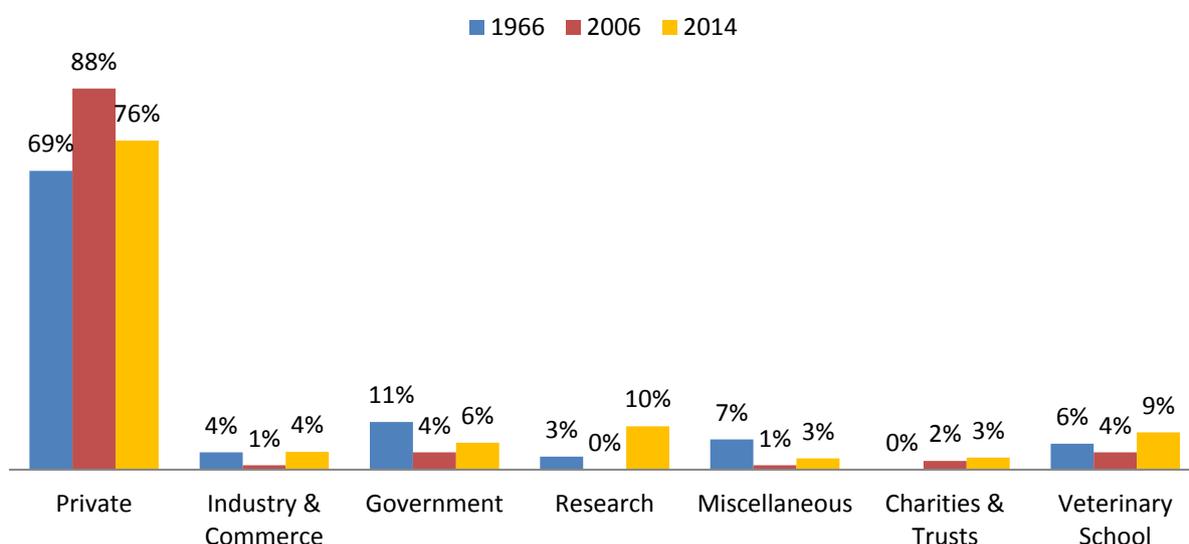


Table 1 Proportion of veterinarians' working time by species

Three quarters of vets responding to the RCVS survey in 2014 still worked in private practice. The survey also revealed that in 2014 over half the survey respondents (54%) considered working in small animal/exotic practices as their main role, with 16% saying mixed practices, 6% equine practices and only 4% specialist farmed animal practices (Buzzeo *et al.* 2014).

In addition to changes in who veterinarians work for, Buzzeo *et al.*(2014) reported that there was an increase in the proportion of vets working on small (companion) animals (see Table 1), increasing from 70% of survey respondents in 2006 to 77% in 2014. Over this period there was also a decline in the proportion of veterinarians working on farm animals (8.2% worked on cattle in 2006 falling to 4.9% in 2014).

Species/Discipline/Activity	2006 (actual)	2010 (actual)	2014 (actual)
Dogs	33.5	35.7	39.7
Cats	29.1	29.1	30.7
Rabbits	4.8	4.7	4.2
Birds	1.1	1	0.8
Other small animals	1.6	1.8	1.4
Total small animals	70.1	72.3	76.8
Horses	9.2	10	7.9
Beef cattle	3	2.7	1.9
Dairy cattle	5.2	4.6	3.0
Total cattle	8.2	7.2	4.9
Sheep	1.3	1.1	1.0
Pigs	0.5	0.5	0.5
Poultry	0.4	0.3	0.3
Exotics	0.6	0.7	0.7
Meat Hygiene	1.1	0.2	0.0
Laboratory animals			0.3
Fish for food	0.1	0.1	0.1
Local Veterinary Inspector	2.7	2.3	1.9
Practice mgmt/admin	5	5.3	4.8
Other	0.8	0.7	1.0

2.1.3 Scale of veterinary businesses

The Inter Departmental Database provides estimates for the distribution of the scale of veterinary businesses by turnover and employment size bands. Table 2 reveals that across the UK one in ten veterinary businesses had a turnover of less than £50,000 with just over a quarter under £100,000. Nearly a third of veterinary businesses were in the £100,000 to £500,000 turnover bracket with one-in-five having turnovers of over £1 million. Over 40% of UK veterinary businesses had fewer than 5 staff, with 62% having less than 20 employees -reiterating how it is a sector dominated by micro businesses. A third of businesses are classified as small, with less than 50 employees with only 5% classed as medium sized business (over 50 employees). The discussions around corporatisation of the sector suggest that the larger scale businesses are likely to become more prevalent in the future (Yasir, and Thomas, 2016).

Table 2 IDBR Veterinary activities businesses by turnover and employee size bands (2014)

Turnover	Businesses	Proportion of Businesses	Employees	Businesses	Proportion of Businesses
£0-£49k	340	10%	0-4	1,400	41%
£50k-£99k	595	17%	5-9	735	21%
£100k-£249k	575	16%	10-19	730	21%
£250k-£499k	580	16%	20-49	430	13%
£500k-£999k	700	20%	50-99	105	3%
£1m-£1.99m	465	13%	100-249	15	0.4%
£2m-£4.99m	215	6%	250+	10	0.3%
£5m-£9.99m	40	1.1%			
over £10m	20	0.6%			

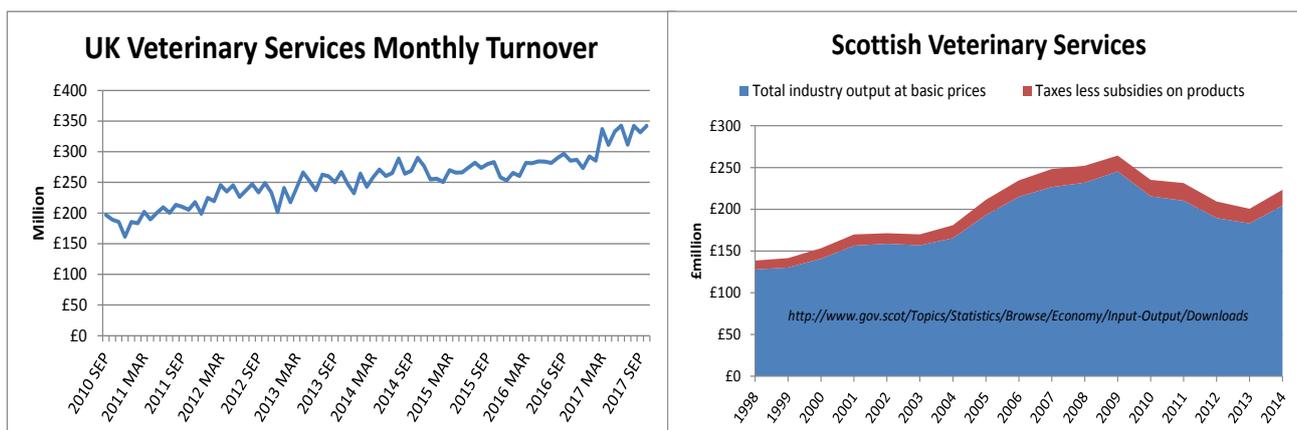
Source: Yasir, and Thomas, 2016

2.2 Veterinary sector output

At the UK level (see Figure 2), Office for National Statistics (ONS, 2018) reveal that the turnover (output) of veterinary activities had risen from £2.4bn in 2011 to £3.4bn in 2016, with average growth of 10% in 2017¹, reflecting the growth in the burgeoning pet insurance market. Assuming that Scottish veterinarians account for 9% of the market this means that **annual output of £304 million from Scottish veterinary practices can be estimated**, before any benefits arising from their activities (such as increased production, etc.) or veterinary activities undertaken in other sectors (research, meat processing, government, etc.) are accounted for. This £304 million is closely aligned to the £308 million turnover estimated from the Annual Business Survey published by ONS. Table 3 shows that in 2015 these Scottish veterinary activities were estimated to be generating £308 million in turnover, generating £186 million in GVA, spending £134 million on goods and services and spending £83 million on wages.

The Veterinary Activities Standard Industrial Classification division includes “*the provision of animal health care and control activities for farm animals or pet animals. These activities are carried out by qualified veterinarians in veterinary hospitals as well as when visiting farms, kennels or homes, in own consulting and surgery rooms or elsewhere. It also includes animal ambulance activities.*” (Yasir, and Thomas, 2016).

Figure 2 UK and Scottish Veterinary Services Industries turnover (various years)



Using the Scottish Government’s input output tables (Scottish Government, 2018) the annual output of the veterinary services sector grew by 90% in the decade to 2009 (£264m) before falling backwards till 2013 (£200m) as a result of the economic downturn (see Figure 2), with some recovery in 2014 (£222m). **It is estimated, using this data source, that the veterinary services sector directly generated £117m gross value added (GVA)² for the Scottish economy in 2014.**

¹ This is based on the average of the change in year on year monthly turnover.

² Gross value added (GVA) is the measure of the value of goods and services produced in an area, industry or sector of an economy.

Table 3 Annual Business Survey for Scotland's Veterinary Activities – 2008-2015 (ONS, 2017).

Year	Total turnover	Approximate gross value added at basic prices (GVA)	Total purchases of goods, materials and services	Total employment costs
	£ million	£ million	£ million	£ million
2008	200	122	78	56
2009	243	149	94	51
2010	205	109	96	55
2011	245	122	123	58
2012	205	121	84	55
2013	206	122	84	54
2014	235	151	88	74
2015	308	186	134	83

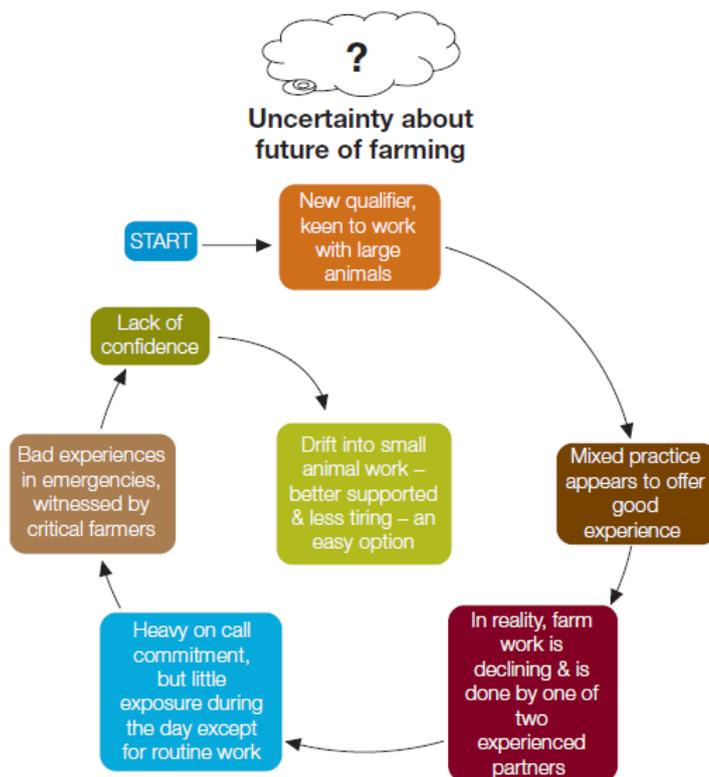
Comparing the Scottish input/output figures to the estimates derived from the UK figures (£267m and £289m for 2013 and 2014 respectively) we can therefore **estimate that the direct output of the Scottish veterinary services sector was between £212m and £308m in 2015 with GVA impacts of up to £186 million.**

2.3 Veterinary careers

Whilst most veterinary professionals (80%) report job satisfaction, in a 2014 survey of veterinary professionals for the RCVS (Buzzeo et al, 2014) nearly 90% reported that their work was stressful. This perhaps reflects the nature of the job and the connection many feel with the animals (and their owners) that they are treating. Job satisfaction is important as it maintains enthusiasm for the profession that leads to the next generation of industry leaders. Linked to the small proportion of vets working on farmed animals the “spiral of disillusionment” was identified by Robinson *et al* (2004) that suggests that there is often a drift by newly qualified vets to small animal work, even where that is not their original intention (as the realities of working with large animals are experienced).

Robinson *et al.* identified a number of factors that lead to this drift (with implications for the future provision of large animal vets) as shown in Figure 3. Some new recruits reported they would not work with farmed animals for ethical reasons, but for many the drift to small animals were related to being unprepared for some realities around working with farm animals, in particular: there was more out of hours ‘on-call’ work (exacerbated by a shortage of farm animal veterinary provision in some areas); challenges from farmers’ attitudes to younger vets; cashflow issues in farming (i.e. animals have a finite economic value); difficulties with physical / strenuous work; bureaucracy associated with farm animals; some routine, repetitive work (such as dehorning and TB testing).

Figure 3 The spiral of disillusionment



Source: Lowe (2009) citing Robinson et al 2004

2.4 Veterinary Education and Research

RCVS Facts (RCVS, 2017) reveals that the University of Edinburgh and University of Glasgow are two of the UK's seven universities that offer undergraduate veterinary degrees. In 2016 the **Scottish universities accounted for 30% of the UK's veterinary graduates** (159 of 278 graduates were from the UK). Many of these graduates go on to have a lifetime working in the veterinary profession, adding economic value to society as a result of their veterinary education. DBIS (2011) estimated that overall veterinary science graduates had a 9.1% higher likelihood than someone with 2 or more GCE 'A' Levels of being employed, and that the net graduate premium (i.e. net of studying costs) for veterinary science undergraduate degrees was £165,000 for men and £128,000 for women. Although the data used in the report is now somewhat dated, evidence from the OECD (2017) suggests that returns to higher education are fairly consistent over time, meaning the DBIS estimates remain the most robust and comprehensive source available for estimating this impact.

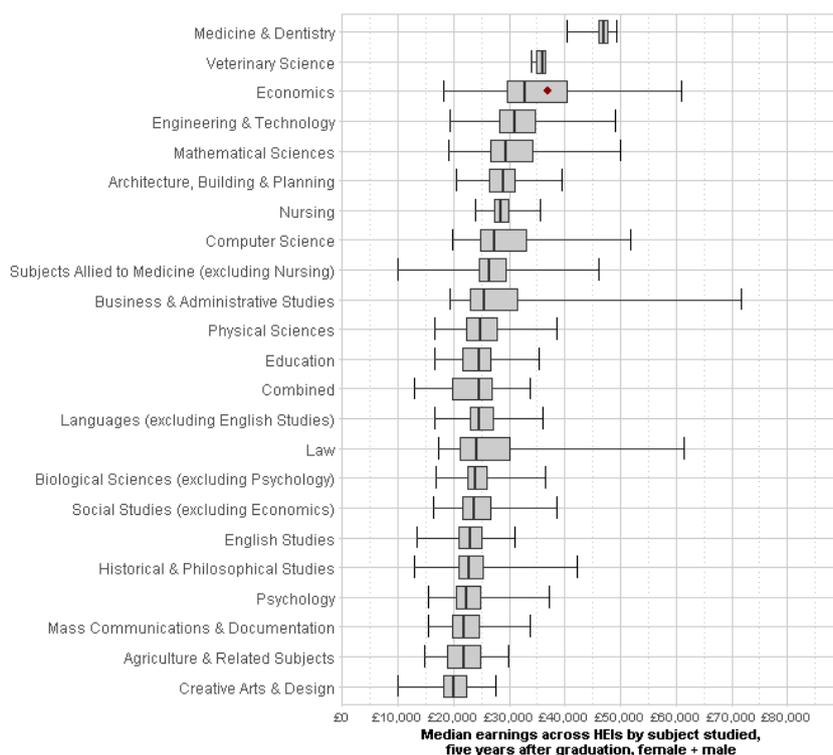
Using the DBIS estimates for the net graduate premium for UK origin veterinary graduates, it can therefore be estimated that in 2016 these 159 graduates could be expected to earn an additional £22m compared to someone without a degree (Table 4). As there is an annual cohort of graduates this can therefore be expected to have a similar annual economic impact within the UK from Scottish educated veterinarians. Of course not all of these vets will go on to practice in Scotland, but it provides an estimate of the annual additional contribution that veterinary education in Scotland can bring.

Table 4. Estimated Net Veterinary Graduate Premium from Edinburgh and Glasgow Universities (2016)

Student Origin	Male	Female	Total
UK	49	110	159
EU	1	9	10
Other	21	89	110
Net Graduate Premium	£165,000	£128,000	
Total UK Graduate Premium	£8m	£14m	£22m

The Department of Employment (2017) report that veterinary earnings five years after graduating are second to only medicine and dentistry, with average earnings of around £36,000 (see Figure 4). There is very small variation reported in veterinary earnings, perhaps due to the similar nature of veterinary work being undertaken compared to other courses where there are less specific career choices (e.g. economics), or greater opportunity to specialise (e.g. law). The Department of Employment (2017) also looked at any gender pay gaps that existed 5 years after graduating and they found no instances of female veterinary graduates earning more than their male counterparts, with men receiving higher incomes on average (see Appendix 1).

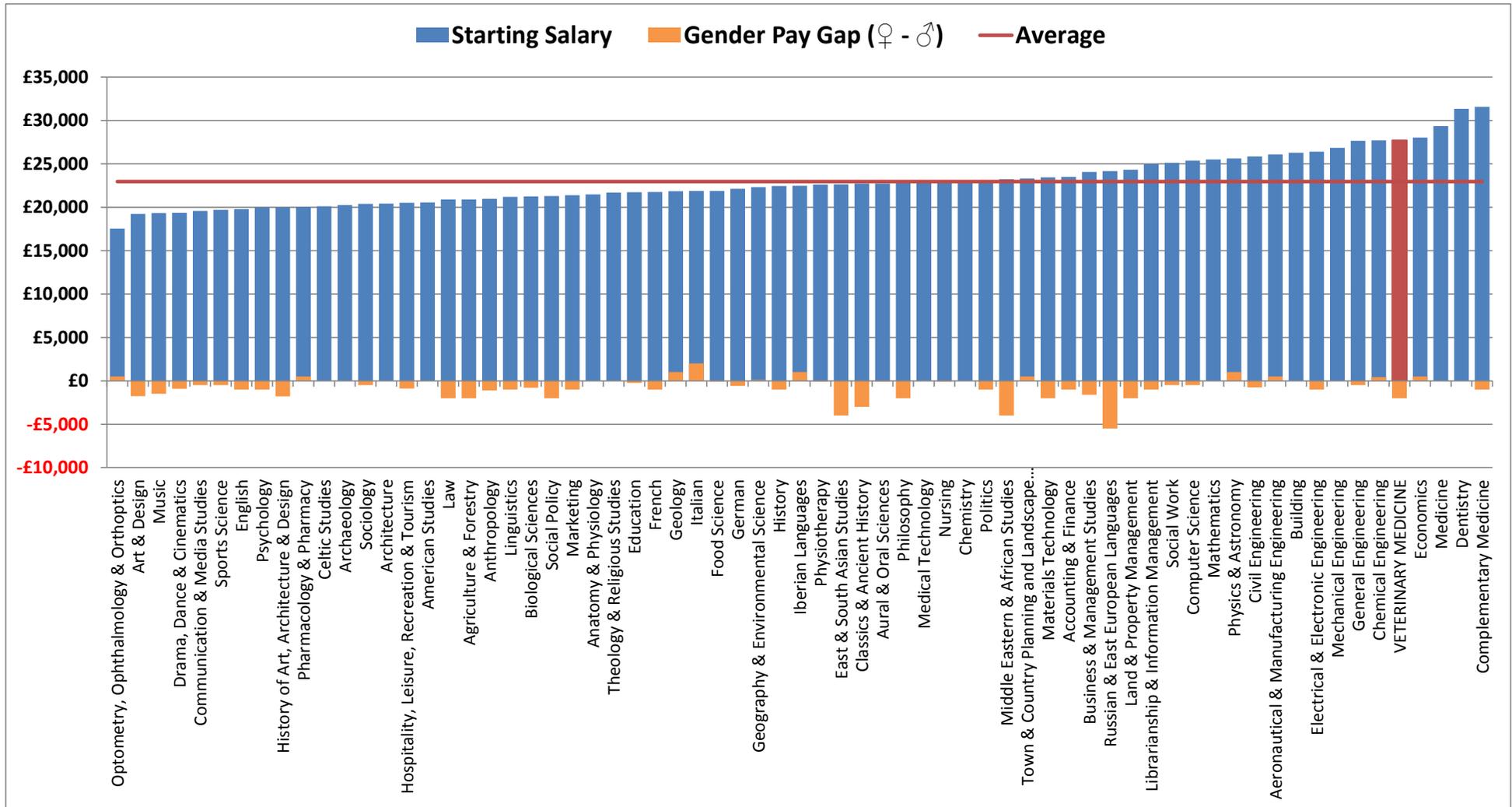
Figure 4 Distribution of median annualised earnings across HEIs for each subject area five years after graduation. Graduating cohort 2008/09, sorted by medians (Department of Education, 2017)



The Complete University Guide (2017) also provides indicative 2016 salary data for UK graduates by courses. This data includes gender pay experiences and it corroborates the DoE findings (see Figure 5). On average veterinary graduates starting salaries are amongst some of the highest by university degree course, starting at £27,721 compared to an average of £22,966 across all courses. According to this data, there is a gender pay gap for those qualifying with a veterinary degree, with female graduates earning £2,000 (7.2%) less, compared to 3.2% less for women across all courses.

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Figure 5 Starting salary and gender pay gap (female less male starting salary) by university subject 2015/16 (The Complete University Guide, 2018a, b)



In addition to the graduate premium that veterinary graduates earn there are additional social and economic impacts from veterinary activities through: study fees, living expenses of students in Scotland; associated employment (and staff wage spend) in vet schools and vet nursing colleges, as well as; related veterinary and livestock science research impacts. These impacts are very difficult to monetise without in-depth study of associated institutions, so illustrative examples are therefore provided to give examples of potential impact.

2.4.1 *Research Impacts*

It is a challenge to attribute research impacts to veterinary science as many of the scientists involved have non-veterinary backgrounds, despite their research impacting on veterinarians or being influenced and informed by the veterinarian profession. This has been acknowledged by the RCVS (RCVS, 2016b), who say: *“Veterinary research is carried out by individuals with a range of scientific backgrounds, including veterinarians, at research institutes and universities, by industry, including pharmaceutical companies, and in privately-owned veterinary practices.”*

The Veterinary Schools Council (VCS, 2016) go on to add: *“Coordinating with colleagues across many sectors, veterinary researchers work to bridge the gap between animal and human medicine. Veterinary schools are the natural place for their ground breaking work. By protecting livelihoods, creating millions of pounds of savings through disease prevention and control programmes, and generating private investment in innovative ways, it is absolutely clear that veterinary research is a great boost to the economy. Beyond financial benefits, though, the case studies demonstrate the importance of veterinary research to society. Every example in this publication delivers benefits for the public that align to key Government objectives to protect public health and animal health and welfare.”* The VCS (2016) report provides useful highlights of the impact of its members' research impacts some of which are illustrated below as examples of impacts of research associated with veterinary science:

Bovine TB (REF, 2014a). A University of Glasgow bovine tuberculosis (bTB) surveillance model was fundamental to new Scottish Government policy on bTB testing. Implemented on 1st January 2012, the policy change used the Glasgow model to indicate which cattle herds can be exempt from routine testing while still maintaining Scotland's official bTB free status. In 2012 this translated to exemption of more than 30% of Scottish herds from routine testing, with an associated government saving of £150,000. The revised policy also provided savings to the Scottish farming industry in the region of £100,000 (2012) and limited the risks of bTB testing to farmers, veterinarians and cattle. The rapid success of the ground-breaking Scottish research-led bTB policy development has been highlighted by the Civil Service as best practice and has been presented to numerous policy audiences including the European Commission, providing the opportunity to transform industry practices and livestock surveillance policy across the UK and beyond.

Breeding salmon for resistance to infectious pancreatic necrosis (REF, 2014b). Infectious pancreatic necrosis is a viral disease that has been a major constraint on salmon aquaculture in Scotland and around the world (where mortality rates are typically 25% with severe outbreaks having up to 90% mortality). Research at the University of Edinburgh found that resistance is a heritable trait and improving genetic selection techniques in industry selective breeding programmes is helping combat resistance and therefore mortality (by 25%) with an estimated economic impact of over £25 million

Anthelmintic resistance research³. Helminths are arguably the most important parasites affecting livestock production throughout the world causing a range of disorders which particularly affect the productivity, fertility and welfare of farmed ruminants. Gastro-intestinal nematodes can cause scouring, reductions in appetite and ill thrift and have been estimated to cost the British sheep industry around £84 million per annum, based upon the costs of lost production, preventive measures and treatment of affected animals. Research being undertaken at Moredun is focussed on improving understanding of a variety of parasitic diseases along with the mechanisms of resistance and the way in which resistance develops. The aims of this research is to provide improved means of diagnosis and develop effective management strategies that can be used to conserve the efficacy of our current anthelmintic families.

Breeding Scrapie resistance sheep flock (REF, 2014c). Breeding Scrapie resistance sheep flock. Scrapie is a disease of considerable economic consequence to the small ruminant farming industry. Within the EU, scrapie is a notifiable disease and affected farms can face severe trading restrictions and may lose a significant number of animals. Selection of sheep for scrapie resistance became a possibility after the pioneering work by the University of Edinburgh. The findings led directly to the implementation of the National Scrapie Plan which ran in the UK from 2001 to 2009 and, following the European Commission Decision 2003/100/EC, to similar programmes throughout the EU. The National Scrapie Plan, funded by the UK government, provided free genotyping of 1.8 million sheep in 11,000 flocks. Genotype selection methods have reduced the reported incidence of scrapie in sheep as a result of profound impact on the genetic structure of the entire UK sheep industry. In June 2013, the USDA followed the example of UK and the EU and implemented a Scrapie Free Flock Certification Program.

Genetic improvement of dairy cattle productivity, health, welfare, longevity and environmental impact (REF, 2014d). UK dairy cattle genetic improvement programmes historically focussed mainly on milk production traits with clear negative impacts on cow health, welfare and fertility, and thus economic performance. SRUC and the University of Edinburgh along with collaborators and dairy industry stakeholders identified that broader breeding goals were needed, encompassing production but also addressing animal health and welfare, and other industry goals. The work has established the biological, environmental and economic consequences of selection for milk production, including testing for unforeseen consequences of selection using the Langhill dairy herd and UK dairy industry data. This work identified that selection for production had a major impact on body condition score change, which in turn, affected reproductive performance. As a result, the UK was the first country in the world to routinely record body condition scores in dairy herds and was the first to use this information in national genetic evaluations for dairy cow fertility. Additionally new 'breeding goals' have been developed – identifying the most appropriate combination of traits to select for, and their relative economic importance. This work contributed to SRUC's award of The Queen's Anniversary Prizes for Higher and Further Education (SRUC, 2017) in the recognition of the estimated £400 million impact in the UK dairy industry resulting from the Langhill study.

³ The Moredun Research Institute. <https://www.moredun.org.uk/research/diseases/anthelmintic-resistance>

Egg quality and hen welfare (REF, 2014e). Key findings of two University of Glasgow research programmes have transformed the UK egg-laying industry, driving substantial improvements in productivity and bird welfare. First, two of the largest international poultry-breeding companies adopted an innovative new tool for assessing eggshell quality that was validated by University of Glasgow researchers. This tool has improved eggshell quality through selective breeding, with increased numbers of undamaged saleable eggs (saving approximately £10 million annually in the UK alone), as well as enhancing the hatchability of breeding stock eggs. Second, University of Glasgow research on the long-term health and welfare implications of infrared beak trimming influenced UK policy debate, preventing a ban on beak trimming (due to be enacted in 2011) that would have exposed 35 million laying hens to potential pecking injury or death, as well as costing the industry an estimated £4.82–£12.3 million annually.

Liver Fluke.⁴ The liver fluke is a highly pathogenic flatworm parasite of ruminants, mainly sheep and cattle. It causes severe liver damage, especially in sheep and can result in the sudden death of previously healthy animals. The disease is also responsible for considerable economic losses, estimated at around £50m in Scotland alone, due to direct production losses, poor reproductive performance and livers condemned at slaughter. The disease appears to be on the increase in the UK and spreading into previously fluke-free areas, possibly as a result of recent climate change (milder winters and wetter summers) favouring the parasite and its mud snail intermediate host. Moredun, research is currently improving diagnosis of active fluke infection, determining the efficacy of treatments, establishing predictors of disease risk, and identifying novel vaccine approaches.

EPIC Centre of Expertise-Animal Disease Outbreaks.⁵ EPIC aims to provide the best available scientific advice to inform government policy on reducing the impact of animal disease outbreaks. It provides access to expertise from across Scotland to enhance the co-ordination and synergy of the science and to stimulate innovative thinking in support of policy. This Centre is allocated £2 million annually and is a partnership including: The Roslin Institute, Biomathematics & Statistics, Scotland, James Hutton Institute, Scotland's Rural College, University of Glasgow and the Moredun Research Institute (MRI). EPIC scientists, for example, were involved in various aspects of the BVD eradication campaign that has led to the majority (90%) of Scottish breeding holdings now have a negative BVD status. EPIC also play an important role on understanding and assessing the risks of vector borne diseases and their potential economic and human health impacts on Scotland – diseases such as Bluetongue Virus, Schmallenberg Virus, Fasciolosis (liver fluke), African Horse Sickness, Lyme Disease, Louping Ill, and West Nile Virus.

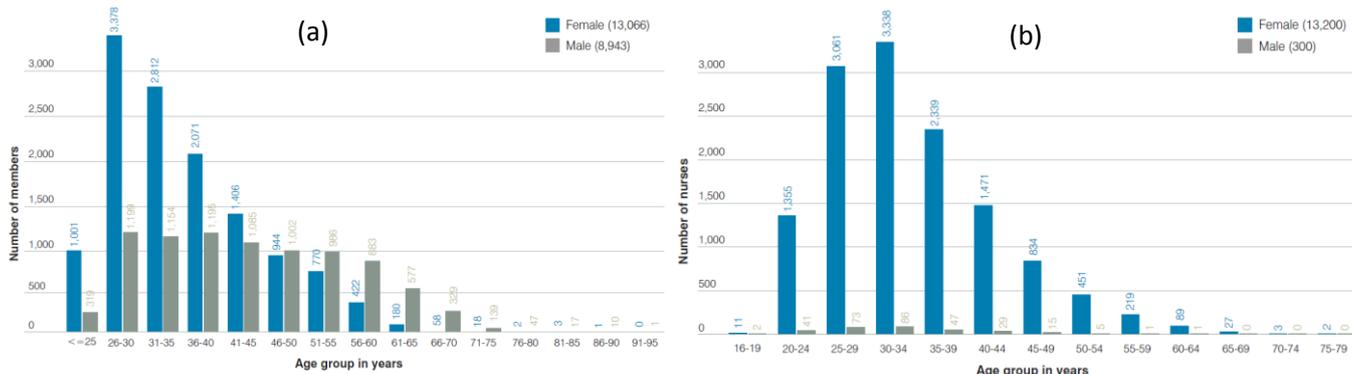
⁴ The Moredun Research Institute. <https://www.moredun.org.uk/research/diseases/liver-fluke>

⁵ <http://www.gov.scot/Topics/Research/About/EBAR/StrategicResearch/future-research-strategy/EPICCoE>

2.5 Gender gaps within the veterinary profession

The RCVS (RCVS, 2017) provide age and gender profiles for the veterinary profession in the UK. Figure 6 reveals how the sector is now dominated by women (59% veterinary surgeons and 98% veterinary nurses). However, the smaller proportion of women in the older age groups of veterinary surgeons reflects the historic male dominance within the industry.

Figure 6 UK-practising (a) veterinary surgeons and (b) registered veterinary nurses by age and gender



Despite the profession being dominated by women, Buzzeo et al (2014) reported that the majority (71%) of female vets were assistants or employees in companies with significantly fewer women in positions of business authority. Reflecting the historic male dominance in the profession (reflected by the gender age profile), considerably fewer men (36%) were classed as assistants, with a nearly a quarter being directors of veterinary companies, 12% being equity partners, 8% sole principal owners and 3% salaried partners. Overall, this means that in 2014 about 47% of male veterinarians were partners, owners or directors of businesses, compared to only 14% of female veterinarians. This chimes with findings from the Federation of Veterinarians in Europe (2015) who reported the UK as having one of the lowest levels of female practice ownership across Europe (see Figure 7).

Table 5 Position in Practice by Gender

Position	Male	Female
Assistant	36.2	70.7
Director	24.5	6.5
Equity Partner	11.8	2.8
Locum	8.1	8.5
Sole Principal	7.6	3.1
Consultant	5.1	2.2
Other	3.7	4.5
Salaried Partner	2.9	1.4
Vet working as a vet nurse	0.1	0.3

Figure 7 Female vet practice owners by country (FVE, 2015)

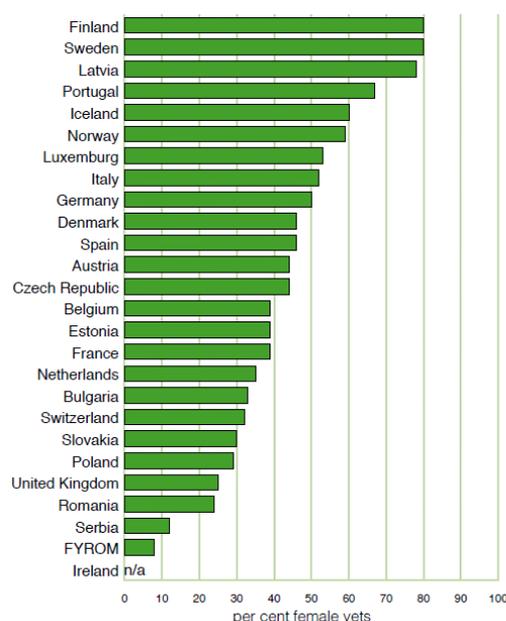


Table 6 Salary by length of time in profession 2016/17

Length of service	Partner	Full time vet	Part time vet	Nurse
1 - 3 years		£28,760		£16,000
4 - 6 years		£32,424		£16,319
7 - 10 years	£34,750	£37,837	£29,400	£18,369
11 - 20 years	£53,061	£46,031	£27,172	£20,191
Over 20 years	£66,126	£48,868	£27,939	£21,440

Waters and Limb (2018) published average salary figures by length of service are shown in Table 6. Waters (2018) reports that CM Research found a gender pay gap of 12% (average salary of £41,152 for women and £46,921 for men) in 2016/17 and the

Society of Practising Veterinary Surgeons (SPVS) found a greater gender pay gap at senior level – up to 20% for those qualified for 11 years or more. Pratt (2018), however, cautions about misinterpreting the data regarding gender pay and creating a belief that there is a significant gender pay gap, stating: *“pay increases in proportion to the number of years qualified so is our gender gap a consequence of measuring a younger cohort of women versus older men? The 10 years qualified subgroup shows no gender pay gap at this career stage....we must understand the data better, because I really worry that well-meaning commentary is preconditioning our female vets with a negative view of their earning potential.”*

3. Veterinary Impacts

A report published by RCVS and BVA in 2015 (VetFutures, 2015) highlights the influence, prominence and impacts of the veterinary profession across a wide range of areas including *“protecting animal health and welfare, the natural environment, biodiversity, managing invasive species, climate change, food security, research and development, and antimicrobial resistance”*. The report emphasises on the roles of veterinarians in society as well as their crucial contribution to the government’s decision-making process in all matters relating to animal science, public health and environmental sustainability. Other impacts of the veterinary profession identified by the mentioned report are: working with medical professionals to address public health agenda, roles in communicates by supporting farming clients, contributing to food-security as a result of working in partnership with farmers, tackling a wide range of scientific challenges, playing crucial roles as experts on national and international platforms and playing a central role in delivering a vision for veterinary research.

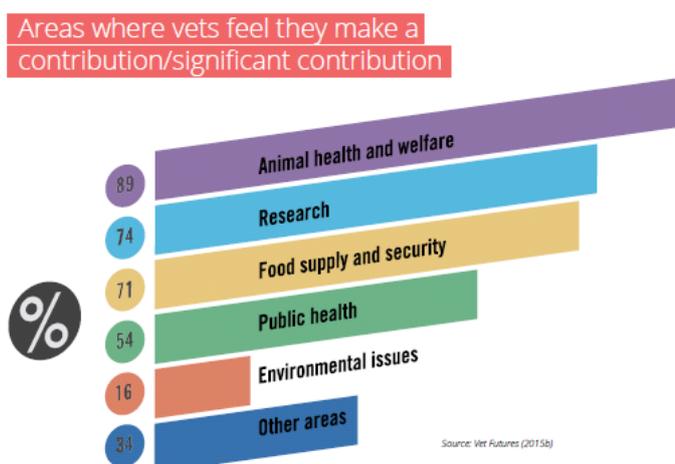


Figure 8 Areas of vets’ contribution to the society (Vet Future Report 2015)

On tackling grand challenges, such as increasing demand for meat protein, the Vet Futures Report (2015) states that: “veterinarians are expected to play a greater role through improving animal health and in helping society understand the broader challenges of sustainable animal agriculture. This includes the need for environmental protection, good animal welfare and public health education on healthy levels of dietary meat intake”.

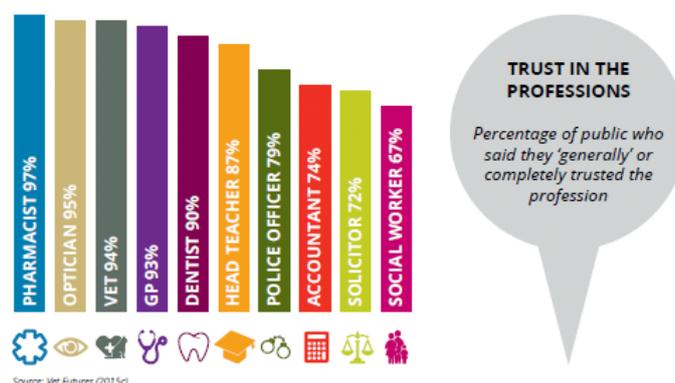


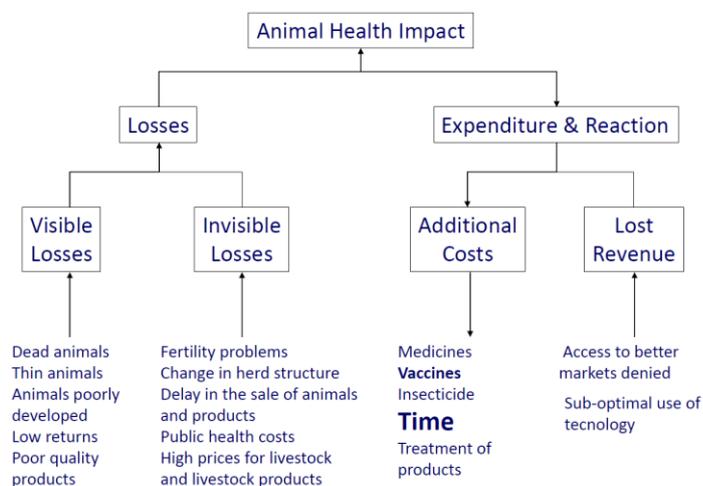
Figure 9 Trust in the profession (Vet Futures, 2015)

In addition the roles of veterinarians in contributing to the “One Health” concept covering areas such as bioterrorism, antimicrobial resistance, climate change, transboundary disease, ecosystem health and sustainability, and zoonotic disease control are highlighted by the report. The report also refers to a survey conducted by BVA that reflects the views of their members on the importance for vets of having a respected and valued role in society, and a perception that the public attaches little value to areas such as food production, safety and security, and public health. According to the report, “many comments from vets reflected a desire to increase awareness of the breadth of contributions vets make beyond companion animal health, and raising the profile of veterinary contributions to public health was identified as a key aim for the future”.

3.1 Impacts on agriculture

Rushton (2015) summarised animal health impacts, discussing the visible losses caused by disease (such as death, meat quality, etc.) along with invisible losses (such as fertility, public health, etc.) that may lead to lost revenues and additional costs of medicines, time to treat animals, etc. (see Figure 10).

Figure 10 Indicative impacts from poor animal health



At a very basic level, veterinarians are valued as they can safeguard resources (farmed animals, pets, or wildlife) and enable farmers to maximise output from the other resources they utilise in animal production (feed, labour, buildings, land, machinery, etc.). The farm vet, in essence is a specialist resource that farmers spend money on to maximise returns, but also to help ensure animal welfare, whilst acting as a social contact for many lone-working farmers in modern Scottish agriculture. In relation to contribution of veterinarians to the health and welfare of animals, there are some literature that indicates there is a disparity between what some of these clients want and what veterinarians are providing. Hall et al. (2012) found that, whilst farmers and vets agree on the three primary functions of the vet on a farm, farmers were unaware of some of the services vets could offer. Also, while vets wanted to position themselves as ‘friend’ to the farmer, farmers tended to place value in having a proactive vet who could provide sound technical advice.

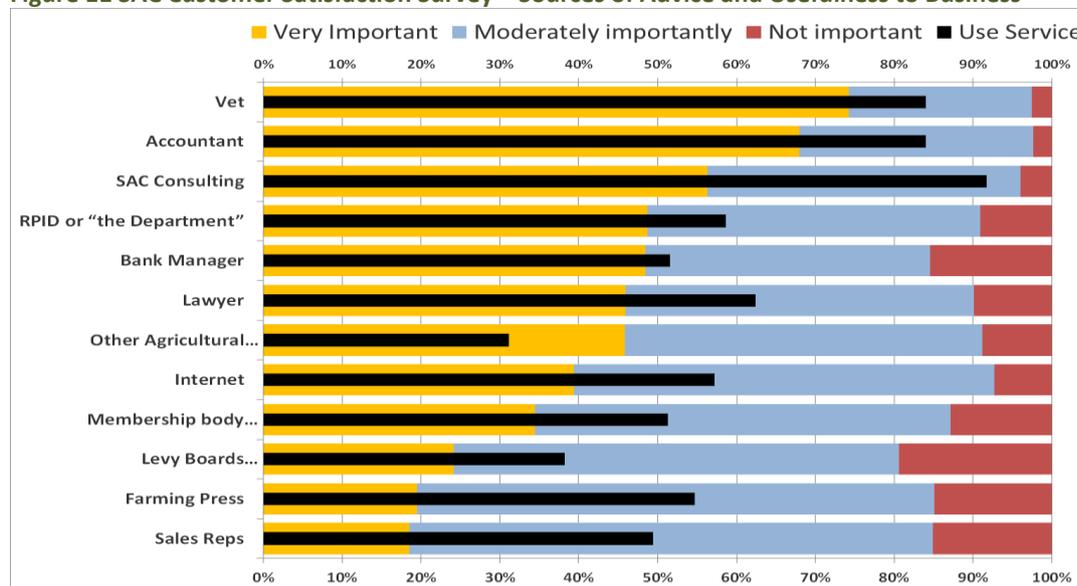
The veterinary profession in Scotland directly support the £1.77bn output generated annually from livestock and safeguard the £1bn of breeding livestock and £1bn of trading livestock in the country – from estimated **£64m agricultural expenditure on veterinary services a year** across Scotland.⁶ Thus for every £1 spent on veterinary services in Scotland farmers generate £26.52 in output or it can be seen to be safeguarding the health of £15 of breeding stock and £156 of trading stock.

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Research (Cresswell *et al*, 2014; Richens *et al*, 2015) demonstrate the important role that veterinary practices play in farmer decision making, particularly around advice on vaccinations, with 93% purchasing vaccines through their veterinary practices. In 2016 SAC Consulting undertook a customer satisfaction survey of 700 agricultural clients (unpublished) and the results corroborate the importance of vets as a source of advice and support to the Scottish farming industry. Figure 11 shows that in 2016 SAC Consulting farm and crofter clients (note that the use figure includes non-livestock farms) ranked the advice and support provided by vets above all other sources, revealing the close and trusted relationship that farmers and crofters have with their vet as a specialist resource to draw on.

In 2017 Biggar Economics in assessing the Economic Contribution of Scotland’s Rural College (unpublished) estimated that SRUC’s Premium Cattle Health Scheme⁷ and Premium Sheep and Goat Health Scheme added £13.7m GVA to the UK livestock sector in 2016, of which around £2.7m GVA was retained in Scotland.

Figure 11 SAC Customer Satisfaction Survey – Sources of Advice and Usefulness to Business



⁶ Figures use 5 year average 2012-2016. Source: (Scottish Government, 2017) .

⁷ Most of the value was in cattle and Biggar consulted with Cattle Health Certification Standards in deriving their estimates.

3.1 Impacts through animal disease control

The impacts of veterinary profession on farm animals in relation to improve health and productivity are categorised under three groups: i) prevention, control and treatment of diseases and animal welfare conditions; ii) health care activities costs; and iii) contribution to feed and pharmaceutical industries.

3.1.1 *Prevention, control and treatment of disease*

Veterinarians play a key role in combating farm animal diseases. Their activities are focused on prevention, control and treatment of diseases animals in both breeding and trading livestock.

This means that vet services impact on annual farm output as well as on the underlying balance sheet value of Scottish farmed animals. Among many items, the impact of the veterinary profession in combating livestock diseases depends on the type of diseases. Infections endemic and exotic livestock diseases impose substantial financial and social costs to farmers and rural communities. In this study diseases and welfare conditions of farm animals are categorised under three main categories of infectious, non-infectious and animal welfare problems.

3.1.1.1 *Infectious diseases*

Infectious diseases of livestock are categorised under three categories namely: endemic, exotic and zoonotic diseases. Existing information and published studies have been used to estimate the impacts and contribution of the veterinary profession to reduce the costs of the three categories of infectious diseases in Scotland.

Endemic diseases

The direct costs of 30 endemic diseases of livestock in Great Britain were previously estimated and reported indicating low, middle and high estimation for each disease (Bennett, 2003; Bennett and Ijpelaar, 2005). To have provide an estimate of the contribution of the veterinary profession in controlling endemic diseases, it was assumed under two scenarios that the veterinary profession was responsible for moving the farming industry from pervasive ('high') disease prevalence to either 'medium' or 'low' disease prevalence ('high to middle' and high to low' scenarios). From Bennett and Ijpelaar's data (adjusted based price index for 2016⁸) the cost difference associated with 'high' prevalence and 'medium' or 'low' disease prevalence in Scotland was then used to estimate an economic value for endemic disease control that is attributable to the veterinary profession. The proportion of GB livestock population in Scotland used for cattle, sheep, pig and poultry were: 18%, 20%, 6%, and 9% respectively. Figure 12 illustrates the estimated total farm level costs that may be saved as a result of the Scottish veterinary profession controlling endemic disease prevalence in 2016.

Whilst the potential avoided costs from disease outbreaks, and the size of the sectors were estimated it must be noted that it is **difficult to assess the attribution of value to vets**. Furthermore, **as the avoided costs are highly probabilistic they should not be summed to provide estimated of accumulated impacts**. They do however provide **indicative figures** for the significant role to be played in monitoring, preventing and controlling animal disease in Scotland and the scales of potential costs of outbreaks.

⁸ Bank of England: <https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator>

It should be noted that respiratory disease (pneumonia) of cattle was not as it was not covered in the reference studies used (Bennett, 2003; Bennett and Ijpelaar, 2005). However, pneumonia of calves in beef and dairy farms is known as a major cause of financial and productivity losses. It was estimated that pneumonia costs £43-84 per cow per year (Potter, 2007). Bazeley (2011) estimated the costs in a 350-cow dairy herd at £17,000 or £48 per cow (£54 per cow adjusted for figures in 2016). The costs were due to: 9% mortality rate in calves (benchmark is around 5%); reduced growth rates at 0.44 kg/day (benchmark target is 0.8 kg/day); and veterinary drug costs that were £3,180 for the herd, or £9 per cow.

Figure 12. Annual avoided costs (£m) from endemic diseases control by the Scottish veterinary profession under scenarios of reducing prevalence from ‘high to medium’ and from ‘high to low’ , 2016.

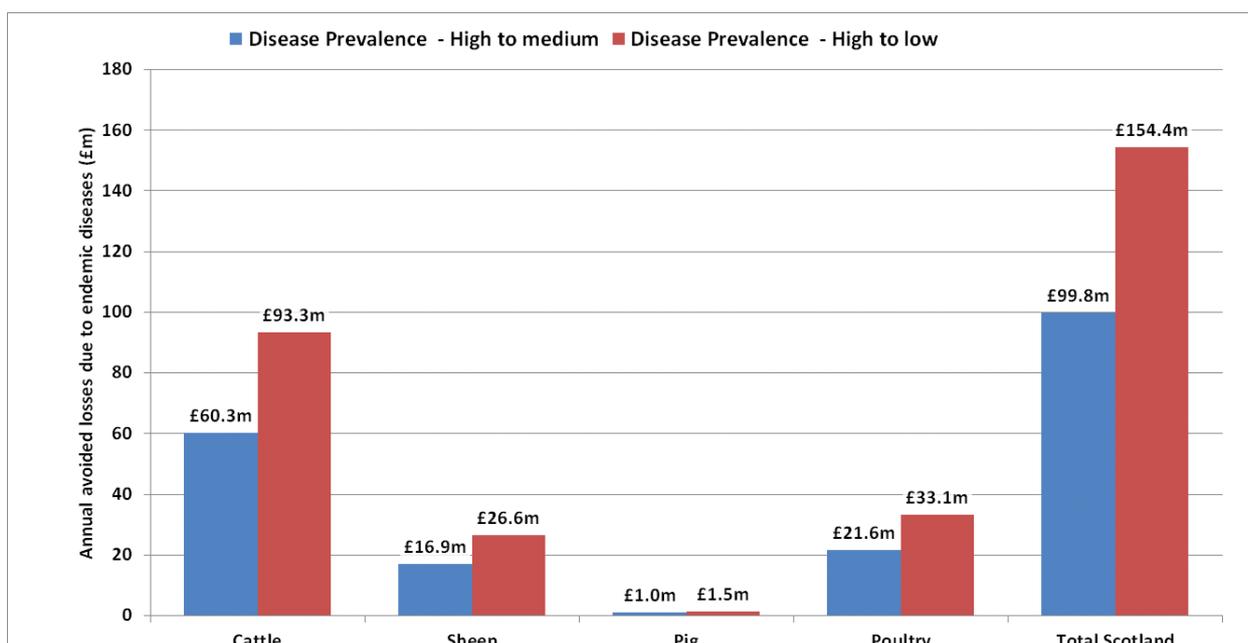


Table 7 presents details of the avoided costs attributed to Scottish vets from reducing individual disease prevalence to ‘medium’ or ‘low’ levels. Based on these estimations, the total annual avoided costs of endemic diseases due to veterinary services are estimated at average of **£127m** with a minimum of £100m and a maximum of £154m.

A preliminary economic assessment of the veterinary profession's value to Scotland

Table 7. Annualised estimated avoided cost of endemic diseases of farm animals in Scotland - based on original model of Bennett (2003); adapted and adjusted for the Scottish livestock population and for two scenarios of reducing disease prevalence from high to medium and from high to low.

Cattle			Sheep			Pig			Poultry		
Avoided cost (£m)			Avoided cost (£m)			Avoided cost (£m)			Avoided cost (£m)		
Disease	high to med	high to low	Disease	high to med	high to low	Disease	high to med	high to low	Disease	high to med	high to low
BVD-MD Complex	5.90	9.80	Acute Enzootic Pneumonia	0.99	2.33	Atrophic rhinitis	0.18	0.32	Coccidiosis	0.22	0.54
E. Coli	1.85	2.87	Blow fly strike	0.12	0.21	Enteric disease	0.19	0.30	Infectious Bronchitis	5.44	7.77
Enteric disease	0.44	1.02	Enzootic abortion	7.29	11.03	Streptococcus suis type II meningitis	0.12	0.12	Infectious Bursal Diseases	0.27	0.37
Fascioliasis	4.79	7.68	Maedi-Visna	0.63	1.05	Swine dysentery	0.12	0.18	Marek's Disease	0.04	0.08
IBK	1.88	3.32	Orf	5.47	7.53	Swine influenza	0.36	0.55	Salmonellosis	15.25	23.58
IBR	0.26	0.50	Scrapie	0.09	0.18				Skeletal Problems	0.38	0.80
Lameness	14.65	20.76	Pulmonary Adenomatosis	0.15	0.24						
Leptospirosis	3.76	5.34	Toxoplasmosis	2.21	4.00						
Mastitis	17.85	29.58									
Parasitic bronchitis	2.00	3.33									
Paratuberculosis	2.54	2.66									
Pasteurellosis	0.15	0.20									
Salmonellosis	2.82	4.02									
Summer mastitis	1.45	2.20									
Total	60.33	93.28		16.94	26.57		0.96	1.46		21.60	33.14

Exotic diseases

The avoided costs due to exotic diseases were estimated for three diseases namely: foot and mouth disease (FMD), bluetongue (BTV) and avian influenza (AI) based on the observed prevalence and costs of previous outbreaks and assumed anticipated outbreak frequency. The total avoided costs due to the three mentioned exotic diseases are estimated at **£135m**. The assumptions and avoided costs estimations are described below.

- *FMD*

Details of direct and indirect costs of FMD 2001 outbreak in the UK have previously been reported (Thompson et al., 2002). It was estimated that the economic effect of FMD outbreak on the agricultural industries of Scotland was £85m with compensation costs of £419m, tourism losses of £437m and indirect losses of £311m. In this study a proportion of the UK overall costs arising from the 2001 outbreak were allocated for Scotland (based on livestock proportions). These costs were then adjusted for inflation using 2001 and 2016 price index. It was then assumed that the frequency of FMD outbreaks follows a triangular distribution with an annual probability of an outbreak of 2% (i.e. a one in 50 year event); most likely 5% (one in 20 year event); max 10% (one in 10 years). Therefore the total annualised cost avoidance resulting from veterinary intervention was estimated by adjusted the estimated costs by the simulated probability. On that basis it is estimated that by **preventing a major outbreak of FMD (similar to 2001) the estimated avoided costs to the Scottish economy are about £107m**.

Table 8. Details of the estimated costs of an outbreak of FMD for the Scottish economy (Thompson et al (2002) adjusted for the proportion of costs in Scotland and for inflation).

Cost Item	Estimated annual avoided costs due to FMD (£m)		
	UK 2001	Scotland 2001	Scotland 2016
Direct agricultural loss	525	85	128
Compensation by government	2,585	419	631
Tourism	2,700	437	659
Indirect agricultural loss	85	14	21
Indirect tourism loss	1,835	297	448
Total	7,730	1,252	1,885
Annual estimated avoided cost of outbreak (1 in 18 years outbreak)			107

- *BTV*

The total avoided costs of a bluetongue outbreak in Scotland in a five year period was previously estimated at £344m in 2008 (Fofana et al., 2016). This equates to **an annual cost of £84m in 2016** (adjusted for inflation) if there had been an outbreak. Assuming an annual outbreak probability follows a triangular distribution with the values of minimum 5% (i.e. a one in 20 year event); most likely 10% (one in 10 year event); maximum 20% (one in five years), the total annual **avoided costs due to BTV is estimated at £9.88m**.

- *AI*

The majority of the cases of Avian Influenza in captive birds in Scotland have been Low Pathogenicity of the disease. However outbreaks of highly pathogenic avian influenza (HPAI) could be expected. The benefit of the Scottish economy of preventing outbreaks of HPAI was estimated based on the direct costs observed and reported from the Netherlands for the outbreak of 2003 (Meuwissen, 2006). The cost of outbreak of 2003 was estimated at €250m or £220m⁹. This was then adjusted for inflation to get £319m for 2016 prices. The Scottish poultry sector in 2013 was approximately 9% of the UK flock and using the EU Parliament data (European Parliament, 2010) the Netherlands poultry sector was estimated to be three-quarters the size of the UK. Given Scotland accounts for 9% of the UK flock that means attribution of avoided costs should be in the region of 12% of the Netherlands costs (cost of outbreak of £38m in 2016). Assuming an annual outbreak probability follows a triangular distribution with values of 2% (i.e. a one in 50 year event); most likely 5% (one in 20 year event); max 10% (one in 10 years), **the annual avoided costs of a disease outbreak is estimated to be £2.2m** assuming that the size of the outbreak and the damage are identical to the reference outbreak in the Netherlands.

Zoonotic diseases

Annual avoided costs caused by four zoonotic diseases namely BSE, salmonella, campylobacter and *E.coli* O157 was calculated. The total estimated annual avoided costs for the four mentioned diseases were **£96m**. The details of calculations are presented below.

- *BSE*

The national BSE enquiry reported that the total cost of BSE outbreaks in the Great Britain was estimated at £3.7bn in 2001 or £5.6bn in 2016 adjusted for inflation (Phillips et al., 2000). Assuming these costs are proportionate to the population of cattle in the country, this figure is translated to £1bn in Scotland (18% of the GB cattle herd in Scotland). Assuming an annual outbreak probability follows a triangular distribution with values of minimum 2%, most likely 5% and maximum 10%, the **annual avoided costs of a BSE outbreak is estimated at £58m**.

- *Salmonella*

The costs of salmonella for the Scottish economy in 1985 was estimated at £5.5m (Yule et al., 1988) that equals to £15.4m in 2016 adjusted for inflation. Assuming an outbreak of the disease follows a triangular distribution with the values of minimum 10%, most likely 20% and maximum of 100%, the **annual avoided costs is estimated at £6.6m**.

- *Campylobacter*

It was previously estimated that campylobacter infection cost the UK economy over £113m in 2000 (ACMSF, 2005). This equals to £172m in 2016 adjusted for inflation. The number of human cases in Scotland was reported at 6,246 (NHS, 2016). The proportion of human cases in Scotland to the cases in the UK was estimated at 11%. Using this information, the **annual avoided costs due to campylobacter in Scotland is estimated to be £19m**.

⁹ Exchange rate used to convert Euro to Sterling 0.88.

- *E.coli* O157

The burden of human infections with *E.coli* O157 was previously estimated at £11m in 2011 (Low et al., 2011). This equates to £12.3m in terms of annual avoided costs of a Scottish *E.coli* outbreak in 2016.

3.1.1.2 Non-infectious diseases and welfare

The total costs to the agricultural industry due to non-infectious diseases and welfare issues were also considered in this study (please note that this is not an exhaustive list). Whilst not expressing an aggregated veterinary impact figure they provide indicative figures for the potential impact from veterinary intervention for a number of animal diseases / conditions. It is acknowledged that disease control and treatment is not wholly attributable to the veterinary profession, rather a partnership between research, farmers, vets, veterinary medicine suppliers, etc. Disaggregating the impact of vets is extremely difficult and outwith the remit of this study.

Metabolic diseases

Veterinarians play a pivotal role in preventing and treatment of metabolic disorders. Hypocalcaemia, retained placenta, ketosis and left displaced abomasum are few examples of metabolic conditions in dairy cattle. The costs of each of these conditions are estimated at: £138, £157, £115 and £237 per case respectively (adjusted for inflation and exchange rate based on reported figures by Guard, C. 1998 reported by Warren, 2016). Assuming 1.5% of the Scottish dairy herd are annually affected by these conditions (i.e. 2,636 cases per year) the total industry costs (lost revenue). Vets work closely with farmers to minimise instances of these metabolic diseases.

Reproduction conditions

Stott et al., (2008) reported that improving reproduction performance of the suckler cow herd in Scotland could improve the profitability of these animals by £64 per cow in 2003, or £93 in 2016. Assuming 41% of breeding herds are affected by infertility problems (Stott et al., 2008) and a within herd infertility rate of 5%, the estimated potential benefit associated with veterinary intervention on suckler cow reproduction is **£1m**. Langford and Stott, (2012) estimated that Improving reproduction performance in dairy cattle could improve profitability by £33 per cow in 2011, £37 per cow in 2016 prices. Assuming an infertility rate of 20% in dairy herds, estimated potential benefit associated with veterinary intervention on dairy cow reproduction is **£1.3m**.

3.1.1.3 Animal welfare

The role of veterinarians in improving the level of animal welfare in farm animals is crucial. Lameness and mastitis that are considered as two main animal welfare problems in dairy cow were included under the endemic diseases in the current study. Amongst the many animal welfare conditions across farm animal species, the study examined three main diseases of sheep that have substantial animal welfare implications. The economic cost of gastrointestinal parasites infestation, footrot and sheep scab in the Scottish sheep herd were reported at £84m, £24m and £8m respectively in 2005 (Nieuwhof, and Bishop, 2005). Adjusted for price inflation these are equal to £115m, £33m and £11m respectively. Assuming a 10% improvement could be achieved as a result of veterinary interventions and advice, the **expected annual benefit from future veterinary interventions could exceed £16m**.

3.1.2 *Summary of impacts on farm animal sector*

There is a wide range of animal disease, prevention control and treatment, pharmaceutical sales and advice and feed industry monitoring and rationing advice that Scottish veterinarians provide. Whilst this section has aimed to highlight the avoided costs from stopping disease outbreaks, and the size of the sector it is (a) difficult to assess the contribution of vets and (b) as the avoided costs are highly probabilistic they should not be added to provided accumulated impacts. They do however provide indicative figures for the significant role to be played in monitoring, preventing and controlling animal disease in Scotland and the scales of potential costs of outbreaks.

The role of veterinarians in the UK and in Scotland may become more important with the UK Government's possible drive toward supporting public goods post Brexit that will include animal health and welfare. For example veterinary surgeons negotiate, draft and uphold necessary legislation and international standards. By carrying out surveillance and enforcement from farm-to-fork, official veterinarians certify the trade in animals and animal products thus contributing to economic prosperity and the sustainability of food production. The future of the UK agri-food production post Brexit is therefore of great interest and importance to the veterinary profession (BVA, 2017).

3.2 Impacts through companion animals

The contribution of veterinary profession to the economy of Scotland through domestic pets can be viewed under three main categories namely: i) health and well-being of pet animals, ii) impact on health and well-being of pet owners, and iii) direct and indirect contributions to the related industries such as pet food, pharmaceuticals, accessories and insurance. In relation to contribution of veterinarians to the well-being of pet animals and their owners, there are some literature that indicates there is a disparity between what some of these clients want and what veterinarians are providing. Similar to observation of Hall et al. (2012) who found that, farmers were unaware of some of the services vets could offer, significant differences have been identified between the attributes of 'a good vet' most valued by pet owners and those considered important by vets themselves (Mellanby et al., 2011).

3.2.1 *Wellbeing of owners*

LaFayette and Buser (2017) highlight that "*animals convey a wide variety of physical, behavioural, mental, psychological and social benefits....among these are the therapeutic value of owning and caring for pets.*" Hodgson and Darling (2011) dubbed the human health benefits derived from animal interactions as 'zoeyia', contributing to the 'One Health' concept. These benefits reportedly include lower blood pressure, alleviation of depression, and improvements in patients suffering from severe mental and emotional conditions, including schizophrenia, psychosis, autism, and post-traumatic stress syndrome (LaFayette and Buser, 2017). Hall et al. (2016) estimated that direct and indirect costs and benefits of companion animals to the UK economy in relation to health and well-being on human owners. They calculated that the total benefit or avoidable costs to the National Health Service (NHS) through reduced number of doctor visits and other health benefits was around £2.5bn per year in 2013 for the UK. Adjusting this for the proportion of human population in Scotland (8%) to the UK population, the **total health benefit of pets for the economy in Scotland is estimated at £209m**. Undoubtedly health services provided by pet animals' veterinary profession play a key role in delivering this positive contribution. It is likely that the health of animals contributes to this health care benefit meaning that some of this benefit is likely attributable to the veterinary profession.

3.2.2 *Pet insurance and accessories*

It is estimated by the Association of British Insurers (ABI) (ABI, 2017) that the UK pet population stands at around 57 million, with an estimated 40% of households owning a pet. Despite the vast majority of pet owners not insuring their pets, the ABI report that the UK pet insurance industry paid out a record **£706m** in claims in 2016 (estimated at £57m in Scotland). Over 900,000 claims were made in the UK, with 708,000 claims for dogs alone - paying out **£544m (estimated at £44m in Scotland)**, and 193,000 claims for cats, worth £112 million **(estimated at £0.9m in Scotland)**.

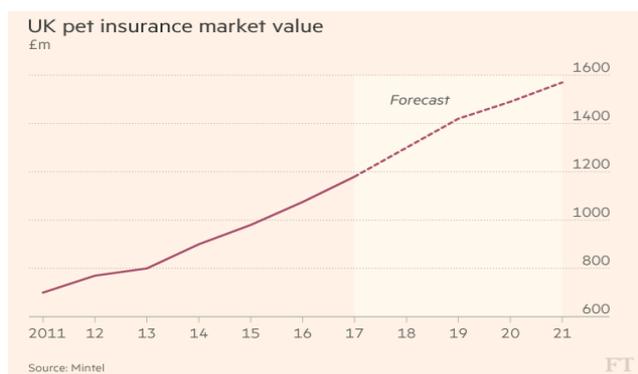


Figure 13 UK pet insurance market value (source: FT, 2017)

The ABI suggest that the 3.5% increase in Insurance Premium Tax in 2016 would cost pet owners some £31m suggests that pet insurance premiums totalled over £885m in 2016 (ABI, 2016) (estimated at £71m in Scotland). Mintel report that the UK market is expected to grow from £976m in 2015 to £1.6bn by 2021 (FT, 2017). It should be acknowledged that the insurance also covers non-veterinary expenses such as third party liability, replacement cost, advertising costs, pet care in case of hospitalisation holiday cancellation, etc. Thus, the full cost of insurance claims cannot be attributed to the veterinary profession.

3.3 Impacts through the equine sector

Mayes (2015) reported that of the UK's 19,000 practicing veterinarians that **around 10% are equine vets with about 300 equine practices, estimated to be turning over £300m per annum**. These service the 1 million horses and ponies in the UK in an industry that has an economic impact of over £7bn and employs about 250,000 people (half the employment is in horse racing). Mayes (2015) estimates that 15% of equine veterinary services are specifically associated with horse racing, but the market is diverse and thriving through increased participation in dressage, show jumping and eventing.

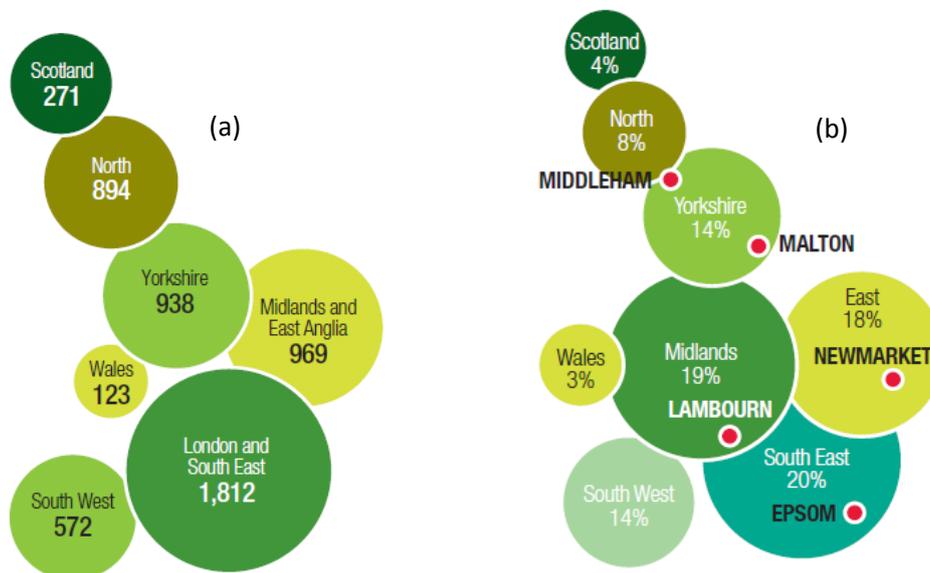
TBA (2014) estimated that the British Thoroughbred Breeding Industry directly contributed £65m GVA to the UK economy (and a further £216m indirect and induced GVA impact) and was directly responsible for 3,546 jobs (and a further 6,454 indirect and induced jobs). They estimated that **13% of the £172m direct, non-staff expenditure incurred by the industry was on veterinary and farrier services (£22.6m)**, with 7% on insurance. Moreover, Deloitte (2013) estimated that the UK horse racing industry spent some £90m on veterinary and farrier fees.

According to the British Equestrian Trade Association's (BETA) National Equestrian Survey 2015 (BETA, 2015), the UK equestrian market was worth £4.4bn in 2016 (adjusted for price inflation). In addition, BETA estimated that an additional value of £4.2bn from racing and £700m from other equestrian events are annually generated that produces a total annual value of £9,200m in 2016 (figures from Micoud et al., 2015 adjusted for price inflation). Assuming Scotland has 13%¹⁰ of the UK

¹⁰ Proportion was calculated based on registered horses on agricultural holdings in Scotland and the UK

horse population¹¹, it is estimated that the total value of the horse industry in Scotland is £1.2bn that consists: £583m market value, £554m generated from racing, and £90m generated from other events.

Figure 14. (a) Attendances of racecourses (to nearest '000) and (b) proportion of trainers by region: 2012



Source: RCA; Deloitte analysis.

Source: Deloitte 2013.

“British Racing continues to play a leading role in the **advancement of equine veterinary research** and techniques which brings benefits for the wider horse population in Britain, not just racehorses. A key role is played by the **Levy Board Veterinary Advisory Committee**, which advises on matters related to the advancement of veterinary science and education by recommending investment in priority areas, identified in consultation with the racing and breeding industries. The Levy Board awards funding grants for equine veterinary research projects based on these recommendations. **In the last decade the Levy Board has invested over £20m in veterinary activities, including research and education.**” *Deloitte 2013*

3.4 Veterinary Pharmaceuticals

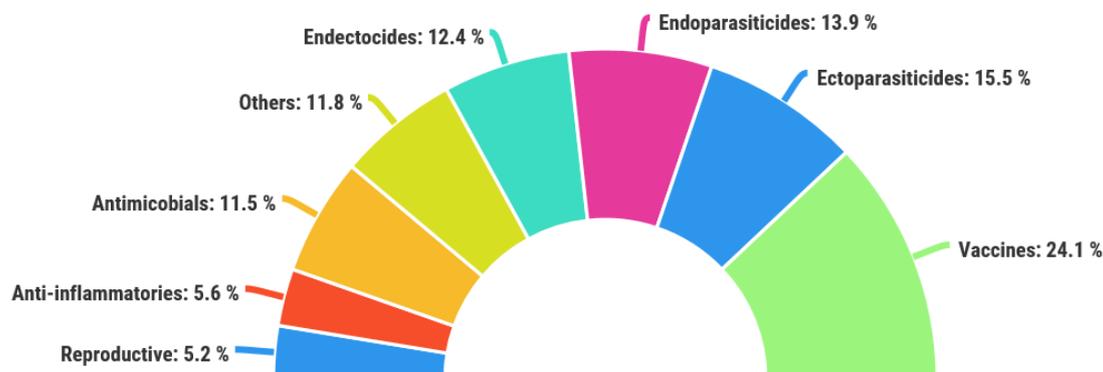
The UK is a net exporter (£2.8bn positive trade balance of) of pharmaceutical products (both for human and veterinary usage) with the rest of the world (EFPIA, 2017). The value of the UK authorised veterinary medicine market is estimated at £700m (NOAH, 2018). Many of these medicines are prescribed and sold through veterinary practices. Assuming 42% percent of the pharmaceutical sales are related to farm animals (NOAH, 2018), and adjusting this figure for the Scotland's livestock (circa 20% of the UK total), the value of the pharmaceutical sales in Scotland for

¹¹ This is slightly lower than the 16.7% attribution to Scotland of UK equine impact by Horse Scotland (HorseScotland, 2012)

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farm animals is estimated at **£59m** per year. Assuming Scotland has 8% of the UK population then it is estimated that the pet medicine sector is worth around **£33m** per year in Scotland.

Figure 15 UK market by product type for the 12 months to end of Quarter 1, 2017



Source: NOAH, 2018.

3.5 Impacts through public health, hygiene and surveillance

3.5.1 One Health

LaFayette and Buser (2017) highlighted that with a wider variety of illnesses common to animals and humans, veterinarians are providing important insights into the symptoms, and treatments, of a wide variety of conditions – a One Health approach. They suggest that “*estimates of the share of emerging and re-emerging infectious diseases that adhere to the zoonosis pattern are as high as 70 percent of all diseases.*” This includes diseases such as Avian Influenza, rabies, Lyme disease, porcine flue, etc.

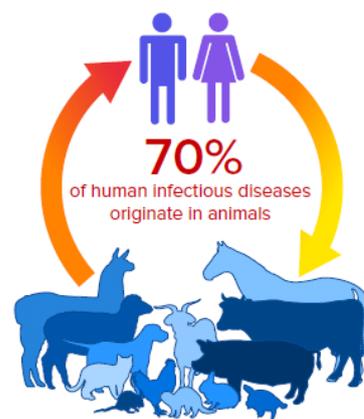
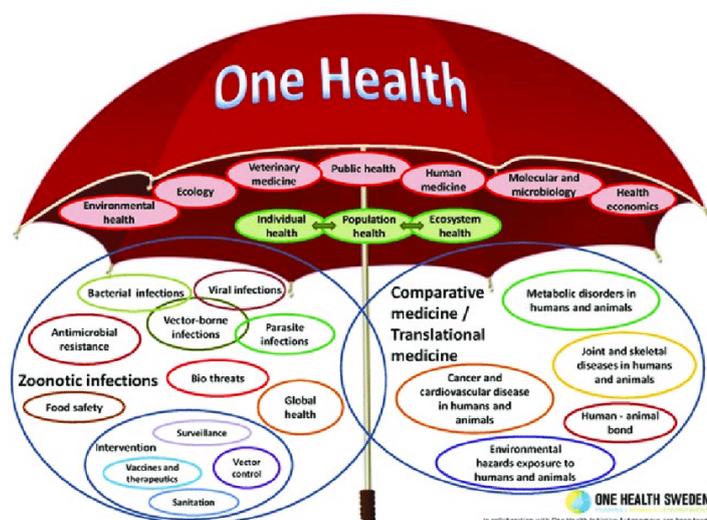


Figure 16 The One Health umbrella (Cassidy, 2018).



As veterinarians routinely observe and treat these diseases in a wide variety of animal species they have often adopted diagnostic methods and treatments that may be applicable to human disease interventions, thereby improving the effectiveness and cost of human treatments. There is growing recognition of the social and economic impacts that this One Health approach (Queenan et al., 2017) to human medicine can play globally, thereby extending the benefits to society of the veterinary profession.

3.5.2 *Abattoir and meat inspection*

The veterinary profession plays a pivotal role in the Scottish meat sector, ensuring the quality of the product going to market. The total cost of meat hygiene inspections (MHI) and official veterinarians (OV) and was reported by the Food Standards Scotland at **£5.9m** in 2016 (Food Standards Scotland, 2016a).

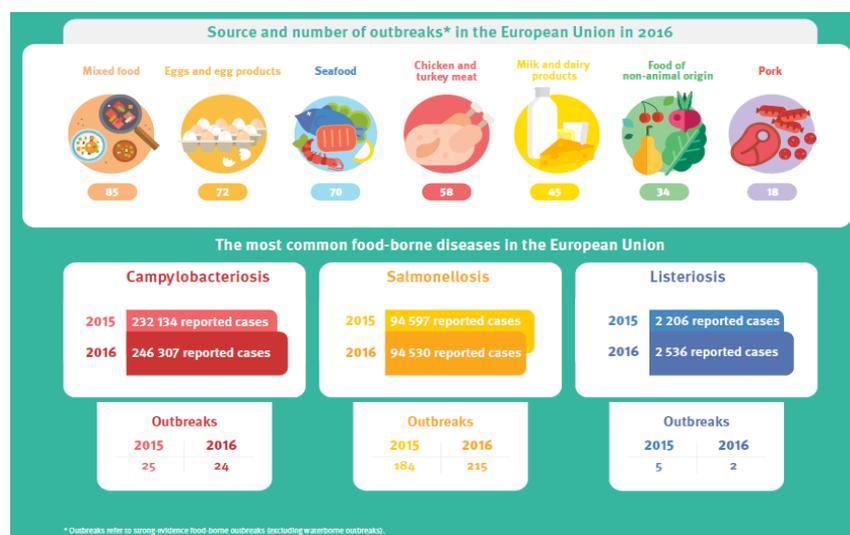
Table 9 Industry official controls hourly rates 2017/18 (Food Standards Scotland, 2017)

	MHI	OV	Total
Direct Costs	3,086,026	2,044,771	5,130,797
Indirect Costs	422,147	176,568	598,715
Total Costs	3,508,173	2,221,340	5,729,512
Official Control Hours	119,332	49,912	166,914
Charge rate before discount	£29.40	£44.51	

3.5.3 *Food-safety*

The total budget allocated to food safety by the Food Standards Scotland in 2016/17 was reported at £15.3m (Food Standards Scotland, 2016b). Assuming 3%¹² of the spending in food safety activities was related to the veterinary profession, the value spent on directly on veterinary expertise was **£0.4m**. Figure 17 shows the incidence of the three most common food-borne diseases in the European Union (EFSA, 2017).

Figure 17. Most common food borne diseases in the EU, 2016.



In addition to food-borne diseases as food-safety hazards, anti-microbial resistance (AMR) is considered as an emerging important grand global challenge. AMR is the quintessential ‘One Health’ challenge with the problem of careless use of antimicrobial (AM). In livestock, AMs are used for preventative and therapeutic purposes, but some evidence suggests that they are largely used in response to poor health/biosecurity. AMR is a multifaceted problem covering livestock systems, environment, plants, ecosystems and humans. Veterinary profession already plays a very crucial role in tackling this global challenge. However, as concerns over AMR become greater there may be an increased responsibility on veterinaries in sales of and applications of AMs. A recent rapid evidence assessment (Hockenhuil et al., 2017) found that “Just over half (53 per cent) of 71 English and Welsh dairy farmers responding to a survey reported knowledge of the Responsible Use of Medicines in Agriculture Alliance’s guidelines for use of AMs in cattle production in the UK, and 30 per cent were not aware of concerns over the use of third- and fourth-generation cephalosporins. Furthermore, 20 per cent of these farmers admitted that they do not always complete a full course of AMs as prescribed”. Jones, et al. (2015) found that veterinarians were cited as farmers’ most trusted information source in the UK.

¹² Proportion of veterinary staff to total number of staff (208/7,530; Food Standards Scotland, 2016b)

3.5.4 *Surveillance and diagnosis activities*

The Scottish Government spends approximately £4 million per year on its Veterinary Services programme, delivered by SRUC (Scottish Government, 2011). This specifically supports livestock disease surveillance and animal health planning and welfare activities (including supporting SRUC's eight Disease Surveillance Centres (DSCs) where diagnostic services are conducted on submitted samples to provide information on the current health and disease status of Scottish farmed livestock - a statutory requirement for the Scottish Government). Clients also pay privately for some SAC consulting diagnostic services (circa £1.3 million revenue, including through health schemes Kenyon (2015)). In 2016/17 the Scottish Government funded activities included diagnostic tests on 5,475 farmed animal carcasses and over 93,000 submissions of blood, faeces, swabs and other materials from veterinary surgeons in practice (this includes diagnostic work undertaken for of SAC Consulting through contract by the Moredun Research Institute). Information on disease and disease trends is captured for Scottish stakeholders and is also added to data from APHA laboratories and approved contractors in England and Wales to provide the picture for Great Britain. In 2016/17 this work included direct veterinary research (lab work) and support an extensive array of topics, such as: porcine epidemic diarrhoea virus; joint-ill; cattle abortion due to *Bacillus licheniformis*; liver fluke; bird flu; a new *Salmonella* strain causing abortions in sheep; *Haemonchus contortus* worm in sheep); antimicrobial resistance in livestock; Continual Professional Development for vets; development of the Scottish Animal Health Planning System; bee health improvement; wild bird disease surveillance SAC Consulting (2017). Kenyon (2015) reported that this surveillance and diagnostic work was undertaken by 144 staff, comprising 25 vets, 4 consultants, 57 scientists, 28 support staff and 30 admin staff.

In addition to the Scottish Government sponsored diagnostic services, the Moredun Research Institute run a commercial Virus Surveillance Unit¹³ and Pathology Unit¹⁴ to help improve understanding of animal disease and pathogens, and developing diagnostic tools and control mechanisms. This scientific work (overseen by veterinarians) is backed up with an extensive outreach programme, particularly to farmers and vets¹⁵.

4. Other impacts

It is evident that there is a very wide list of social and economic impacts that are related to the veterinary profession that this small project has been unable to investigate. A comprehensive study should investigate these indirect impacts, where a proportion is attributable to the veterinary profession, or at least the farmed livestock sector, the companion animal sector and the equine sector. Some of these impacts may relate to: : social impacts on rural communities; impact on protecting and enhancing the quality of the environment and ecosystems, impact on wild life preservation; impacts on recreation and tourism expenditure (particularly noticeable after the 2001 FMD outbreak); and impact on and contribution to education, research and policy.

¹³ <https://www.moredun.org.uk/research/surveillance/virus-surveillance-unit>

¹⁴ <https://www.moredun.org.uk/research/surveillance/pathology-unit>

¹⁵ <https://www.moredun.org.uk/foundation/outreach/livestock-health-roadshow>

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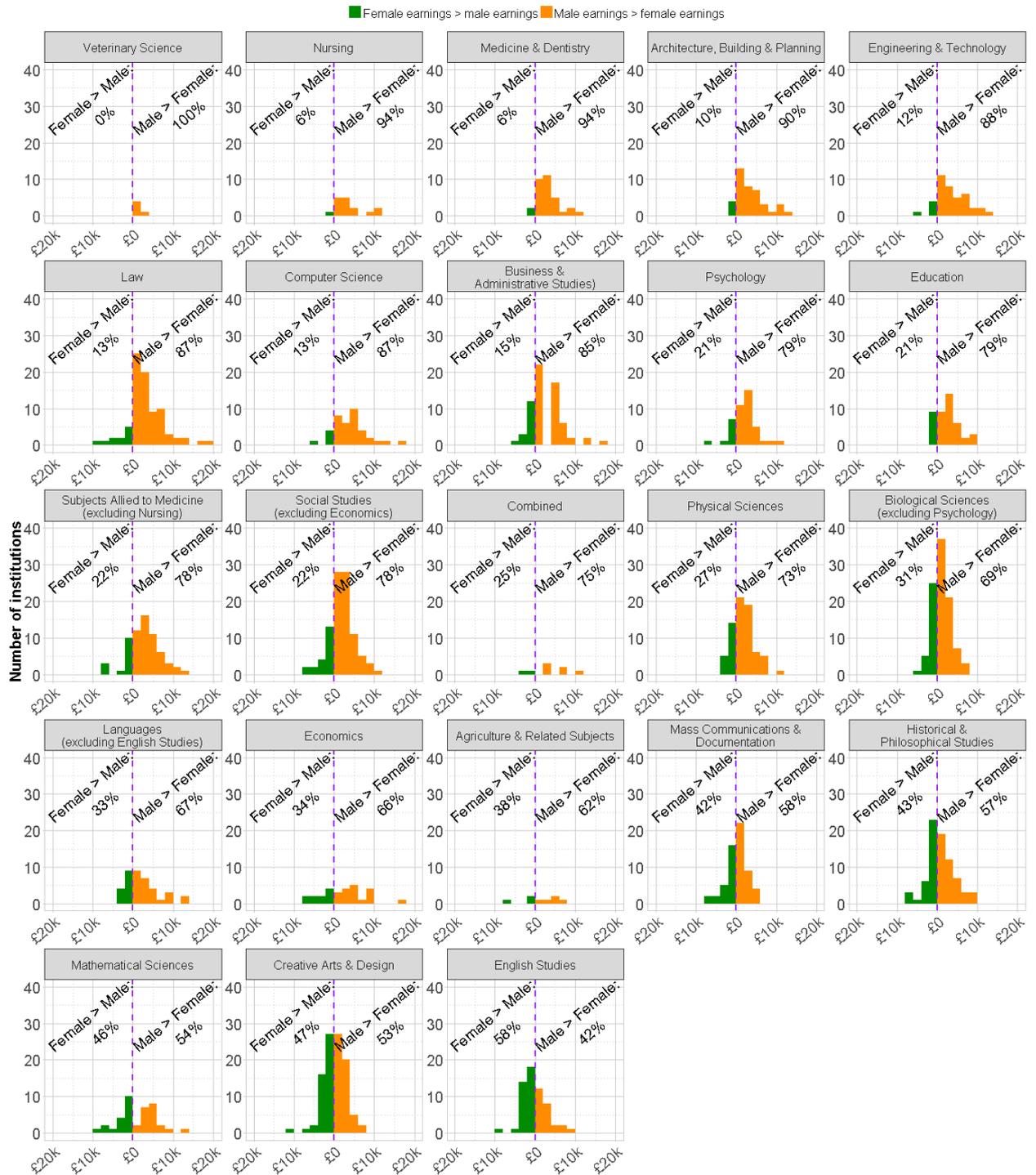
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Appendix 1

Gender Pay Gap 5 Years After Graduation:





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