

Viewpoint

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The multimarket model of the veterinary industry

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ABSTRACT

Within this article, a graphical discussion of the veterinary industry is constructed and discussed. This viewpoint centers around the 4 main markets that operate in veterinary medicine: the market for veterinary education, the market for veterinarians, the market for animals, and the market for veterinary services. Moreover, how each market within veterinary medicine is interconnected is the important point of the article. The purpose of the article is to provide a mechanism for discussion on how changes in one market will affect other markets. From this view, I argue that the market for veterinary services is completely dependent on the other 3 markets in terms of defining supply, demand, and market equilibrium. The remainder of the article discusses how to use the multimarket graphical model to aid in discussions around policy changes and provides an example. Some concluding remarks about this view on the interconnectedness of markets within the industry are provided. Again, the intended purpose of this viewpoint is to provide a graphical understanding of the multimarket nature of the industry and a way to discuss any proposed changes to a market based on literature that empirically estimates many aspects of these various markets. I highly encourage any proposed changes to the industry be supported by mathematical/statistical modeling, but the graphical model can aid in a conceptual understanding of those same changes.

Often the veterinary industry is discussed as a singular market that operates around veterinarians and veterinary clinics and the animals they serve. The reality is that there are many markets that comprise the industry. How we arrive at the exchange of veterinary services relies on the functioning of several other markets. It is important to understand the interconnected nature of the markets to discuss the prominent issues facing veterinary medicine today. This discussion is centered around characterizing the 4 distinct markets that comprise veterinary medicine. I will describe each market, the functioning of each, and how they are all connected. While I discuss the markets in the context of companion animals, the structure is much the same for other areas (food/farm animals, equine, public health, zoo animal, etc) of veterinary medicine with some slight modifications. I will briefly mention these throughout the article. While I attempt to detail the multimarket model of veterinary medicine, there are many other facets to each market and the industry as a whole that I will undoubtedly fail to mention. The ultimate goal of this article is to allow for a cohesive understanding of how changes in one market will cause other markets to adjust. Further, this article only provides a graphical examination of the problem (rather than

a mathematical examination) to enhance general understanding of the concepts.

A graphical view of markets is especially useful as it allows for a conceptual understanding of policy and workforce analysis, forecasting, and shifts in demand. While precise estimates of changes from such “shocks” to the markets is left to the mathematical derivations, a graphical examination helps to understand the general direction of changes and the resulting changes in connected markets. If we assume that a change in workforce or demand only affects 1 market, we are likely to have unexpected consequences that could be detrimental to the industry. So, the graphical representation of the markets aids in the discussion around potential changes to one sector and allows us to follow the path of cause and effect across all markets.

It is key to remember that this depiction of the multimarket model of veterinary medicine is a simplified version of how the industry operates. These graphs, obviously, do not cover all the nuances of the problem nor the complex decision-making those individuals within each market encounter. However, the goal of presenting these graphs is to help aid in the many discussions occurring about the veterinary workforce. There are many discussions about pos-

sible shortages within veterinary medicine. Burnout continues to increase turnover and reduce working hours for many veterinarians. There are several new veterinary programs being established, and existing programs have or are considering expanding class sizes. All these issues should be discussed, but it is imperative to discuss the issues and the impacts on the entirety of the industry, not just the independent markets. It is also important to note that each market is discussed as a fixed point in time. In other words, for a given year these are how the markets interact and look. From year to year, there will be changes.

Supply-Side Markets

As in all markets, there are 2 sides that are typically discussed—supply and demand. Here I start with the markets, which within themselves also have supply and demand, that determine the supply side of the veterinary services market. Starting on the supply side, 2 markets need discussing. The first is the market for veterinary education, and the second is the actual market for veterinarians. Again, each of these has its own supply and demand—represented as curves and lines in graphs—but these 2 markets interact to form the basis of supply in the market for veterinary services.

The market for veterinary education

As with most other professional service degree programs, the education market for veterinary medicine is often characterized by the ratio of applicants to seats.¹ This ratio is, in essence, a supply-and-demand ratio. However, before we discuss this ratio it is important to discuss the other 2 factors that provide the basis of all market graphs—prices and quantities. Prices and quantities, which are reflected respectively on the y- and x-axes of a graph, are important in determining the amount of supply and demand in a given scenario. More importantly, they help to determine where supply and demand intersect, which gives us an equilibrium point. In the case of veterinary education, price is measured as the cost to obtain a DVM, while quantity is the number of applicants/students. It would also be reasonable to assume that this education/workforce framework could be applied to veterinary technicians. However, I present this from the veterinarian view, as they are the primary providers of care for animals.

Demand within this market is perceived to be downward sloping, which means that as the cost of obtaining a DVM declines, there will be an increase in the number of applicants. It is important to note that all markets are dynamic. Therefore, the simplistic statement that there will be less demand if the cost of education rises may only be true in the short term. Factors such as family income rising, better access to low-interest educational loans, the role of pets

in the household, the need for food/farm animals along with higher food safety standards, and other outside factors will cause demand to change in the long term.² Note that a downward-sloping demand curve only suggests that if the cost of obtaining a DVM were cheaper, then there would be a larger number of applicants.

On the supply side, the quantity is measured as number of available seats. The supply (**Figure 1a**) is fixed in the short term, as there are only so many schools and seats available in a given year. In the medium to long term, the supply of seats can adjust as new schools are started and/or existing schools add seats. In other words, seats can be added. It is important to note that international schools also offer admission to

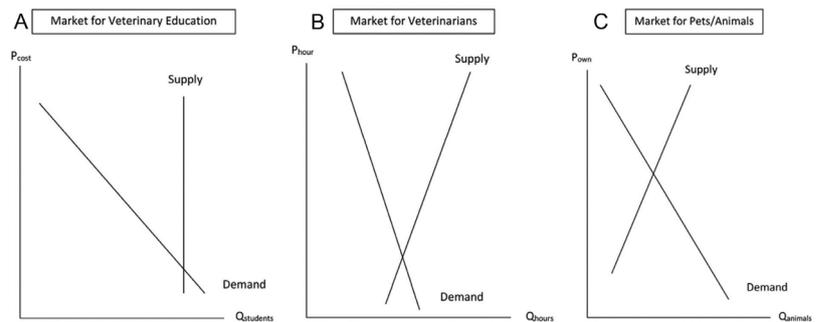


Figure 1—(A)—Graphical representation of the market for veterinary education. P_{cost} = Cost of veterinary education. Q_{students} = Quantity of students. (B)—Graphical representation of the market for veterinarians. P_{hour} = Hourly wage (wage equivalent) paid to veterinarians. Q_{hours} = Quantity of hours. (C)—Graphical representation of the market for pets/animals. P_{own} = Cost of owning an animal. Q_{animals} = Quantity of animals.

students who then return to the US to practice, but also have fixed capacity in facilities.³ The bottom line is that the market for veterinary education is predominately characterized by the fixed supply curve.

Because supply is generally fixed in the short term, the equilibrium point—where supply and demand intersect—is fixed at a certain quantity and price. However, if the cost of education is above the equilibrium, then there would be a surplus of seats (more applicants than seats), while a price below the equilibrium would indicate a shortage of seats to meet demand. Since there are always more applicants than seats⁴ (and assuming they are all deemed qualified), then there may be a shortage of seats even though the price increases. But the assumption of all applicants being qualified is likely too strong, and only a portion of them are qualified.

The market for veterinarians

Perhaps one of the more discussed pieces of the veterinary industry—especially among employers of clinicians—is the market for veterinarians. Often this market is discussed in terms of job openings, number of veterinarians working across the country, and number of people looking for jobs. To characterize this market, it is important to define how price and quantity are measured. We often think that quantity in this market is measured as number of veterinarians or jobs available. However, labor markets are

better described in terms of hours demanded and supplied.⁵ This more accurately represents the flexibility of how veterinarians spend their time. Within this market, “price” represents the earnings per hour worked. In other words, it is the price a veterinarian is willing to receive to work an additional hour versus spending that hour doing anything else. A graphical depiction of this market is presented in (Figure 1b).

From the demand perspective, clinic and hospital owners offer jobs to work a specified (average) number of hours. For food/farm animal sectors, this could involve increased demand from dairy farms and feedlots expanding their herd and in need of a full-time veterinarian. Some job postings are temporary or for relief veterinarians, but far fewer are in demand from clinics and hospitals because they tend to pay a higher wage. So, on the aggregate/industry level, there are a larger number of businesses that demand 60-hour work weeks at \$40/h than the number of businesses that demand the same working hours at \$50/h. Thus, there is a downward-sloping demand curve. Demand for aggregate veterinary work hours can shift if there are increases or decreases in the number of veterinary businesses. However, veterinary businesses becoming busier would cause a rotation in the demand curve or a movement along the demand curve (ie, businesses are willing to pay more for an hour of work). In the short term, this wouldn't cause a shift because there are no more businesses to cause a need for more hours. On the other hand, if all (or most) businesses increase the number of hours they are open (demanding), then this would cause a shift in the demand curve. There must be a change in total number of hours needed to shift demand.

For example, consider that there is an influx of new veterinary businesses due to the availability of more small business loans backed by the federal government. This would be a structural change, as the presence of more businesses means there is a need for more veterinarians. However, in terms of something like COVID-19, if businesses have more working hours due to the addition of enhanced cleaning procedures or curbside service, which changes the number of hours needed to operate a practice but (in isolation) does not increase the need for more veterinarians, then the demand curve rotates. Other factors in association with COVID-19 could cause a shift in demand, but that is discussed later in the multimarket view.

Supply is, as normal, upward sloping. As the price per hour of work (wage) increases, veterinarians are willing to work more hours. Shifts in the supply curve only come from more veterinarians entering or reentering the market place—such as from graduating DVM programs, exiting clinical practice and then reentering, or migrating from other countries—or from exits such as retirement or otherwise leaving the labor force.⁶ The supply curve can rotate if veterinarians begin to demand higher wages. Some veterinarians may desire to work fewer hours for less pay than other veterinarians. However, a market-level (aggregate), upward-sloping demand curve simply indicates that the number of work hours for

the entire industry increases as the wage rate increases on the average. This information cannot necessarily be extrapolated to an individual veterinarian, as their preferences for work hours and wage may be different. It is known from the empirical literature⁷ that supply curves for veterinarians do follow this normal, upward-sloping trend.

The equilibrium point within the labor market is the average wage per hour and the number of hours veterinarians are willing to work. This point shifts as supply and demand shift or rotate, but it is important to remember that the equilibrium is constantly changing in the short term. Medium- to long-term shifts depend on structural changes such as delays in retirement, increases in numbers of schools and class sizes, a shift in number of businesses, and so forth.⁸ Understanding what constitutes a shift in demand or supply and a rotation in the curves is vital to being able to determine what is a short-term reaction versus a long-term change in the market.

Demand Side Market: Market for Pets and Animals

The demand side of the industry is driven by 1 market: the market for pets and animals. Within this market, one could consider price as not only the cost of buying animals, but also the cost of taking care of the animals. In the case of pets, this would include the cost of food, grooming, and so forth. For food/farm animals the cost would be feed, shelter/structures, maintenance on property, equipment, and so forth. The quantity is straightforward—the number of animals owned.

The demand curve for this market is related to the cost of owning an animal. For simplicity, I will describe the companion animal market, but the concepts can be used for the food/farm animal sector as well. The higher the cost of owning a pet, the fewer people who end up owning pets. Note that the cost of owning a pet does not include the cost of veterinary care, as that is not a requirement of owning a pet. The demand for veterinary services is its own market to be discussed later. The demand curve is also determined by the number of households able and willing to own a pet. The demand for pets can shift as the population of the country changes, the number of independent households declines or increases, or other changes occur related to households and population.⁹ On the supply side, the supply of pets is driven by several intricacies such as pet surrenders, shelter populations, pet breeding, and so forth. It can shift if more pets are imported or there is an increase in pet breeding (intentional or feral) or something along those lines (Figure 1c).

When it comes to the equilibrium of this market it is key to understand that there will always be more demand for pets and more supply of pets than are actually owned. What I mean by this statement is that persons in general may want (demand) more pets and animals; however, they may not feel as though they can cover the cost to own the animals. Similarly, the supply of pets and animals is always

greater than what is actually owned because of feral animal populations, and there are usually animals available through adoption, even if not in the immediate area. The intersection of these 2 sides of the market represents the willingness and ability of people to own pets. In other words, the equilibrium, at least in the short term, is purely the number of pets currently owned. In the long term, the point of equilibrium will change as trends in ownership change. If, for example, millennials are more likely to own pets, then the equilibrium will shift as millennials come to represent independent households.¹⁰ However, if the boomer generation is more likely to own pets, the market for pets will shift the opposite direction as boomers become a smaller proportion of the general population.

The Interconnectedness of Markets

The fourth market in veterinary medicine is the market for veterinary services. While the other markets tend to operate independently in the short term, the veterinary services market is completely dependent on the supply and demand of the 3 aforementioned markets. Veterinary services are the lynchpin for the rest of the industry, as they bring together the labor markets that make up supply and the pet and animal market that makes up demand. As such, this creates a highly interdependent market structure. In other words, shifts in 1 market will have ramifications in all other markets.

First, it is imperative to discuss how the veterinary services market is created. How the market is formed specifically from the market of veterinarians for the supply curve and the market for pets and animals for the demand curve is depicted (**Figure 2**). The equi-

librium point of the veterinarian labor market directly impacts the minimum point in which quantity of veterinary services is supplied. Quantity in this case is the number of services provided to pets and animals. As usual, as the price of services increases, the more services veterinarians are willing to provide. On the other side, the equilibrium point of pets owned creates the minimum demand within the veterinary services market. As the price of services increases, fewer pet owners demand services. The important points to remember are that (1) the labor market can always provide more services and (2) pet owners will demand more services if the price declines, but that does not mean all pet owners will seek veterinary care. The equilibrium point within the services market represents the trade-off in willingness to supply services at a given price and the willingness of pet owners to pay for those services at that same price. The curves can rotate to reflect changes within this market, but shifts in the curves only occur from outside markets. For example, the demand curve may rotate to become flatter or steeper if the aggregate frequency of visits per pet owner changes (ie, pets go to the clinic more or less). Similarly, the supply curve could rotate if there are bottlenecks that increase the time needed to perform services.

One may also notice (Figure 2) a point made earlier in the supply-side markets—the maximum of the supply curve in the market for veterinarians is directly influenced by the equilibrium point in the market for education. As previously stated, the equilibrium point in the education market is essentially the number of seats available across all veterinary schools in a given year. Upon graduation, the senior class of DVM students (at least those who decide to enter clinical practice) enters the labor market and shifts the maximum total number of hours available. This inter-

connectedness is how the supply curve is formed in the market for veterinarians, which then influences the supply within the veterinary services market. Because the supply curve in the education market is fixed in the short term, the only way the supply curve within the labor market shifts is if the balance between people exiting the labor market and the number of new veterinarians entering the market changes or there is a collective change in the number of hours veterinarians are willing to supply.

Example of Graphical Evaluation

To help visualize how to use the multimarket graph, let us use the work done by Neill et al,¹¹ which mathematically analyzes how increasing the veterinary workforce changes earnings. Suppose there is an increase in the number of students graduating from DVM programs; this is realistic given the establishment of several new programs and the expansion

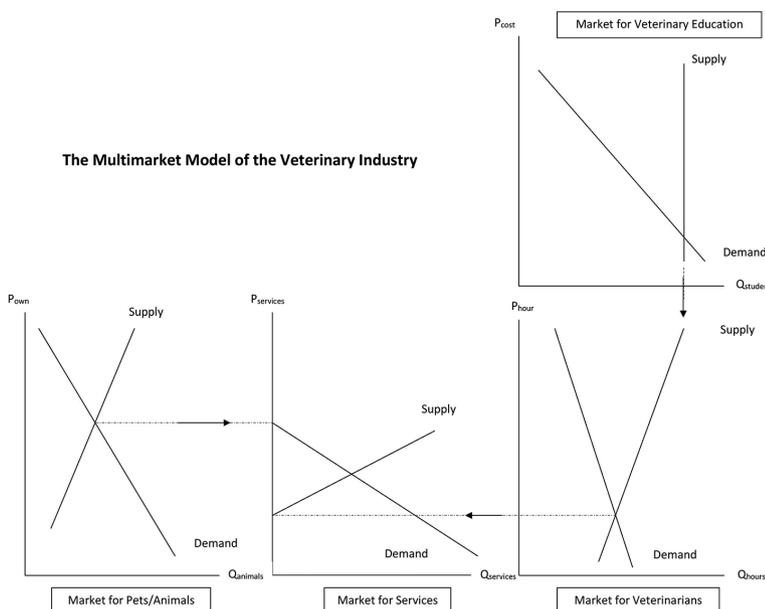


Figure 2—Graphical representation of the multimarket model for veterinary medicine. $P_{services}$ = Cost of veterinary education. $Q_{services}$ = Quantity of services. See Figure 1 for remainder of key.

of class sizes at current programs. Note that everything else is assumed to not change (also known as the *ceteris paribus* assumption). While there is a delay between the effects between the market for education and the market for veterinarians, the fact remains that the supply curve in the education market shifts to the right and remains vertical. Similarly, the supply curve in the market for veterinarians shifts to the right. Because of this, the supply of veterinary services is also shifted to the right. These movements from the baseline scenario presented earlier are demonstrated (**Supplementary Figure S1**).

The final result is that the equilibrium price in the veterinary services market decreases while the quantity increases. This means that the quantity demanded for services (determined by the animal ownership market, which has not shifted) is also greater, but the price animal owners are willing to pay for services has declined. This also causes the equilibrium price in the market for veterinarians to decline, meaning that veterinarians are likely to be paid less per hour because the market has become more competitive. Without increases in the market for pets, which would simultaneously increase the demand for services, there is no way for veterinarians to see an increase in wages by increasing supply. The reason is that, assuming no changes in other costs of care, the competition between veterinarians increases, which means pet and animal owners can more easily substitute one veterinarian with another that offers services at a lower price. In turn, the cost of care would decrease. This is also proved mathematically by Neill et al.¹¹ Now it is quite reasonable for demand and supply to shift simultaneously and cause supply and demand in the veterinary services market to shift. The impact of such shifts is easily understood via graphs. However, it would take a mathematical model to determine the true magnitude of the impacts.

Conclusions and Take-Home Points

To summarize, I find it important to remember some key points, as these discussions about the veterinary industry continue to be top priorities:

1) It is important to determine whether a shock to the market is a short-term impact or a long-term structural change.

2) In the short term, the market for veterinary education has a fixed supply. In the long run, the supply can be expanded or contracted, but it will have reverberating impacts on the other markets (ie, will impact equilibrium wages and prices).

3) The quantity portion of the market for veterinarians should be considered in number of hours, not individuals. Individuals are the ones choosing to work more or fewer hours, and it is important to understand why veterinarians change their working hours. However, recent data demonstrate that, although many veterinarians want to work fewer hours, they are working more than desired and have increased working hours over the last year.¹²

4) There will always be more animals available in the pet market than are actually owned in equilibrium.

5) There will always be more pets that could be receiving veterinary care. Not all pet owners are willing to go to the veterinarian, and price is a large determinant of that decision.

6) When seeking out solutions to workforce issues, consider the ramifications in other markets, not just the market that is directly impacted. The aforementioned example is a prime example that changes in supply must be met with increases in demand to offset potentially detrimental effects to earnings.

Overall, the future of veterinary medicine is bright, as it is considered a fast-growing industry in terms of revenue.¹⁰ However, it is imperative to ensure that proposed changes to the workforce are thought about from as many angles as possible to ensure a prosperous future.

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Supplementary Materials

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