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Remi Shendell April 10, 2024

An Appetite for Data? Drivers of Variation in U.S. State Food Animal Antibiotic Use Data Collection Policies

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Abstract

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This thesis investigates the causes of variation in the strength of three U.S. state policies to collect antibiotic use data from farm animal operations. The overuse of antibiotics in food animal production contributes to the emergence of antibiotic-resistant bacteria, posing a grave threat to humans in the form of drug-resistant infections. Collecting and analyzing antibiotic use data is essential to design, enforce, and improve policies to prevent human drug-resistant infections. Two U.S. states have passed legislation to collect antibiotic use data from veterinarians and farm operations; the puzzle this thesis addresses is why states vary in the presence and strength of their animal antibiotic use policies. I use a most-similar, comparative case analysis of three states (Maryland, California, and Georgia) to test the theory that strong consumer advocacy groups and producer group support are necessary and sufficient to pass strong state antibiotic use data collection policy. Based on evidence from nine interviews with government officials, subject experts, and employees of state producer and consumer advocacy groups, this project demonstrates that most meat producer groups across species sectors are cohesive in their preferences opposing state AMU regulation. However, when pushed by consumer advocacy groups and progressive producer groups like Perdue Farms in Maryland, the differing capacities of poultry compared to cattle and swine producers increased poultry producer groups' willingness to accept state data collection policy. Maryland consumer advocacy groups exhibited greater strength due to stronger linkages with human healthcare groups and legislative actors than their counterparts in California. Consumer advocacy groups' addition of strong data collection provisions and stringent implementation directions in the Maryland law was aided by a weaker iron triangle relationship between legislative committees, Departments of Agriculture, and producer groups demonstrated in Maryland compared to California. Ultimately, this research shows that the responsibility to push for antibiotic use data collection at the state level lies mainly with strong consumer advocacy group coalitions that leverage fragmentation within state producer groups to weaken the meat industry's control over state policy agendas and outcomes.

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"With antibiotics, the more you use them, the faster you lose them." - Rebecca Goldburg, Environmental Defense Fund[1]

Introduction

Americans love their meat. In the year 2022, the average American had retail access to 224.6 pounds of red meat and poultry, making the United States the second leading country in meat consumption per capita (USDA 2022 & World Population Review 2023). Since the 1950s, meat producers, farmers, and veterinarians have used antibiotics to keep animals healthy and support the growth of large-scale animal food production. The same antibiotics that cured humans of infections helped food-producing animals grow faster and larger, and they prevented diseases from flowing between animals on farms. Antibiotics added to feed and water allowed farms to raise a greater number of animals in the same amount of space, transforming the business from small backyard farms to concentrated animal feeding operations (CAFOs) where thousands of animals are confined and fed (Neff 2015:296).

But there has been an unintended consequence in the liberal use of antibiotics to improve human survival and increase food production; the bacteria, at first subdued and overtaken by the new antibiotics, fought back. In humans and animals that received antibiotics, new strains of the treated bacteria evolved to evade the drugs that were designed to kill them. These bacteria acquired new defenses and strategies at a shocking pace; after just a few days or weeks of antibiotic treatment, antibiotic-resistant strains can appear in humans and animals and cause infections with few (or no) available drugs to treat them (Talkington 2016).

[1] See Toner 2005 article.

Reducing the use of antibiotics in food animal production is instrumental to addressing the public health crisis of human drug-resistant infections (WHO 2017 & Tang *et al.* 2017). However, the U.S. federal government does not sufficiently collect data one of the *direct causes* of antibiotic resistance: antibiotic overuse in agriculture (Ferreira 2017). Collecting and analyzing antibiotic use data helps to define the scope of antibiotic overuse, evaluate current antibiotic use regulations, and promote evidence-based policy to deal with the rapidly evolving issue of antibiotic resistant bacteria and infections, also known as antimicrobial resistance (AMR) (Bright-Ponte 2020 & Quaade 2024). A few U.S. states have undertaken this vital responsibility, but there is significant variation in the presence and strength of state policies to collect antibiotic use data from farm operations (Bliss *et al.* 2023 & Wallinga 2022). I will use a political science lens, focusing on models of iron triangles and collective action, to investigate the puzzle of variation between state antibiotic use data collection policies.

Antibiotic use (ABU, or AMU for antimicrobial use[2]) data shows regulators the amount and type of antibiotic given to animals on farms, its route of administration (via feed, water, or injection to the animal), and the reason for its use (FDA 2023). As Dr. David Wallinga writes in his 2022 review of AMU policies regarding meat and poultry production,

> *"The lack of national data on antimicrobial usage at the production level severely weakens public health's ability to measure the benefit from US efforts to curtail uses of these drugs in food-producing animals. Without such assessments, political will in the USA to adopt more targeted surveillance programs or more aggressive measures to curtail usage... in the interest of public health also remains elusive." (Wallinga 2022:350)*

In response to federal inaction, the states of Maryland and California have adopted their own policies regarding antimicrobial use data collection in food animal production. However,

[2] Antimicrobials are an umbrella term describing substances to kill microorganisms or prevent them from causing disease. Antibiotics are used to kill and subdue bacteria, while antivirals are used against viruses, and antifungals against fungi. For this thesis, antimicrobial and antibiotic are used interchangeably.

there are significant differences in the strength of Maryland and California state policies and most other states have not introduced legislation on this topic (Bliss et al 2023, Wallinga 2022)[3]. The origin and design of these state policies are the topic of this thesis, which asks: w*hat causes variation in the strength of state policies to collect antimicrobial use data for food-producing animals?*

In the following sections, I will build a case for and then test my theory that *changes in strength of both food animal producers and consumer groups are individually necessary and jointly sufficient for the passage of strong AMU data collection policy*. In recent years chicken producers have significantly decreased their AMU due to increasing demand of individual and institutional buyers for antibiotic-free meat, but beef and pork industries have not decreased their AMU (Dall 2020). I posit that the fragmentation between industries within a state has weakened the existing state agricultural iron triangle between state Departments of Agriculture, relevant Agriculture committees, and meat producer groups, facilitating the entry and acceptance of new consumer advocacy group proposals. I will test whether an iron triangle policy process explains the relationship between the independent variables of consumer advocacy group and producer group strength and the dependent variable of state AMU data collection policy strength.

My hypotheses lay out the predictions of consumer advocacy and producer group strength within each state based on the known outcome of policy strength. I hypothesize that the passage and strength of state AMU data collection legislation is primarily explained by:

1. An increased strength and capacity of state consumer advocacy groups in the years directly before introduction of legislation in their state, allowing these groups to push legislators to introduce and design effective AMU data collection legislation.

[3] Key informants at the state and federal level rated Maryland's policy as more effective at collecting data on AMU from producers and reducing misuse and overuse of antimicrobials (Bliss et al 2023:7).

2. Chicken producers' private reduction of AMU increased their willingness to accept and partake in the design of AMU data collection policy. Therefore, states with a large chicken production market are more likely to introduce legislation and enact strong policies than states with strong beef and/or pork production industries.

I will use a most-similar qualitative case comparison between three states (Maryland, Georgia, and California) to test the proposed relationship between consumer advocacy and producer group strength and policy outcomes. These states were chosen based on the outcome of strength (or absence) of data collection policy: Maryland has the strongest state AMU data collection policy, California has a weaker policy whose implementation has resulted in insufficient data collection (Quaade 2024 & Casey et al. 2023), and Georgia has no policy at all[4].

Through interviews with state producer group and consumer advocacy group representatives and state officials, I will quantify the strength of producer and consumer interest groups and how they used this strength to improve (or block) data collection policy design. Policy strength will be assessed based on the legislative provisions included in the bill text; provisions such as assigning responsibility to specific state agencies, defining terms necessary for data analysis, and ensuring the publication of collected data are essential to nimble and accountable implementation of public health policy (Bliss *et al.* 2023:4 & Burris *et al.* 2018 199-202).

This thesis will first explain the science and public health implications of antibiotic-resistant bacteria, how agricultural antibiotic use contributes to AMR, and why political

[4] Food animal products are a top commodity in each of these states (University of Georgia Extension 2024, "Maryland at a Glance" 2024, & CDFA 2022). Relevant state consumer advocacy and producer groups within the three states share national parent organizations that set priorities and membership structures to dictate their activity and interaction with government. The similarities between states and research design will be discussed further in the Research Design section.

scientists should care. I will then provide background on the history of U.S. federal policy regarding animal AMU regulation and the control of AMR, followed by a review of how existing political science theory could explain the gaps in U.S. national policy. I detail my theory and hypotheses for how concepts from the literature review could apply to state policy processes, lay out the construction of state cases and variables, and present my findings. I conclude with ideas of how the results from this thesis may be applied to other state cases of proposed AMU policy and similar public health policy issues including pesticide use in crop agriculture.

Background

Motivation

Patients, healthcare systems, scientists, and governments across the globe are currently fighting a losing battle with drug-resistant bacteria. According to the Center for Disease Control and Prevention (CDC)'s 2019 Antimicrobial Resistance Threats Report, 2.8 million antibiotic-resistant infections occur and at least 35,000 people die from these infections each year (CDC 2019). The overuse of antibiotics in human and agricultural settings has created antibiotic-resistant bacteria that cause foodborne illnesses and put citizens at risk of contracting infections during treatments such as surgery and chemotherapy.

When an antibiotic is introduced to a bacterial population, some bacteria will have an advantage[5] over others; they possess one or more mutations allowing them to resist the antibiotic designed to kill them. Mutations, or changes in the genetic code of an organism, occur when a cell makes an error while synthesizing a new copy of its genetic material to pass down to offspring (Holmes *et al.* 2015:176). Mutations can enable antibiotic resistance through

[5] Most have heard of the survival of the fittest concept that explains evolution, or the change in frequency of a genetic trait in a population (Orr 2009). "Fitness" is a measure of how a person's (or bacteria's) genetic traits allow them to thrive under a set of environmental conditions (Orr 2009). A bacterium's fitness is tested when an environmental change, such as the presence of antibiotics, occurs (Holmes *et al.* 2015:176).

modifying the target of the antibiotic so the bacteria can evade detection, inactivating the antibiotic, making it difficult for the antibiotic to enter the cell, or coding for a pump that pushes antibiotics out of the bacterial cell (CDC 2019:22). Bacteria with these mutations survive and pass down their genetic code to offspring. However, mutations in the genome and passage of resistant genes during replication are not the only ways that antibiotic resistance can be passed between bacteria.

Bacterial cells carry DNA separate from their genome that can be expressed to protect the cell under stressful conditions such as exposure to antibiotics. This emergency DNA, housed in a *plasmid*, can be copied and transferred to nearby bacterial cells of the same or different species (Holmes *et al.* 2015:178). Transfer of plasmids enables bacteria with an antibiotic-resistant gene (or multiple genes) to share that resistance with nearby cells of the same or different bacterial species, facilitating exponential growth of drug-resistant bacteria inside a host (Sheraz *et al* 2009:35 & Holmes et al 2016:178). The treatment of an animal or human with one antibiotic can drive the evolution of bacteria resistant to multiple antibiotics because plasmids can contain numerous genes conferring resistance against different antibiotics. When bacteria share their plasmid with other bacteria, multiple genes are copied and transferred to other cells, increasing the risk of multi-drug resistant infections with few treatment options (ReAct 2023). The policy implication of plasmids and their ability to carry multiple resistance genes is that use of one antibiotic endangers the efficacy of other antibiotics. It also means that policies reducing the use of antibiotics in agriculture have the power to prevent the spread of bacteria resistant to human antibiotics (Hoelzer *et al.* 2017:3).

Some bacteria that can spread from animals to humans (including some strains of bacteria such as *E.Coli, Salmonella,* and *Campylobacter*[6]) grow in the guts of animals and are *pathogenic*, meaning they can make humans sick (Ramos *et al.* 2020:2). When animals ingest antibiotics, some of these pathogenic gut bacteria become resistant to antibiotics. These pathogens can then exit the body through animal feces, or gut bacteria can contaminate animal meat during slaughter and processing. Humans can be infected by antibiotic-resistant bacteria from animal meat through ingestion of contaminated meat that is not properly cooked, or contamination of surfaces when preparing and cutting meat (WHO 2024).

Another primary route for transmission of drug-resistant bacteria from animals to the environment - and eventually to humans - is through animal feces and manure (Neff 2014:299)[7]. Manure from animals treated with antibiotics can contain drug-resistant bacteria; when manure is sprayed on cropland as a fertilizer, it exposes other agricultural commodities such as lettuce to drug-resistant bacteria or genes that can then be passed on to humans (Jauregi *et al.* 2021). Bacteria and excess antibiotics from animal feces also travel through soil and groundwater and feed into nearby water and food sources, putting human and animal communities near industrial farm operations at higher risk for drug-resistant infections (Pew Commission on Industrial Animal Food Production 2008:11). Indeed, drug-resistant bacteria have been found in higher concentrations in farmers, their families, and communities who live close to animal production operations (Neff 2014: 301-302).

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[6] Most strains of *E.Coli* and other gut bacteria are *commensal,* meaning that they help our body digest food and are a natural part of the diversity of bacteria in our bodies. The human gut microbiome has many types of commensal bacteria, including 'good' strains of *E.Coli* (Ramos *et al.* 2020). However, some strains of these bacteria are *pathogenic*, meaning that they cause disease in a host. Importantly, bacteria that are pathogenic in humans may not cause disease in animals; therefore, animals who seem healthy and have no visible symptoms can still contain bacteria that, once it enters the *human* body, would cause disease. (Ramos *et al.* 2020)

[7] See Figure 1 in the Appendix for an illustration of how antimicrobial resistance emerges and spreads between animals, humans, and the environment.

Antibiotic overuse in agriculture warrants study in the political science field because its consequences (AMR bacteria and infections) exemplify negative market externalities that government regulation has failed to properly address (Armbruster & Roberts 2018:296). The producers of the externality (in this case, food animal production corporations and animal pharmaceutical companies), benefit from the sale of their products without paying for the massive costs that drug-resistant infections incur. The costs are instead borne by individuals with AMR infections in the form of decreased health, hospitalization, medical bills, and even death. It also endangers communities near concentrated animal feeding operations exposed to high levels of antibiotic resistant bacteria which can linger for years in humans and their environment after initial exposure[8]. Although the total cost of AMR and its associated infections is incalculable, the World Bank puts the yearly cost to American GDP at $1 to $3.4 trillion dollars *per year* by 2030. It also projects an extra $1 trillion healthcare costs in the US by 2050 (WHO 2023). In 2014, AMR infections were the cause of an estimated 700,000 deaths per year; that number could climb to 10 million deaths per year by 2050 (NASEM 2021).

An increase in drug-resistant infections also depletes the supply of effective antibiotics to treat and prevent human illness. As a result, essential antibiotics such as tetracyclines, cephalosporins, and fluoroquinolones are hanging on the precipice of efficacy, threatened by drug-resistant bacteria that often carry genes conferring resistance to multiple antibiotics – and right now, we don't have the science to replace them (Coates, Halls, & Hu 2011). New antibiotic

[8] The spread of AMR bacteria from food production sites to the nearby environment and into humans has caused scientists and policy advocates to categorize resistant bacteria as industrial pollutants like PFAS chemicals and pesticides (Davis & Rutkow 2012: 340). Antibiotic-resistant bacteria, like PFAS chemicals (also known as forever chemicals), are persistent in the body long after initial exposure (McFall-Johnsen 2023). Even when treatment of an animal herd with a specific antibiotic is discontinued, bacteria that have developed resistance to it tend to linger in animals and resistance can be passed down through generations; as a result, resistant bacteria persist and continue to be transmitted to humans, underscoring the importance of the judicious use of antibiotics in animal operations (Holmes et al 2016:181 & McKenna 2015:183).

discovery is extremely difficult because most antibiotic classes are naturally derived and antibiotics to new drug-resistant strains cannot be easily, rapidly, or cheaply synthesized (CDC 2019:41)[9]. Meat producers argue that the use of antibiotics in food animal production is necessary to keep animals healthy, decrease production costs, and satisfy a global appetite for low-cost protein sources; however, industry calculations regarding the profitability of their antibiotic use do not include the costs of antibiotic resistance incurred by current and future generations (Neff 2014:291). Given that about *65 percent* of antibiotics used to treat human disease, or medically important antibiotics, are sold for food animal production purposes, the meat industry should be paying for their role in producing AMR (Dall 2020 & FDA 2013).

Collecting AMU data and monitoring the duration of antibiotic use and the concentration of antibiotics in feed is key to distinguishing between the necessary and unnecessary uses of antimicrobials in meat production (Bright-Ponte 2020 & Ferreira 2017). Although antibiotic resistance can develop from any use of antibiotics, the use of antibiotics for disease prevention and growth promotion is especially dangerous due to animals' prolonged exposure to low doses of antibiotics (Holmes *et al.* 2015). Frequent addition of a low dose of antibiotics to animal water and feed presents more opportunities for mutations to emerge and resistant bacteria to grow than when antibiotics are administered for a short duration in a high dosage (Hoelzer *et al.* 2017). Because the duration of use for a course of antibiotics in animals differs based on the reason for antibiotic administration, data specific to farms or producers that includes duration of use would facilitate the enforcement of current FDA rules banning the use of antibiotics for growth promotion (Pew Charitable Trusts 2021).

[9] Pharmaceutical companies lack sufficient profit incentives to pursue R&D for new antibiotics, since it only takes two years from market entry for resistance to a new antibiotic to develop (Coates, Halls & Hu 2011 & Bax *et al* 1998*).* Consequently, there have been only two new classes of antibiotics introduced to the market since 1962 (Coates, Halls & Hu 2011).

Data on food animal producers' agricultural antibiotic use combined with the prevalence of AMR bacteria in humans can also prove the causal link between antibiotic use on farms and antibiotic-resistant infections in humans required for evidence-based policy innovation. Although the causal link between animal antibiotic use and human AMR infections has been well-established (Holmes *et al.* 2015), a national "integrated monitoring" system is required to analyze the threat of overuse on a case-by-case basis such as investigating the threat of using a specific antibiotic in animals, or determining whether animal antibiotic use leads to higher rates of human-resistant infections within a geographic area (Wegener 2012).

The goal of adding antibiotic usage data to available data on human AMR infections is to provide evidence that justifies reducing or removing essential antibiotic use from food animal production to save these antibiotics for use in human health. In the past, integrated AMU and AMR data has "led to implementation of specific interventions to contain AMR in the food-production chain in many countries" across the European Union and once in the United States[10] (Wegener 2012). The accumulation of evidence, and the resulting policy improvements based on integrated monitoring systems in countries such as the Netherlands and Denmark has led to a significant, sustained decrease in AMR bacteria and infections found in animals and humans within those countries (McKenna 2017:237 & Jacobs 2019). A better system of integrated data is required in the United States to achieve similar public health improvements, and that system must include specific and accessible animal antibiotic use data.

[10] United States FDA data from antibiotic sales of the fluoroquinolone class of antibiotics for poultry production were paired with bacterial isolates from animal and humans that showed resistance to fluoroquinolone antibiotics to justify the FDA's prohibition of fluoroquinolone use in animal agriculture (McKenna 2017:144). In the United States, the removal of the fluoroquinolone antibiotic Enrofloxacin was "the only animal drug ever forced off the U.S. market for generating resistance that threatened human health" (Ibid. 147). This case will be discussed further in the following section on page 18.

Since 2017, the FDA requires veterinarians to keep logs detailing the antibiotics they prescribe to farm operations, including written Veterinary Feed Directives (VFDs) permitting farm operations to obtain animal feed containing antibiotics from feed manufacturers (FDA 2023). This data includes the type and volume of antibiotic(s) included in animal feed, the animal species and approximate number of animals antibiotics will be used in, and the duration and reason for administration of antibiotics (FDA 2023). Although VFD records are kept by veterinarians for two years after their issuance, and the FDA has the authority to collect and analyze these records, they rarely do so (Wallinga 2022:341). The result: vital, available data characterizing patterns of antibiotic use on large scale farms is not used in the United States to enforce current laws and provide evidence to improve policy in the future.

State legislation directing state Departments of Agriculture or Health to collect and monitor AMU data from veterinarians and farm owners could strengthen the implementation of current federal regulations and provide more data on how agricultural antibiotic use contributes to human and environmental AMR levels. One strength of California and Maryland laws compared to federal rules is better-defined limits on when antibiotics can legally be prescribed. Both states prohibit the use of antimicrobials in livestock “in a regular pattern”, meaning the “drugs cannot be used repeatedly in the same animal or group of animals or as a standard operating procedure” (Wallinga 2022:345). This closes the “loophole” in federal regulations where antimicrobials are only banned for growth promotion purposes and are still allowed to be used in a regular pattern at a low dose to prevent disease (Wallinga 2022:341 & U.S. GAO 2017). However, the content and implementation of data collection provisions differ between the Maryland and California laws and most other state legislatures have not introduced AMU data

collection programs (Bliss *et al.* 2023)[11]. To understand why some states achieve effective AMU data collection policy designs and others do not, it is necessary to first explain what all states have in common: the history of antibiotic use in agriculture and regulatory responses from the U.S. and other national governments.

International and U.S. Federal Landscape

A turning point in the enduring struggle between humans and the pathogens that infect them was the discovery of the antibiotic penicillin in 1928 (Hutchings *et. al* 2019). Between 1940 and 1962, 20 new classes of antibiotics were discovered and brought to market (Coates, Hall & Hu 2011). This "antibiotic revolution" increased the average human lifespan by 23 years and allowed developed nations to control widespread infectious diseases like tuberculosis, pneumonia, meningitis, and syphilis (Hutchings *et al.* 2019 & Kalvaitis 2008).

The rapid utilization of antibiotics in humans beginning in the 1940s led pharmaceutical companies and agricultural producers to experiment on whether antibiotics could improve the health of farm animals. These experiments found that feeding animals small doses of antibiotics through feed or water reduced the presence and severity of infections in farm animals (McKenna 2017). The use of antibiotics for *disease prevention* [one of the three "indications" antibiotics are used for in food production] came to be defined as the prolonged use of antibiotics to prevent a suspected, but not officially diagnosed, disease from spreading to nearby animals (Hoelzer 2017). The use of antibiotics for disease prevention allowed farmers to raise more animals in the same amount of space with less risk of infections, facilitating healthier and larger herds.

[11] Four other states (NY, OR, PA, and IL) introduced legislation similar to Maryland and California but none were adopted. The city of San Francisco enacted an ordinance to collect AMU data from food supply chain actors as well (Bliss et al 2023).

In 1950, the experiment commissioned by Lederle Pharmaceuticals found that in addition to lower incidence of disease, animals consuming feed with small doses of antibiotics grew much faster and accumulated more body mass than animals not fed antibiotics (McKenna 2017). Before the use of antibiotics, farmers had to purchase costly vitamins, fishmeal, and other sources of protein to put in animal feed so that farm animals could grow body mass (McKenna 2017). Antibiotics improved animals' feed conversion ratio, or the measure of how efficiently food is translated into body mass in animal metabolism (Pew Commission on Industrial Animal Farm Production 2008). This use of antibiotics in feed for *growth promotion* purposes [another "indication" of use] allowed farmers to cut production costs and maximize profits gained from each animal.

Antibiotics for *therapeutic purposes* [the third indication] are given only when a disease is diagnosed in an animal or group of animals, compared to disease prevention which seeks to prevent future disease (Patel 2020:1650). Antibiotics for therapeutic purposes are usually administered through injection of diagnosed animals rather than to a large group through feed or water. Using antibiotics in food animals only for therapeutic purposes, with limited use for disease prevention, is the goal of many AMR policy advocates (Patel 2020:1654 & Pew 2021).

Mass outbreaks of drug-resistant infections originating from food-producing animals in European countries including the United Kingdom, Sweden, Denmark, the Netherlands, and Germany spurred legislation starting in 1969 to decrease the use of antibiotics in food animal production (Davis & Rutkow 2012: 386). National surveillance programs compare data collected from farms and veterinarians to scientific standards of antibiotic use to determine whether farms use antibiotics appropriately to prevent the emergence of antibiotic-resistant bacteria in farm

animal**s** (Davis & Rutkow 2012:31)[12]. These countries have used their AMU data to design, justify, and improve regulations governing the use of antibiotics in farm animal production (McKenna 2017:237).

A prime example of AMU data collection is the DANMAP surveillance program in Denmark, which collects data from farmers, veterinarians, and pharmacies on their animal antibiotic use and sales[13] and compares the data to national standards on the frequency of AMU (Jacobs 2019 & FAO 2019). Through the "Yellow Card Scheme" implemented in 2010 (FAO 2019:20), public health officials in Denmark use DANMAP to reward farmers and veterinarians for judicious AMU, provide consumers with information on producer AMU, and send extension agents to non-compliant farms to devise strategies to improve their production (Jacobs 2019 & McKenna 2017:240). The Yellow Card Scheme has promoted "a continuous reduction in antimicrobial use in Danish pig herds, particularly in herds with high antimicrobial consumption" since its inception in 2010 (Antunes & Jensen 2020). Considering that Denmark's pig meat export industry is the 5th largest in the world, cooperation from producer companies, farmers, and veterinarians sets an example for countries like the United States to improve their AMU policies (Observatory of Economic Complexity 2023). However, decades of political battles between federal agencies, meat industry sectors, and legislators over agricultural

[12] Judicious use, a common term in both human and animal use of antibiotics, is defined as using the correct amount of antibiotics, for the correct amount of time, for the right reasons (Arnold 2024).

[13] The DANMAP system analyzes granular sales data in the VetStat database obtained from "prescription information submitted by pharmacies at the point of sale of the product to the pig producer. In addition, medicines used or sold by veterinarians are recorded in VetStat by each individual veterinarian or veterinary practice" (FAO 2019:11). The amount of antimicrobials sold to each producer is combined with farm and species-level population data from a database called the Central Husbandry Register (CHR). Population data from CHR is used as the "denominator information… for reporting of veterinary antimicrobials relative to herd size" (FAO 2019:11). The resulting technical unit used for monitoring farm-level AMU is the animal daily dose, a measure of the "assumed average maintenance dose of a given [antimicrobial] product per day" per animal (FAO 2019:11-12).

antibiotic use shows that reform at the U.S. federal level is unlikely to produce results seen in countries like Denmark.

The Food and Drug Administration (FDA), United States Department of Agriculture (USDA) and the CDC collaborate to set standards of antimicrobial use and monitor the presence of drug-resistant bacteria in animals and humans (Davis & Rutkow 2012:342). After the United Kingdom's Swann Report was published in 1969, the FDA created a task force of scientists to report on AMR and AMU, who recommended placing the growth promotion use of antibiotics under veterinarian control[14] (McKenna 2017:108). Severe pushback from Congress and the growing "agricultural establishment" caused the FDA to delay regulation until the industry conducted its own studies to assess the human health risk of antibiotic use in agriculture (McKenna 2017:109 & Nestle 2013). The agricultural establishment includes food producer companies, farmers and cattlemen's associations, commodity associations such as the National Pork Board and National Chicken Council, animal pharmaceutical companies, university agricultural extension programs, legislative agriculture committees, and departments of agriculture. These "agricultural establishments", also known as agricultural iron triangles between industry, regulators, and legislative committees, have influenced state and federal agriculture and food policy since the industrialization of agriculture after World War II (Nestle 2013 & McDowell 2004:39). After industry-funded research proved that AMU in food animal production produces resistant bacteria that can enter the human body, the FDA tried to ban

[14] At the time, antibiotics used as growth promoters were available for mass purchase and did not require a veterinarian's prescription.

growth promotion in 1977 but was squashed again by Congress and the agriculture industry (McKenna 2017:118)[15].

From 1999 to 2011, two major pieces of legislation to limit AMU in agriculture and expand federal regulatory programs have been introduced; both failed due to opposition from agribusiness, veterinary, and pharmaceutical associations (Davis & Rutkow 2012:358-361)[16]. Allied associations and legislators claimed that reducing antibiotic use would debilitate the agricultural industry and cause consumer prices to skyrocket, and that there was insufficient evidence that antibiotic use led to drug-resistant infections in humans (McKenna 2012:120). This narrative went unchallenged until a massive drug-resistant *Salmonella* outbreak in 1985 sickened over 2,000 people across the Midwest and the drug-resistant strain's origin was traced back to contaminated milk and beef products (Green 1985). Evidence collected by a CDC epidemiologist showed that people infected with the "farm-related resistant strains, compared with strains that still responded to antibiotics, were 21 times more likely to die" (McKenna 2012:134-135). The outbreak generated media attention and consumers demanded government action, leading to a series of hearings and reports alleging that the FDA neglected to remove the approval of animal antibiotics that posed a risk to human health (McKenna 2012:135-137). However, no substantial

[15] A study commissioned by the Animal Health Institute, a representative for veterinary pharmaceutical companies opposed to restrictions on AMU, enlisted Dr. Stuart Levy to do an experiment on the links between antibiotic use on a small farm and antimicrobial resistance in humans that grew the animals. The Animal Health Institute hoped to find proof that treating animals on a farm with antibiotics had no impact on bacterial resistance in humans, but Dr. Levy's 1974 experiment on a small family farm proved the opposite (McKenna 2017: 110-117). The publication of Levy's research coincided with the entry of an ambitious new FDA commissioner named Donald Kennedy. Kennedy announced that the U.S. would ban the use of antibiotics for growth promotion in 1977, but the effort was shut down by Congress and the allied agricultural industry (118).

[16] The Preservation of Antibiotics for Medical Treatment Act (PAMTA) was first introduced in 1999 and re-introduced in 2011. Davis & Rutkow write, "The American Veterinary Medical Association (AVMA) has opposed the bill and actively advocated for its defeat. Some have argued that the AVMA's position on the PAMTA bill remains one of the strongest barriers to its passage." (Davis & Rutkow 2012: 360-361). The other piece of legislation introduced was the Strategies to Address Antimicrobial Resistance (STAAR) Act in 2006, which would have created an office within the Department of Health and Human Services to coordinate federal efforts on antimicrobial resistance (358).

action was taken to improve federal food safety regulations until another deadly foodborne illness outbreak occurred in 1992, this time affecting children (McKenna 2012:172-173 & Cuellar 2014:338).

The strain of *E. coli* found in sick patients, *E. coli* O157:H7, was linked back to contaminated fast food meat from western Jack-in-the-Box establishments and prompted changes from the USDA Food Safety and Inspection Service (FSIS) to increase the government's "capacity to address pathogen-related risks that did not involve obvious sanitation violations" (Cuellar 2014:338). The FSIS's protocol at the time did not include systematic laboratory testing of animal samples for dangerous pathogens like *Salmonella, Listeria* and *E.coli* O157:H7 (which is now the most common pathogenic *E. coli* strain at 70,000 U.S. infections per year) (Cuellar 2014 & Johns Hopkins Medicine 2024). USDA FSIS slowly gained support from meat producers, food retailers, and other government actors to publish the Hazard Analysis and Critical Control Points (HACCP) rule (Cuellar 2014:338). HACCP required food processors to "identify critical control points that could be used to detect and reduce pathogen contamination" and develop plans and laboratory testing capacities to quickly intervene in the case of pathogen contamination (Ibid.). The HACCP rule is a significant example of how consumer advocacy, producer groups, government officials, and legislators interacted to reform food safety regulation; therefore, it will return later and serve as an important example to illustrate existing evidence for my theory.

Besides serving as the director and auditor of producer HACCP plans, the USDA Animal and Plant Health Inspection Service (APHIS) conducts research on AMU in farm operations; additionally, antibiotic use questions are sometimes included on the USDA Agricultural Census filled out by farmers every five years (McCluskey 2017 & USDA NASS 2023). Although these

surveys are instrumental to understanding general AMU trends on farms, they do not provide the systematic data needed for policy evaluation and enforcement of the 2017 FDA ban on the use of antibiotics as growth promoters (Pew 2024). The USDA (and FDA) also face enormous staffing and budgetary constraints in dealing with food safety and data collection (Nestle 2010: Understanding Food Safety Oversight). These agency constraints are compounded by limited access to farm operations and weak enforcement power over food producers on a range of data collection, testing, and safety control issues (U.S. GAO 2017 & Nestle 2010).

In 1996, the National Antimicrobial Resistance Monitoring Program (NARMS) was created as a joint surveillance effort between the FDA, CDC, and the USDA to aid investigations of AMR foodborne illness (FDA 2023: About NARMS). This network integrates bacterial isolates from state public health labs, food animal carcass samples collected by the USDA from slaughterhouses, and retail meat packages collected by the FDA to identify patterns of drug resistance and foodborne disease (see Figure 3) (Davis & Rutkow 2012:344). Data analysis across states and different stages of the food supply chain allows NARMS to trace outbreaks of foodborne illness back to the farm or processing facility where the specific bacteria was first found (Ibid.).

NARMS surveillance helped the FDA ban the agricultural use of the fluoroquinolone class of antibiotics in 2005 after the system documented rising resistance to the essential antibiotic Ciprofloxacin (McKenna 2012:144). However, the ban was too late to curb resistant infections in humans; it came into full effect 9 years *after* fluoroquinolone-resistant strains of bacteria originating from poultry were found in humans[17] (Davis & Rutkow 2012: 355-356).

[17] Outbreaks of fluoroquinolone-resistant *Campylobacter* infections began in 1996, and the FDA proposed restrictions in 2000 to withdraw the use of fluoroquinolones in poultry production. However, the pharmaceutical company Bayer sued the FDA about the removal of its antibiotic enrofloxacin used in agriculture; this litigation

NARMS is instrumental to tracking and preventing outbreaks of foodborne disease; however, the data that NARMS collects are bacterial isolates from human or animal sources. Data about the use of antibiotics on farms [data on the actions that propagate AMR bacteria] is not included in NARMS and is mainly collected by the FDA at the federal level (Wallinga 2022:348).

The FDA Center for Veterinary Medicine (CVM)'s roles in monitoring and reducing AMU are:

1) controlling the approvals of New Animal Drug Applications for use in agriculture[18].

2) collecting samples of retail meat from grocery stores and sending them to NARMS for detection of drug-resistant bacteria.

3) collecting antimicrobial sales (AMS) data from animal drug sponsors.

4) monitoring AMU in food production through Veterinary Feed Directives (FDA CVM 2023: What CVM Regulates).

Although the FDA Center for Veterinary Medicine has made significant policy improvements over the past two decades, the quality and frequency of AMU surveillance (achieved through roles 3 and 4) is still very low (Davis & Rutkow 2012:150 & Wallinga 2022:342). As with the NARMS data, AMS data provides insufficient information to impact AMU reduction policy targeted at farm operations and food producers (Bright-Ponte 2020)[19].

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lasted five years and the FDA "ultimately succeeded in banning fluoroquinolone use in poultry in 2005" (Davis & Rutkow 2012: 356).

[18] In 2003, the FDA issued a new industry guidance (FDA Draft Guidance #209) requiring New Animal Drug Applications to include an industry-run risk assessment on the possible impacts of their drug on human health.

[19] "As of 2016, drug sponsors are required to provide estimates of species-specific sales for the four major food-producing species in the US (cattle, swine, turkeys and chickens).. however, sales data submitted by animal drug sponsors are not indicative of how these antimicrobial drugs were actually used in animals (e.g. for what indications, doses or durations). Consequently, sales data do not provide information needed to understand how antimicrobial use practices might relate to development of antimicrobial resistance and to inform antimicrobial stewardship efforts. In addition, the nature of sales data limits what conclusions can be drawn if the data are used to make comparisons between animal species, between animals and humans, between antimicrobial drug classes (i.e. due to wide variations in drug potency), and between sales and on-farm antimicrobial use data" (Bright-Ponte 2020:3).

Sales data provides *estimates* of the amount of antibiotics used in farm operations stratified by animal species, intended indication for use (disease prevention or therapeutic purposes), and the route of administration. However, sales data can only estimate the actual use of antibiotics by food producers that purchase them, and this information is aggregated nationally, leading to limited accountability for specific food producers, USDA regions, or states (Wallinga 2022: 342). Wallinga and others also mention that estimates of AMS are a crude estimate of actual AMU because the same antibiotic may be used for different indications at the same time, and the fact that pharmaceutical drug sponsors have imperfect information about how food producers are using antibiotics at the farm level (Bright-Ponte 2020:3).

A long-awaited step for AMU reduction in agriculture was completed in 2017 when the FDA finalized its Veterinary Feed Directive (VFD) rule (FDA 2023: Fact Sheet on VFD). Starting in 2013, the FDA worked with food producers to phase out antibiotic use for growth promotion purposes and use antibiotics only for disease prevention and therapeutic indications (McKenna 2017:30). The VFD rule also required producers to consult with a veterinarian before purchasing any medicated animal feed, whereas before some medicated animal feed could be accessed without a prescription or veterinary oversight (FDA 2023: Fact Sheet VFD).

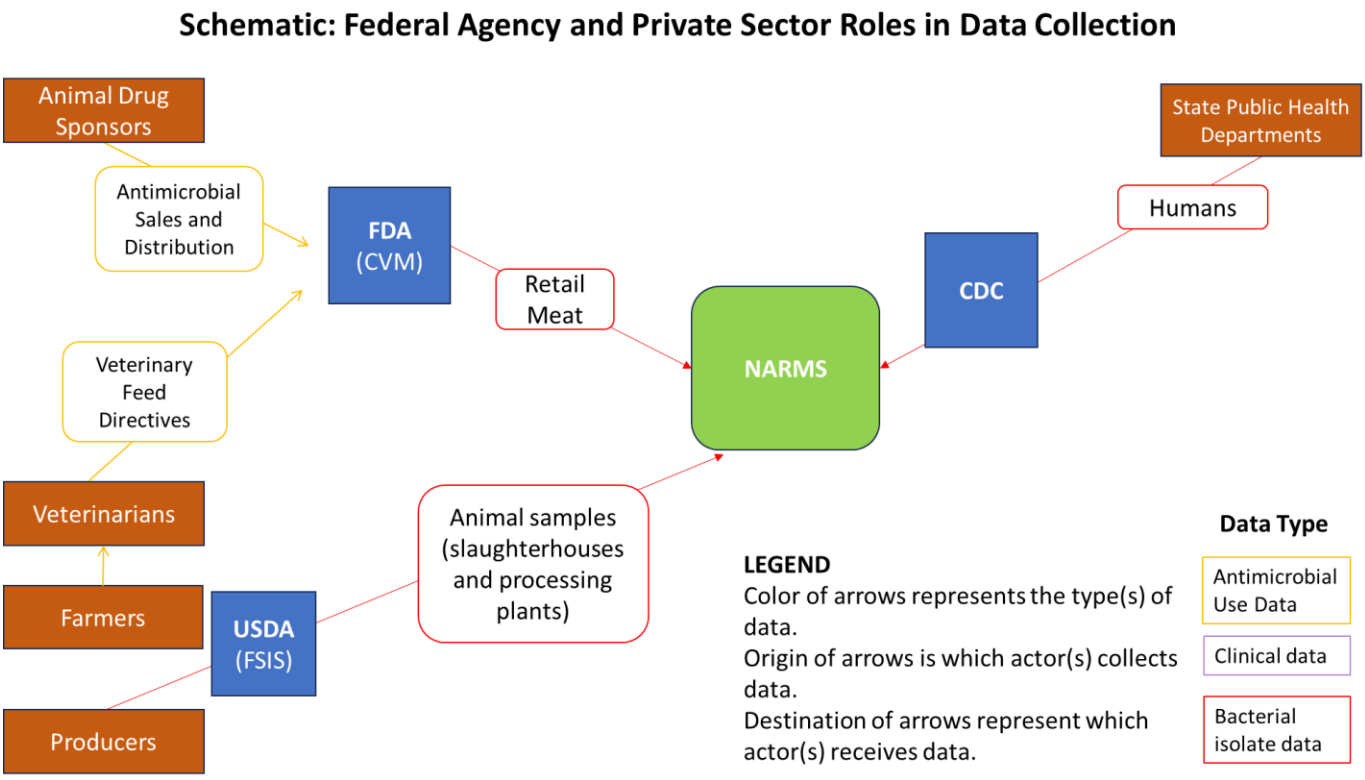

Figure 2. Schematic of Federal Agency and Private Sector Roles in Data Collection. Created using information from background interviews with CDC officials[20].

The Veterinary Feed Directive (VFD) is a contract between a veterinarian and their client (who could be a farmer or a producer group that contracts with multiple farmers) specifying rules on the administration of feed containing antibiotics (Ibid.)[21]. The VFD, which is kept by veterinarians for each of their clients using medicated feed, includes data on the type and concentration of antibiotic used in feed, the indication and duration of use, and the species and approximate number of animals given antibiotics (FDA 2023 and CVM Guidance for Industry #233 2016)[22]. Aggregation and analysis of VFDs by federal or state governments could yield

[20] See Appendix for more information on interviewees for this project.
[21] VFDs were established as a category of animal drugs (along with over-the counter and prescription drugs) in the 1996 Animal Drug Availability Act. Under this law, drugs would be approved specifically for use in animal feed, and VFD drug orders were required to come from a veterinarian (FDA 2023: Animal Drug Availability Act of 1996).
[22] For an example format of a VFD, see FDA Guidance #233 Appendix A.

farm-level and producer-level metrics on the use of antibiotics (Pew Charitable Trusts 2021). The data requirements also create opportunities for more exact analysis and stratification by animal species and type of antibiotic, leading to clearer estimates of antibiotic use than sales data currently provide (Ibid.). However, the FDA currently does not systematically collect or analyze patterns of use from VFDs, which veterinarians are required to keep records of for 2 years (Wallinga 2022:348).

However, advocates and scientists have pointed out gaps in the VFD rule design and implementation that have allowed the non-judicious use of antibiotics to continue in farm operations. The most common criticism is that the VFD rule continues to permit the use of antibiotics for routine disease prevention purposes (Wallinga 2022:341 & U.S. PIRG). The disease prevention indication does not require a diagnosis of disease and - depending on the duration limit set by the drug manufacturer - can administers antibiotics through animal feed for extended periods of time, creating abundant opportunities for the selection of drug-resistant bacteria (Pew Charitable Trusts 2021). Indeed, multiple epidemics of drug-resistant infections originating in Europe were caused by the preventive use of antibiotics even after growth promotion was banned (McKenna 2017:237). Scientists and activists worry that producer groups are continuing to overuse antibiotics under the indication of disease prevention rather than growth promotion:

> *"Of more pressing concern is the oft-mentioned "loophole" created by the FDA's approval of these antibiotics in animals for the purpose of preventing disease. Given that six out of eight medically important antibiotics are currently approved by the FDA for both growth promotion purposes and disease prevention in some species, this loophole allows the industry to continue the same practice (adding low doses of antibiotics to the feed and water of healthy animals on a daily basis) but under a different name."* (Despenes 2015:584-585).

This concern is bolstered by the patterns of antimicrobial sales reported by the FDA. From 2016 to 2017 when the VFD rule was finalized, antimicrobial sales for animal use dropped 30%, but increased by 8% the following year and stayed relatively constant since then, hinting that banning use of antibiotics for growth promotion is not sufficient on its own to reduce AMU levels (Patel *et al* 2020:1653). Although duration limits for antibiotics were prioritized in a 2018 5-year FDA plan to reduce antibiotic overuse, 35% of medically important antibiotics used in animal agriculture still do not have defined durations of use for legal preventive dosing (FDA List of Approved Medically Important Antimicrobial Drugs 2023 & FDA 2024). Since the same antibiotics are used for growth promotion and disease prevention, limits on how many days antibiotics can be administered would assist the FDA in enforcing their ban on growth promotion (Pew Charitable Trusts 2021). These FDA-approved antibiotics currently have insufficient standards to direct veterinarians and producers on how to use their product, compounding the risk of antibiotic overuse[23].

The collection of VFD records from veterinarians and producers has been scarce, highlighting the federal government's half-hearted efforts to compile data on antibiotic use and enforce the ban on growth promotion (Wallinga 2022:348). From 2016 to 2018, there have only been a few dozen inspections *across the country* to check if producers and feed mills (manufacturers who mix antibiotics into animal feed according to VFD orders) were following the AMU rules dictated by the VFDs made with their veterinarian (FDA CVM Summary Assessment Table 10). Although inspections found a high level of producer compliance, the

[23] The FDA released a draft guidance #273 in September 2023 to require animal drug sponsors to define a duration of use on the labeling for their antibiotics, stating that all companies will need to revise their labels by 3 years after the publication of the final draft guidance. See the draft guidance here: https://www.fda.gov/media/172362/download.

extremely low number of inspections shows that VFDs are not being collected to generate representative and politically useful AMU data.

In October 2023, the FDA released a draft framework for a voluntary on-farm data collection program through a Public Private Partnership (PPP) with the Reagan-Udall Foundation for the FDA (Reagan-Udall Foundation for the FDA 2023). If implemented, this would be a large step forward for tracking AMU at the national level, however the Keep Antibiotics Working advocacy coalition has criticized the program for prioritizing data privacy and voluntary participation over creating actionable and transparent AMU data (Keep Antibiotics Working 2023). The coalition claims that the drafting process "ignored critical public input to the proposed framework...the public – whose health is endangered when antibiotics are overused, whatever the setting – is being left out of the process" (Keep Antibiotics Working 2023). The history of animal antibiotic use policy begs the question: just how powerful are consumer groups and the voice of the "public" in influencing government action? Analyzing the relationship between meat producer associations, consumer advocacy groups, and government actors from a political science perspective is necessary to inform my theory of why some states have entered the policy arena to collect their own data and enforce limits on AMU in food animal production.

Literature Review: Iron Triangles and Interest Group Strength

Prominent literature focusing on U.S agricultural policy conceptualizes the federal agricultural policy process as a weak iron triangle between the USDA, congressional Agriculture committees, and industry associations, with consumer advocacy groups and other federal agencies modifying the triangle and changing policies over time (Jordan 1981, Nestle 2013, Termeer & Werkman 2011). My theory will test if the concept of a weak agricultural iron

triangle can explain how similar actors at the state level (mainly state consumer advocacy and producer groups) engage in the introduction and design of antibiotic use data collection policies.

The United States is often described as a pluralist or neo-pluralist society where multiple interest groups compete and collaborate to shape policy[24]. Pluralist theory evolved to acknowledge that not all interest groups have equal financial and organizational resources, and that government bodies have policy preferences rather than being a "referee" between the preferences of multiple interest groups (Howlett & Ramesh 2003:37-39). Different government actors including agencies and legislative committees can vary in their interest and interpretation of issues within the same policy sphere (Cigler, Loomis, & Nownes 2016:349). Interest groups with significant resources that interact regularly with these government actors can impact their priorities and actions; this concept is the foundation of iron triangle theory.

Iron triangles are described as "a stable set of participants coalesced to control fairly narrow public programs which are in the direct economic interest of each party to the alliance" (Heclo 1978:102, as cited in Howlett & Ramesh 2003:149)[25]. The classic iron triangle model is a historically close relationship between one or multiple industry organizations, legislators serving on committees related to industry policy, and the government agency (or agencies) charged with regulating the industry[26] (Cater 1964 as cited in Howlett & Ramesh 2003:149). Actors within the triangle have established and constant systems of communication with each other, resulting in a

[24] Pluralist policymaking is often contrasted with corporatism, in which a central government authority directs public policy with hierarchical interest group representation consisting of a peak association representing the private sector in distinct industry categories (Jordan 1981:96).

[25] The first part of this literature review draws upon Chapter 6 of *Studying Public Policy: Policy Cycles and Policy Subsystems* 2nd edition by Howlett & Ramesh, especially discussions on Hugh Heclo's theories of policy subsystems. Heclo's definition of iron triangles also applies to subgovernments, which are "understood as groupings of societal and state actors in routinized patterns of interactions" (Howlett & Ramesh 2003:148-149).

[26] Iron triangles are a useful way to conceptualize the relationships between government agencies, industry, and legislative committees on a specific issue/policy area. Triangles are not technically limited to three actors, though: there may be multiple agencies or committees that are embedded with industry and play a significant role in the policy process.

closed decision-making and policy design process that privileges industry information and priorities over actors outside of the triangle (Howlett & Ramesh 2003:149-150)[27]. Defining the actors in the federal agricultural policy subsystem- and their patterns of interaction- is necessary to later test whether and how changes in consumer and producer group strength have affected state AMU policy design[28].

The relationship between the agricultural industry, the USDA, and congressional Agriculture committees after World War II is cited as a prime example of an iron triangle (Cigler, Loomis, & Nownes 2016:29, Nestle 2010, Jordan 1981:118, Cater 1964 as cited in Howlett & Ramesh 2003:149)[29]. The agricultural industry has many powerful actors besides food animal producers, however for this thesis I will narrowly define industry actors in the iron triangle in as the most relevant industry actors posited by previous literature as meat producer associations, meat companies (also known as integrators or processors), farmers, veterinarians, and animal drug manufacturers (Armbruster & Roberts 2018:307). At both the federal and state levels, these industry stakeholders are represented through trade associations that set industry and policy priorities. These associations are effective at translating their priorities into policy due in part to their collective action capacity, or their ability to effectively organize and advocate for their preferences (Cigler, Loomis, & Nownes 2016:208 & Root Cause 2024). Part of this capacity is due to the selective benefits that are only enjoyed by members of industry interest group(s). Farmers, veterinarians, and meat companies participating in producer associations

[27] Iron triangles are often related to subgovernments and closed policy communities in political science literature; a subgovernment is understood as "groupings of societal and state actors in routinized patterns of interaction" (DeHaven-Smith & Van Horn 1984 as cited in Howlett & Ramesh 2003: 144).
[28] Howlett and Ramesh note that studying the structure and behavior of policy subsystems is vital to understanding the policy formulation/design step in the policy process (145).
[29] In his analysis of theories of policy processes including iron triangles and issue networks, Jordan writes, "Thus Lowi in 1964 was writing 'That agricultural affairs should be handled strictly within the agricultural community is a basic political principle established before the turn of the century.'" (Jordan 1981:117-118)

accrue selective benefits, such as decreased insurance rates, a network of local agricultural expertise, and profits incurred by lower meat production costs and higher production volume (Loomis & Cigler 2016:9 & Ekakoro 2019:5). As a result, producer groups that provide selective benefits often have high organizational strength in the form of financial resources and large or consistent membership (Loomis & Cigler 2016:9).

Another reason for producer groups' strong collective action capacity to influence agricultural antibiotic use policy is that concentrated costs of increased regulation of AMU would impact their daily operations and economic bottom line (Cuellar 2014:359 & Nestle 2010). The effects of legislation on corporations and the farmers they contract with would be relatively immediate compared to the years and decades-long timeline expected by scientists and consumers to reduce human drug-resistant infections. Analysis of AMU data could expose the improper use of antibiotics acquired from a veterinary feed directive or prescription, such as using antibiotics for a longer duration or for a different indication (such as administering antibiotics for disease prevention rather than as a therapy for a diagnosed disease). The documentation of improper use could lead to legal action or increased regulation against specific producer groups or the whole industry. Financial penalties incurred due to antibiotic overuse or the costs of changing farming practices to reduce the need for antibiotics to prevent disease would be concentrated to a small group of society, leading to "powerful incentives for corporations and other private interests in a pluralist, democratic system to thwart or water down reforms" (Cuellar 2014:359).

As a result, meat industry associations provide informational and fiscal resources to policymakers and government officials charged with regulating their industry, especially legislators on Senate and House Agricultural committees and USDA officials (Cigler, Loomis, &

Nownes 2016:208). Trade groups like the National Pork Board, National Chicken Council, and the National Beef Cattlemen's Association, and some large corporations such as Tyson and JBS, contribute directly to candidates or send money through political action committees (PACs) like the American Meat Institute (Open Secrets 2024). These producer groups are often allied with other associations representing farmers that contract with companies to grow food animals, pharmaceutical companies that manufacture animal antibiotics, and veterinarians that prescribe antibiotics for farm operations. There is abundant evidence that industry associations and PACs target financial contributions to legislators on agriculture committees, especially to incumbent and Republican legislators (Nestle 2013 & Open Secrets 2024)[30]. Although financial contributions to legislators may not significantly influence legislators' floor voting patterns, lobbying and campaign contributions can facilitate information exchange between the interest group and legislative staff that encourages a pro-industry viewpoint and leads to prioritization of industry issues on committee agendas (Powell 2014:80-83).

In addition to legislators, associations like the American Farm Bureau and the National Pork Board also communicate closely with the USDA to implement farm and food safety policies. Industry groups lobby government officials involved in federal rulemaking processes to dictate how legislation is implemented, including USDA standards for meat production, food labelling, and testing for foodborne pathogens like *Salmonella* and *E.coli* (Nelson & Yackee

[30] "From 1987 to 1996, 18 of the 25 leading Senate recipients of contributions from meat and poultry processor PACs—and 17 of the 25 leading House recipients—were members of agriculture committees, as were about half of the top 25 recipients of contributions from grocery distributors, wholesalers, and retailers. About 95% of the funds from agricultural PACs go to incumbents." (Nestle 2013). According to OpenSecrets, 79 percent of contributions from the meat processing and products industry have gone to Republican candidates or legislators.

2012:343 & USDA FSIS 2024)[31]. The revolving door of employment between USDA officials and industry leaders has also been used as evidence of an iron triangle (Nestle 2010)[32].

Close relationships and co-creation of policy between industry groups, legislators, and officials often connote corruption and the undue influence of industries and corporations on public policy. However, it is natural (to an extent) for constant communication, information exchange, and the shared provision of resources to develop between industries and the government actors that regulate them (Jordan 1981:117). When committees or agencies specialize in regulating a set of related public policies, they must obtain information from the private sector about the feasibility of proposed policies or rules; this creates "a pattern of probable participants" who engage in policy discourse, and "in that environment exchanges between negotiators limit the uncertainty in which each operates" (Ibid.)[33]. However, the vertical fragmentation endemic to the United States due to the federal system[34] and the horizontal fragmentation between agencies (mainly the USDA and FDA, and between State Departments of Agriculture and Health) create an environment in which government actors often lack sufficient

[31] Industry groups often provide fiscal resources to implement policy through public-private programs or governance models, where responsibilities for data collection, analysis, and pilot programs are shared between industry groups and agencies. One example of this in food safety is the HACCP program between meat producers and the USDA, discussed in the background U.S. Federal Action section.

[32] Marion Nestle provides a short but thorough overview of the agricultural iron triangle between USDA, Congressional Agriculture committees, and industry in Chapter 2 of her book *Safe Food: The Politics of Food Safety (2010 edition)* under "The USDA's Historic Mission: Promoting Food Production."

[33] In his discussion of major types of policy processes, Jordan states, ''there is a logic to negotiation within the professional-bureaucratic complex. Participants recognize the 'natural' members of the system and relationships develop. It would be too costly (in terms of effort) for all groups to intervene in all areas, or even randomly, and a pattern of probable participants in an area develops. In that environment exchanges between negotiators limit the uncertainty in which each operates; in any case both sides will gain by increasing resources devoted to that sector. This is echoing Christoph's point (1975) that 'it would be unnatural if officials did not identify in some way with the interests of their clienteles and within the overall framework of current government policy advance claims finding favour in the department"' (Jordan 1981:117).

[34] Cigler, Loomis, and Nownes write, "the existence of a federal system thus significantly affects the capacity of state officials to deal with pressing issues in a timely and consistent fashion because public policies are made and implemented by the national/central as well as state/provincial governments. It makes public policy-making a long, drawn-out, and often rancorous affair as the different governments wrangle over jurisdictional issues..." (Cigler, Loomis, and Nownes 2016:63).

autonomy and capacity to direct food safety policy (Buck 2018:324). This lack of government autonomy can lead to industry capture of government agencies and/or legislative bodies.

In an ideal world, government agencies and industry coexist in a relationship of *embedded autonomy*[35]; strong private sector actors like meat producers work with an equally strong state to exchange information necessary for policy design and evaluation, iterate and improve existing regulations, and address negative externalities like AMR bacteria (Evans 1995:57 & Howlett & Ramesh 2003:70). When the balance of resources - such as information, money, market power, and collective action capacity - between an industry and the agency/agencies that regulate them is disturbed, the goal of embedded autonomy can descend into a reality of *regulatory capture* by a private interest or sector of society (Burris et al. 2018: 232). Carpenter and Moss define regulatory capture as "the result of process by which regulation, in law or application, is consistently or repeatedly directed away from the public interest and toward the interests of the regulated industry, by the intent and action of the industry itself" (Carpenter & Moss 2014:13). Capture can also occur between industry actors and legislative bodies or committees. Legislative capture can be facilitated by direct producer engagement with legislators through lobbying and campaign donations and indirect methods such as developing voting blocs in the legislator's constituency (Carpenter & Moss 2014:19). Policy decisions made under government capture are often misaligned with public preferences and, in the case of food policy and other public health issues, can be detrimental to consumer health.

[35] Evans, who coined the term embedded autonomy, used it to describe the how developmental states work with industry sectors to achieve industrial transformation, including Japan, Korea, and Taiwan. In his book *Embedded Autonomy: States and Industrial Transformation,* Evans explains that embedded autonomy consists of ''bureaucratic insulation with intense connection to the surrounding social structure'' and asserts that ''given a sufficiently coherent, cohesive state apparatus, isolation is not necessary to preserve state capacity. Connectedness means increased competence instead of capture" (Evans 1995:57).

However, iron triangles and capture occur in degrees; strong iron triangles and instances of strong industry capture exist but weak iron triangles and "weak capture" of agencies are far more common in U.S. politics (Carpenter & Moss 2014:11, Rausser & Zilberman 2014, & Bagley 2010:4). The degree of capture of government agencies by industry partly depends on the autonomy of the government agency involved. Partial agency autonomy, denoting weak regulatory capture, can be observed when "evidence indicates that external parties do not design or uniformly support a major new agency policy" but industry can still direct policy outcomes against the public interest for a myriad of reasons, including that agencies lack sufficient resources "to protect their legal jurisdiction and advance their policy commitments" (Carpenter & Moss 2014:333-336).

Although the literature on indicators of strong iron triangles is relatively scarce, a stronger instance of industry capture can credibly indicate a stronger iron triangle relationship because strong capture implies (among other things) that 1) agencies consistently align with industry proposals and that 2) the captured government actor uses their government resources to economically reward industry through policy (Carpenter & Moss 2014:15)[36]. Therefore, the extent to which agencies exhibit partial autonomy, shown through industry disagreement with a proposed agency rule, will serve as an indicator for a weaker iron triangle (Ibid.).

Iron triangles also differ based on their inclusion of new actors and ideas in the policy process, with strong or tight iron triangles indicated by a completely insulated process that is not receptive to any force outside the triangle. Weak iron triangles, on the other hand, may allow

[36] Carpenter and Moss write about ways to identify regulatory capture by an industry: "three general empirical standards follow straightforwardly from our definition. To claim capture, an argument ought to: 1) Provide a defeasible model of the public interest 2) Show a policy shift away from the public interest and toward industry (special) interest 3) Show action and intent by the industry (special interest) in pursuit of this policy shift sufficiently effective to have plausibly caused an appreciable part of the shift" (Carpenter & Moss 2014:15).

some new actors or ideas to enter but retain the power structures and patterns associated with an iron triangle. Heclo theorized that policy subsystems exist along a spectrum, with subgovernments and iron triangles are often defined as the most rigid and autonomous policy subsystem, contrasted with issue networks where many actors are included in a policy process and their relationships with each other are variable and fluid (Howlett & Ramesh 2003:148-149). Therefore, there is sufficient evidence from the literature to claim that a more open policy community receptive to new ideas and actors signifies a weaker iron triangle, while a closed and rigid subsystem including only established actors indicates a strong iron triangle (Howlett & Ramesh 2003:148-149). The U.S. federal agricultural iron triangle, and the relationship between the USDA and meat producers, is an example of an iron triangle that weakened over time, demonstrated through the entrance of new actors and food safety policy aligned with public over industry interest[37].

The landscape of agricultural politics underwent significant transformations in the 1970s when consumer and environmental interest groups began exerting influence on the agricultural policy agenda to include considerations of the impacts of fertilizers, herbicides, and pesticides on public health (Cigler, Loomis, & Nownes 2016:29). The content and process of agricultural policy and rulemaking was criticized for prioritizing "price and income support policies" over addressing "environmental pollution, the degradation of nature, animal diseases, and animal

[37] For this literature review, I have chosen to focus on the weakening of the traditional iron triangle relationship established in the 1950s and 60s between the USDA, Agriculture Committees, and the food producer and farm industry. This is because this iron triangle relationship is more pertinent to *state* policies regarding antibiotic use than the relationship between FDA and the agricultural industry. Most state policies introduced (including the MD and CA policies studied in this thesis) are implemented through the state Department of Agriculture, not the Department of Health. Additionally, the USDA has the most history of closely monitoring food producer and veterinarian behavior on farms, which is what state policies seek to accomplish. The policy landscape for agricultural antibiotic use, however, has also included close relationships between FDA, Ag committee legislators, and the agricultural industry since the 1970s: for more information on FDA's role, see the U.S. Federal Response section in the background for this paper.

welfare issues" (Termeer & Werkman 2011:284). At the same time, a new federal agency became involved in agricultural antibiotic use; following the release of the 1969 Swann Report in the United Kingdom, the FDA began investigating the human health impacts of animal antibiotic use and FDA Commissioner Donald Kennedy proposed a ban on antibiotic use as growth promoters in 1977 (Schwartz 2014). Although the ban on AMU for growth promotion was not finalized until 40 years later with the VFD Rule, these events exemplify "the participation of more and more participants seeking a re-allocation of values in 'triangles' which were essentially committed to existing values" (Jordan 1981:118).

Although the U.S. agricultural iron triangle has allowed new actors such as the FDA and consumer groups to influence policy, meat producers, USDA, and Congressional Agriculture committee actors still "tend to exclude new participants and to dominate the discourse" over agricultural policy (Termeer & Werkman 2011:284). Environmental and public health policy literature on other topics emphasize that weakened iron triangles still create policy prioritizing industry profit over the health of current and future generations of U.S. citizens (Ainsworth, Godwin, & Godwin 2016:350). One example is analyses on the regulation of perchlorate, a toxic chemical that can damage the human thyroid gland, especially in fetuses and infants (FDA 2017)[38].

Perchlorate is manufactured by space and military actors including the department of Defense (DoD), the Navy, the National Aeronautics and Space Administration (NASA), and private defense companies like Lockheed Martin to aid combustion for rocket fuel and explosives (Ainsworth, Godwin, & Godwin 2016:350 & FDA 2017). Removing perchlorate from

[38] See *Interest Group Politics* 9th Edition Chapter 16 pgs 348-352 for the referenced case study on perchlorate regulation and see Chapter 10 for a case study on tobacco regulation discussing weakened iron triangles.

the environment after defense installations is extremely costly, so when the Environmental Protection Agency (EPA) investigated perchlorate as a potential drinking water contaminant in 1985, the allied defense industry, DoD, and NASA mobilized a separate Perchlorate Study Group (PSG) to discredit the EPA and encourage President Reagan to limit the agency's involvement (Ainsworth, Godwin, & Godwin 2016:350 & U.S. GAO 2010:4)[39]. After President Clinton came into office and worked with Congress to request a review of the evidence on perchlorate toxicity by the National Academy of Sciences (NAS), the EPA set the perchlorate standard, or reference dose, at NAS's recommendation of 24.5 parts per billion (ppb) (Ibid.). Although this new standard was significantly lower than the status quo, it was not as stringent as the EPA's draft standard of 1 ppb[40] (350-352).

The *watered-down policy* created through battles between the EPA and Departments of Defense and NASA mirrors the interaction between the FDA and the USDA over animal antibiotic use. One agency concerned with a negative health externality affecting citizens tries to intervene in the production of that externality, which is regulated by a different agency. The ensuing interagency competition and lobbying results in the new agency limiting their policy objectives to align with the interests of the original iron triangle. The perchlorate case study showcases another indication of an iron triangle; intergovernmental lobbying between an agency and a legislative body or lobbying between an established agency and an agency attempting to

[39] "Personnel from NASA, the Navy, and the DoD played the key roles in coordinating the perchlorate industry and counteracting the EPA's efforts", including providing the Perchlorate Study Group with "technical information that signaled the [Reagan] White House of the impact of the proposed RfD [reference dose] on industry and government" (Ainsworth, Godwin, & Godwin 2016:350-352).

[40] Parts per billion (ppb) is a measure used to describe the concentration of a contaminant in drinking water. The reference dose (RfD) is a measure of the maximum concentration, in ppb, of a contaminant that can legally be present in drinking water. Originally, the RfD for perchlorate was set at 200 ppb. The EPA proposed to decrease the RfD to 1 ppb in 1985. (U.S. GAO 2010:4)

enter the original triangle. The extent of intergovernmental lobbying on antibiotic use policy will be another indicator used to assess the strength of state iron triangles.

The perchlorate case also demonstrates that new consumer groups and government actors can enter established iron triangles and improve industry regulations, albeit incrementally (Apollonio 2016:207)[41]. In both the antibiotic use and perchlorate case, state governments were the next actors to enter the policy space and demand reform. In 2006, two U.S. states (Massachusetts and California) adopted perchlorate standards stricter than the federal standard (Massachusetts set their standard to 5ppb and California to 6ppb). Perchlorate manufacturers and industry users in those states were put at a "competitive disadvantage" and lobbied representatives in Congress to push a federal revision of the perchlorate standard to match their states' standards (Ainsworth, Godwin, & Godwin 2016:351). Although California representatives were not successful in securing a new standard in 2007 and 2008 due to intense lobbying from the perchlorate industry and DoD, new state legislation on the topic reinvigorated the debate around perchlorate standards at a federal level (351)[42].

The introduction of state legislation on perchlorate after insufficient action from the federal government invokes the idea of states as laboratories for democracy (also known as democratic experimentalism theory) where states test laws and regulations that can inform federal policy reforms (Aguirre 2017:64). This strategy has been openly used by consumer

[41] Although the perchlorate example contains more than one government agency with close relationships to the defense industry and may better be termed as an iron maze of government and industry interests, I use the term iron triangle for simplicity.

[42] In 2011 the EPA (in collaboration with the Obama administration) officially declared perchlorate as a hormone disruptor and "issued a determination to regulate perchlorate in drinking water in accordance with the Safe Water Drinking Act" (EPA 2024) This determination was withdrawn in 2020 due to evolving perchlorate testing and reference dose recommendations. On their website, the EPA states that they plan to issue a proposed National Primary Drinking Water Regulation for perchlorate by November 2025. (EPA 2024. "Perchlorate in Drinking Water"

groups including the U.S. Public Interest Research Group (U.S. PIRG) and the Natural Resources Defense Council (NRDC) to improve antibiotic use data collection, leading to the introduction of antibiotic use data collection laws in Maryland, California, and four other states. In a 2018 article, U.S. PIRG stated,

> *"Since large farming operations and the drug industry have so far blocked efforts in Congress to federally regulate antibiotics on factory farms, we've turned to the 'laboratories of democracy.' By working with state legislators to pass bills regulating or banning the use of human antibiotics on factory farms in their states, we can more quickly shift away from the food industry practices that led us to our current predicament." (U.S. PIRG 2018)*

Whether at the federal or state level, consumer groups need significant collective action capacity, or the ability to channel their preferences into policy outcomes, to enter closed policy spaces, build coalitions with supply chain actors, and impose costs on representatives or agencies who support the status quo. However, producer groups' collective action incentives to oppose antibiotic use regulations is generally greater than consumer groups' incentive to advocate for them due to the differing nature and timing of benefits enjoyed by participating group members:

> *"In many regulatory settings, consumers and citizens face a collective action problem in advocating for their preferred outcomes, whereas regulated entities can coordinate to overcome free rider problems. The resulting imbalance in participation can, in some cases, produce outcomes that are 'consistently or repeatedly directed away from the public interest" (Cuellar 2014:365)*

Mancur Olson's theory of collective action states that groups offering selective benefits are often more successful in formation and survival than groups that offer collective benefits, or benefits that "accrue to all members of a class or segment of society regardless of membership status" (Loomis & Cigler 2016:8). Consumer groups aim to provide a collective benefit; in this case, the reduction of antibiotic overuse in agriculture and a decrease the transmission of resistant pathogens for all current and future members of a society (Smith & Coast 2020).

Groups that advocate for collective benefits often face a free-rider problem; there is little incentive to participate or allocate resources to that group if those who do not participate also receive the good that the group provides (Loomis & Cigler 2016:8).

Other attributes of the AMR issue, including issue visibility and the concentration of benefits (and costs) to members of each group also make consumer group formation difficult (Buck 2018:329). The spread of AMR bacteria through nationalized (and globalized) food supply chains limits group formation because people affected by food illnesses are geographically dispersed. In modern food supply chains, meat from animals slaughtered on one farm is often sold on a supermarket shelf in multiple states or even other countries (McKenna 2017:22-23). Cases of foodborne illness that derive from one meat source are often dispersed across states and appear in humans weeks or months apart, depending on when the food was bought and consumed (Ibid). This national meat supply creates a geographical dispersion[43] of consumers who face high costs to their health through acquiring foodborne drug-resistant illness, preventing consumers from forming groups with people who share their experiences and interest in decreasing foodborne AMR.

The lack of food supply and process information available to consumers adds to a general lack of knowledge on when and how often foodborne illnesses occur, making it difficult for consumers to be informed about tracing resistant foodborne illnesses back to farm practices

[43] The geographical and time bound dispersion of an outbreak of drug-resistant foodborne infection also complicates the ability of public health officials to identify the source of foodborne AMR infections. Data on bacterial resistance patterns found in animals on farms can be difficult to obtain and integrate into a cross-state public health investigation. Some farms and the integrators that own them refuse to provide animal samples to test for AMR bacteria during outbreak investigations (Richtel 2019). This prevents public health officers from determining if consumers' infection was ultimately caused by the non-judicious use of antimicrobials in livestock. Although numerous studies have proven that antimicrobial misuse in food animal production leads to human drug-resistant foodborne illness, the difficulty obtaining proof in many real-world cases can stifle an organized response from consumers.

(Buck 2018:329). There are many aspects of food production that consumers cannot easily access, partly because USDA FSIS and CDC requirements for publicizing an outbreak or issuing a recall require that "testing on a food associated with an outbreak must be performed on an unopened food package found in the possession of a foodborne illness victim or a food retailer", which is often unavailable in the days, weeks, and sometimes months after an investigation into a foodborne illness outbreak begins (Buck 2018:326)[44]. If the consumers' cost of obtaining accurate information about antibiotic use in food production or the source of foodborne illness is higher than the individual benefit that the information would provide, then the consumer remains "rationally ignorant" (Downs 1957 as cited in Anderson, Rausser, & Swinner 2013:455-456). The rationally ignorant voter principle implies that although better information can increase consumers' willingness to act on an issue, the lack of accessible information in the present decreases consumers' incentive to support policies that would create better data in the future (Ibid.).

Another collective action attribute that can make consumer advocacy difficult is the timing of benefits from a proposed policy. For public health prevention policies such as improving antimicrobial use data collection, the benefits of reduced antimicrobial resistant infections would likely take many years and require implementing additional policies to be enjoyed by citizens. The extended timeline for receiving benefits and the complexity of solving the AMR issue often prevents the public from advocating for AMU reduction. Additionally,

[44] In Chapter 15 of *Food Safety Economics*, Buck describes an instance where 100 illness cases with the same antibiotic-resistant *Salmonella* strain across multiple states was investigated by FSIS and CDC. Consumer groups pressed both agencies to declare an outbreak or issue a recall because 87% of the victims "had consumed ground beef prior to the onset of symptoms, meaning that there was enough evidence to connect these illnesses to a food product". However, because an unopened package was not found in a victim's home or in a food retail establishment, the CDC and FSIS refused to publicize it and the investigation was closed (Buck 2018: 326).

attention to the costs of antimicrobial resistance often correlates with specific events such as outbreaks or media attention on the issue.

An outbreak affecting state citizens or found to have an origin on a farm within the state could make risks to consumers more visible and concentrated, increasing the organizational capacity of consumer groups and improve legislator's awareness and positions on AMU policy (Buck 2018:328). Additionally, consumer groups like the National Consumers League, STOP Foodborne Illness, and the Center for Foodborne Illness Research & Prevention allied with food supply chain actors and producer groups who "wanted improved oversight to restore the consumers' shaken confidence in the safety of the food supply" after a series of resistant *Salmonella* and *E. coli* outbreaks in the early 2000's (Buck 2018:336-337)[45].

Due to the considerable resource and collective action differences between producer and consumer groups, researchers emphasize that non-business groups' success in advocating for policy change "depends largely on whether they can get large numbers of corporate and/or professional groups on their side" (Loomis & Nownes 2016:370). However, there has been little academic investigation in the literature of whether (and how) producer groups supported U.S. state animal antibiotic use legislation[46]. Previous research on this subject has also called for studies of why other states have not entered this policy arena. To answer these questions, my research will characterize the strength of consumer and producer groups in three state cases and investigate whether the weak iron-triangle process attributed to federal antibiotic use policy can

[45] Allied public health, consumer, and producer groups, including the National Restaurant Association, Produce Marketing Association, and the Grocery Manufacturers Association, wrote a letter to the Senate Majority and Minority Leaders to urge the scheduling of a floor vote and support passage of the FSMA. The letter can be found on page 340 in Chapter 16 of *Food Safety Economics: Incentives for a Safer Food Supply.*

[46] To my knowledge, the only articles that prominently feature a political analysis of state antibiotic use legislation are Bliss et. al. 2023 and Wallinga 2022.

be applied to state relationships between meat producers, state Departments of Agriculture and Health, consumer groups, and state legislators.

Theory

My theory posits that *changes in the strength of food animal producers and consumer advocacy groups are individually necessary and jointly sufficient to pass strong AMU data collection policy.* Changes in group strength, including changes in organizational capacity and cohesion of actor preferences, affect producer and consumer groups' engagement with legislators, officials, and private sector groups to design and adopt policy. I seek to test whether differing consumer group strength and support from meat producers within a state can explain the variation in state AMU data collection policy design by analyzing key policy actors in Maryland, Georgia, and California.

I theorize that starting in 2014 when major poultry producer groups voluntarily reduced their AMU and increased their transparency with the government and the public, fragmentation within the meat industry decreased beef and pork producer groups' (especially in high chicken production states) strength to block government surveillance of AMU. Consumer groups, emboldened by recent AMR outbreaks and scientific discoveries of the 2010's, recognized the diverging preferences of poultry compared to beef and pork producers as an opportunity to push legislation strengthening government surveillance of AMR. Beef and pork producer groups' decrease in strength reduced the overall industry capture of state Agricultural committees and Departments of Agriculture, allowing consumer advocacy groups to gain more influence over the policy process. I assume for this thesis that a stronger capture of a government agency or legislative committee causes a tighter, more insulated iron triangle that prevents consumer groups and other state agencies from entering policy discourse. Therefore, I propose that a

decrease in industry strength weakened the industry capture of state actors and opened the state agricultural iron triangle to new food safety advocacy groups.

This theory is supported by the fragmentation of meat producers leading to food safety reforms such as the HACCP. In his analysis of HACCP, Cuellar states that new opportunities for regulatory innovation can be opened due to "fragmentation among relevant private sector actors (Cuellar 2014:357). In the HACCP case, some producer and food supply chain groups wanted new regulation to restore consumer confidence in the food supply chain, while other industry groups opposed new testing requirements and "some lawmakers from the House Agriculture Committee sought to force the agency [USDA] into a compromise with industry" (Cuellar 2014:338-340). Although the HACCP encountered implementation problems stemming from industry opposition and the USDA's "lack of explicit enforcement provisions" in meat and poultry inspection acts (341), the policy did significantly decrease the prevalence of *Salmonella* in raw meat samples from slaughterhouses and contributed to a decrease in human *Salmonella* infections (342-343). Cuellar also notes that the HACCP success was accomplished "against a backdrop of broad public concern and capacity for agency action", including support from consumer groups and media attention following the Jack-in-the-Box outbreak (Nestle 2010 & Cuellar 2014:357).

I predict that a similar fragmentation between chicken producers supportive of AMU reduction and beef and pork producers opposed to reduction occurred at the state level in Maryland and California to facilitate consumer advocacy and government actor support for antibiotic use data collection programs. My theory centers on the importance of state consumer groups like Maryland and California PIRG in leveraging supply chain actors and galvanizing legislators to introduce antibiotic use data collection legislation. Increased support for legislation

and regulation from consumer and producer groups has been key to weakening iron triangles and driving policy change in other food safety policy reforms besides the HACCP, including the Food Safety Modernization Act (FSMA) in 2010 (Carpenter 2014:358)[47]. In the design and adoption of the FSMA in Congress, meetings between legislators and victims of foodborne illness on Capitol Hill "motivated Congressional Members to regard food safety reform as a top priority"; these stories bolstered consumer advocacy groups' descriptions and proposed solutions for specific "loopholes and gaps that existed in America's food inspection and foodborne illness surveillance systems" (Buck 2018:338-339).

These events inform my theory that the support of consumer *and* producer groups create the best antibiotic use policy design at the state level. However, consumer groups must overcome substantial collective action obstacles to pressure state government to enact legislation for AMU data collection and enhance producer support of effective legislation (Cuellar 2014:359). There is partial evidence that collective action problems common to consumer groups discussed in the literature review have been partially overcome by consumer groups advocating for enhanced food safety and judicious antibiotic use. One point of progress has been increased issue visibility of the dangers of farm antibiotic overuse among consumers, allowing consumer advocacy groups to engage more members and exert demand-side pressure onto small and large meat producers to support reform (Buck 2018:328). Consumers have taken notice of the increase in drug-resistant infections deriving from the food supply. Due to the expansion of NARMS in the U.S.[48], consumers have learned more about links between AMU and AMR infections and have been

[47] The creation of the FDA in 1906 and a subsequent overhaul of food safety policy was largely due to the public's response to Upton Sinclair's *The Jungle* and other journalism that detailed the unsanitary and unregulated conditions in meat production facilities (Waller *et al.* 1).

[48] Just a short list of major outbreaks linked to antibiotic resistance in farm animals: MRSA (methicillin-resistant *staphylococcus aureus*), VRE (vancomycin-resistant *enterococci*), MCR (mobilized colistin resistance), *Salmonella Heidelberg*, *E. coli* O157:H7, and ESBL bacteria (extended spectrum beta-lactamase producing bacteria). (McKenna 2012:172-173, 176-177, 206-207, 231, 234, 237-238 & Johns Hopkins Medicine 2024).

exposed to the effects of antibiotic-resistant infections through media coverage, food recalls, and personal or family illnesses due to drug-resistant bacteria. This growing awareness has solidified food safety and antibiotic overuse as priorities for many consumers; a survey from the 2016 International Food Information Council Foundation reported that 29% of survey participants "regarded pathogenic food contamination as the number one safety issue" (Buck 2018: 327).

Consumer concern with the safety of the current food supply has placed greater value on enhanced information and monitoring of how food animals are raised, slaughtered, and processed (McKean 2001:363 & Buck 2018:327)[49]. Consumer groups, including large buyers like school and healthcare systems, have bolstered the market for production process certifications such as "No Antibiotics Ever" (NAE), "Raised Without Antibiotics" (RWA), "Certified Responsible Antibiotic Use" (CRAU), and "Organic" products[50]. Demand for products with these labels (approved and managed by the USDA) has increased since the early 2010s (NRDC 2016:2)[51]. According to the USDA Economic Research Service, there is a strong correlation between consumers' concern regarding AMU in meat production and purchasing of RWA and Organic labelled meat products (Page *et al.* 2021:20).

Many consumers are also willing to pay higher prices for antibiotic-free meat, further incentivizing food producers to reduce their antibiotic use. A 2012 Forbes survey recorded that "61 percent of consumers would pay an additional five cents or more per pound for antibiotic-

[49] Buck notes that a study conducted by the Center for Food Integrity in 2016 found, "over 50% of US consumers want more accurate labeling information, including details about food sources and food preparation." (Buck 2018:327).

[50] Institutional buyers such as the University of California hospital systems and the Chicago Public School system pledged to only purchase meat raised without medically important antibiotics, causing their caterers to source meat from different food producers and retailers (Champeau 2014 & Healthy Schools Campaign 2017).

[51] "Sales estimates of meat raised without any antibiotics were up 25 percent from 2009 to 2011, according to reporting published in 2012. The increase occurred despite an overall decline in U.S. per capita meat consumption across the four major categories (beef, pork, chicken and turkey) over those same years" (NRDC 2016).

free meat, and 31 percent reported that they would pay an extra dollar or more per pound" (Despenes 2015:588). Perdue Farms, the fourth largest poultry producer by market share in the United States (Zaheer 2023), estimated in 2016 that sales for antibiotic-free products were growing 12-17% faster annually than conventional chicken sales (Bunge 2016 and Armbruster & Roberts 2018:308). This change in consumer purchasing habits has been cited by multiple producers and food retailers as a primary reason for the reduction of AMU in chicken production[52] (Armbruster & Roberts 2018:310, PBS Newshour 2017, & McKenna 2017:276).

The inclusion of business associations in consumer group initiatives also serves as a powerful signal to legislators that antibiotic overuse could negatively impact not only consumer and public health, but also the state economy and food production-related industries. Although these business groups are generally not corporate food producers like Tyson, Perdue, and stakeholders directly involved in meat production and processing, some other supply chain groups like restaurants, grocery companies, and food retail companies have a history of advocating for reduced animal antibiotic use. Increased issue visibility and coalitions with supply chain actors helped consumer groups prioritize antibiotic use on state policy agendas and facilitated their active role in policy design. I theorize that consumer group success in encouraging food retailers like McDonalds, Panera, and Chipotle to reduce AMU signals (and

[52] As consumer preferences change, "organizations will source products which meet consumer standards for quality and safety" because "the ability of the retailer to meet or exceed consumer expectations dictates commercial success" (McKean 2001:365). Grocery stores such as Whole Foods and restaurant chains including McDonalds, Chipotle, Panera, and Chick-Fil-A responded to consumer expectations by pledging to sell and use antibiotic-free chicken. The excellent consumer response allowed some of them to build out their own antibiotic-free supply chains (Despenes 2015:589-90 & McKenna 2017:271-272).

contributes to) an increased collective action capacity to work with state legislators and agencies to pass state policies to combat antibiotic overuse.

State groups like CalPIRG and Maryland PIRG worked with legislators on policy provisions to ensure that data collection was systematic and enforceable, however in California, policy provisions to define limits on AMU and ensure full agency implementation were less robust. I hypothesize that these provisions were excluded due to the strength of opposition from beef and pork producer groups during the policy process in California (which has a relatively small poultry industry compared to Maryland).

Demand-side pressure from consumers and their allied supply chain actors caused many of the top meat production companies to voluntarily reduce AMU before the FDA banned AMU for growth promotion purposes in 2017. However, the change in preferences regarding AMU in food production is not equally distributed; chicken producers have far outpaced beef and pork producers in their reduction of AMU (Kar & Brook 2019 & Wallinga 2020:5)[53]. From 1998 to 2002, Perdue Farms conducted a company-wide study to quantify the economic costs of producing antibiotic-free chickens (McKenna 2017:266). Although the meat industry had maintained for decades that using antibiotics in feed improves feed efficiency, or the conversion of feed mass into animal body mass, Perdue found that differences in feed efficiency and disease rates between antibiotic-laced feeds and non-medicated feeds were practically negligible[54].

[53] In her book *Big Chicken*, journalist Maryn McKenna writes, ""Yet after the events of 2013, chicken turned against its own history. Some of the largest production companies in the industry renounced antibiotic use. Some of the largest food service retailers in the United States committed to carrying only birds raised without routine drugs. Medical centers, college campuses, school systems, and restaurant chains joined the refusal, pushed by advocates and by parents who had awakened to the danger to their kids. At a point where the cattle and hog industries were digging in their heels to resist FDA policies, poultry rushed to the front of the line and called it a parade." (McKenna 2013:32).

[54]The chickens not exposed to antibiotics also had the same mortality and disease rates as chickens on antibiotics, showing that the "disease prevention" use of antibiotics did not produce drastic health benefits like the industry

Perdue found that the benefits of using antibiotic feeds outweighed the costs of losing consumer confidence and business over antibiotic use (PBS Newshour 2017 & McKenna 2017:266-267), leading them to remove antibiotics from all their production processes by September 2017 (Perdue 2023).

Other large producers like Tyson Foods and Sanderson farms have also reduced their antibiotic use, and because a few mammoth integrators encompass most of the chicken market, the estimated sales of MIAs for chicken production decreased by 69% from 2016 to 2021 and in 2021 composed only 3% of the total MIA sales in food-producing animals (FDA CVM Summary Report 2022:19-20)[55]. Cattle and swine producers have reduced their MIA purchases by 32% and 19% respectively, making up a combined total of 82% of MIA sales in 2021 (FDA CVM Summary Report 2022:19-20)[56]. I build on existing evidence that the differential costs of AMU data collection between chicken and beef producers have caused beef and pork producers to vehemently oppose data collection provisions, while chicken producers may tolerate and even support antibiotic use data collection legislation[57].

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claimed. Antibiotics did vastly improve the feed efficiency and growth of animals when antibiotics first started to be used, but their effect has declined over the decades of use. Because scientists have not pinpointed the exact reason why antibiotics were such good growth promoters in the first place, their reduced efficacy is also somewhat of a mystery. According to Jim Perdue (chairman of Perdue Farms), "There was a perception that they [animals] would grow better if you gave them antibiotics, because it would, for lack of a better word, clean up the gut and absorb nutrients more efficiently...But you do a lot of things that you have been doing forever, and you just assume that's the way you do it, until you actually look at it and test it." (PBS Newshour 2017).

[55] The NRDC states that 92% of U.S. chicken sold last year was produced without MIAs (Kar & Brook 2019). Many producer companies and government statistics use the term "medically important antimicrobial" to refer to antibiotics that should not be used for agricultural purposes due to their importance (and use in) human medicine. This distinguishes them from antimicrobials (and antibiotics) that are not used in humans, such as ionophores. However, because bacterial plasmids can transfer multiple antibiotic-resistance genes after exposure to one antibiotic, scientists and doctors warn that the overuse of any antibiotic, whether classified as a "medically important antimicrobial" or not, poses a risk to human health (Interview with CDC NARMS Official, 11/29/2023).

[56] Because these are sales data and not actual antimicrobial use data, these species-specific metrics are only estimates of the actual use of MIAs in chicken, cattle, and swine. Other food-producing animals such as turkey and fish are also included in the summary report. For this paper, I will be focusing on chicken, cattle, and swine producers.

[57] Since the fragmentation between poultry, beef, and pork producers is key to explaining why some state AMU legislation has succeeded, it is necessary to understand the possible causes of this fragmentation – including the role

Beef and pork producers' resistance to change is due partly to the longer growth period required to raise cattle and pigs before slaughter compared to chickens. This longer growth timeline presents more opportunities for animals in crowded conditions to get sick, increasing beef and pork producers' dependence on antibiotics to keep animals healthy (Wallinga 2022:343 & Torrella 2023). Additionally, chicken integrators, as their name suggests, are vertically integrated; companies such as Perdue and Tyson control every step of chicken production and therefore control the use of antibiotics on chickens even before they hatch from their eggs. Although beef and pork industries are becoming more vertically integrated to mimic chicken production (Wallinga 2020:6), they are still decentralized, and therefore the producer companies have a harder time controlling the use of antibiotics throughout a cow or pigs' life (Torrella 2023).

The reputational and legal costs of data collection and analysis would likely affect beef and pork producers significantly more than chicken producers in the United States. 20 of the top 22 chicken producers in the United States participate in labeling and certification programs through the USDA, meaning that their antibiotic use is already monitored by the federal government (Kleven 2019). Additionally, an estimated 85% of the poultry industry reports antibiotic use data to the U.S. Poultry and Egg Association, which is collected and published online through a cooperative agreement with the FDA (Mindwalk Consulting Group 2022). The data collection pilot confirmed a drastic decrease in the use of MIAs, touting "voluntary

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of consumer pressure in shaping industry actions. There are many proposed reasons for why chicken producers drastically changed their AMU preferences while other meat sectors did not; although these theories are outside the scope of this paper, a few core differences between the industries can explain differences in the collective action capacity of various production sectors. Ultimately, I consider the changing preferences of chicken and beef/pork industries as exogenous – there is sufficient evidence in the literature to assume that a significant fragmentation in preferences does exist. My thesis focuses on how this divergence in preferences affected producer group strength and their role in the policy process.

participation of most of the major companies in the broiler chicken industry of the U.S." (Singer *et al.* 2023:15). Poultry producers' willingness to report AMU data to national trade organizations in collaboration with the FDA has not been mirrored in cattle or swine industries, providing preliminary evidence of the differences in data collection preferences and capacities between the industries. I hypothesize that tolerance for *private* data collection run by a poultry industry group could also contribute to greater poultry producer tolerance for *public* governance of AMU data collection by state Departments of Agriculture.

Beef and pork producers would also experience the brunt of concentrated-front costs and profit losses if AMU regulation were passed. Since the United States beef and pork production industry has made little progress on reducing antibiotic use, government regulation and limits on AMU would require a large investment from companies and farmers into improved agricultural infrastructure. Reducing the use of antibiotics usually requires costly improvement in farm management and new measures to protect animal health (Ekakoro 2019:6-7). This is because CAFOs have relied upon antibiotics to prevent the spread of disease in concentrated conditions and to support the weakened immune system of herd animals caused by crowding, stress, and an inactive lifestyle (Neff 2014:295 & Wallinga 2020:8). However, many chicken producers and the farmers they contract with have already invested in and adopted the infrastructure necessary to keep animals in CAFOs healthy while decreasing or eliminating antibiotic use. Chicken producers like Perdue have prided themselves on obtaining No Antibiotics Ever certifications and have marketed their reduced antibiotic use to consumers and food retailers; it is possible that chicken producers are motivated to support legislation that would further bolster their claim and increase customer confidence in their products (McKean 2001:368).

Participation of supportive producer groups in the policy process also adds valuable knowledge of how to ensure the efficacy and sustainability of a data collection program that requires industry cooperation. Producer group support could translate to lawmakers' ability to include more explicit definitions and standards about what constitutes complete data reporting and what constitutes lawful AMU. Even in high-chicken production states such as Maryland and Georgia where major poultry producer groups may tolerate or support government collection of AMU data, my theory posits that consumer groups play the key role in pressuring legislatures to consider and introduce AMU data collection legislation. I hypothesize that consumer groups in Georgia lacked collective action and organizational strengths that were present in California and Maryland groups, therefore preventing legislation from being introduced in the Georgia legislature.

Hypotheses

	Consumer Groups' Strength of Support for Legislation	**Producer Groups' Strength of Support for Legislation**	**Legislative Strength**
Maryland	Strong	Strong	High
California	Strong	Weak	Medium
Georgia	Weak	Strong	0 (No legislation)

Hypothesis 1*: An increase in consumer advocacy group strength within a state will be correlated with bill introduction and more effective policy design.*

Hypothesis 1A: *If Maryland and California enacted a similar bill in 2017 and 2015, respectively, they should both have experienced increases in consumer advocacy group strength that correlate with legislation passage.*

Hypothesis 1B: *An increase in strength of Maryland's consumer groups will correlate with the 2019 legislative addition to the No Antibiotics Ever Act.*

I hypothesize that positive changes in the strength of consumer groups in Maryland and California played a causal role in designing and enacting antibiotic use data collection legislation. Specifically, an increase in consumer advocacy group strength preceded the introduction of legislation in 2015 for California, and in 2017 and 2019 in Maryland, facilitating greater access to government actors including legislators and officials at state Departments of Health and Agriculture. Based on the history of how the increased strength of food safety advocacy groups facilitated their entrance into agricultural iron triangles at the federal level, I predict that increased consumer access to the agricultural policy space allowed consumer groups to add new provisions and definitions in policy writing to strengthen data collection.

There are multiple implications stemming from my hypothesis that increased consumer group strength caused the prioritization and improved design of antibiotic use legislation. One implication of Hypothesis 1A is that consumer groups like MD PIRG and CALPIRG were the key drivers of policy introduction in 2017 and 2015, respectively, and were not brought into the policy discussion after legislation was already encouraged by other actors like activist legislators or industry groups. Another implication for my theory is that consumer groups involved in the 2019 legislative addition in Maryland, which added most of the data collection provisions and enforcement, worked closely with food supply chain actors and were openly supported by business groups.

Hypothesis 1C: *Consumer advocacy groups in Georgia did not have the organizational strength required to serve as a catalyst for legislation like consumer groups did in Maryland and California.*

Given the historical iron triangle relationship between legislators, food producers, and Agriculture agencies, it seems unlikely that legislators would push the introduction of legislation to further regulate the meat industry without strong incentive from consumer advocates. Landmark legislation in food safety has been catalyzed by greater consumer knowledge of outbreaks and support from producer groups; these events inform my theory that the support of consumer *and* producer groups create the best antibiotic use policy design at the state level. I predict that a lack of consumer group strength is why Georgia has not yet introduced legislation to collect AMU data even in the context of a dominant chicken industry; I expect to find no change (or negative change) in consumer groups' ability to influence legislation and translate their preferences into action over the period where Maryland and California have introduced and enacted legislation.

Hypothesis 2: *An improvement in producer groups' strength of support for AMU data collection within a state will be correlated with bill introduction and more effective policy design.*

Hypothesis 2A: *States with a large chicken production industry (Maryland and Georgia) experienced a greater increase in producer support for AMU data collection legislation than states with a dominant beef and/or pork industry (California).*

Existing literature has suggested that state producer groups including the California Cattlemens' Association opposed state legislation, and that in some cases poultry producers were more cooperative than their pork and beef counterparts (Bliss et al. 2023:10-15). Hypothesis 2A expands on existing knowledge and predicts that fragmentation of AMU preferences between chicken producers as opposed to beef and pork producers decreased the industry's overall ability to control state Departments of Agriculture and state legislatures, leading to new opportunities for consumer groups and legislators to introduce and pass policy designed to collect AMU data.

Increased producer support for AMU reduction (especially from the chicken industry) weakened the existing iron triangle between meat producers, state departments of Agriculture, and related legislative committees. This weakened relationship (and possibly decreased capture) between industry and government actors would allow government agencies and legislators to modify their priorities and collaborate with consumer groups. I assume that producer groups opposed to antibiotic data collection prefer the weakest possible policy design to exploit policy loopholes and avoid reporting and reducing their AMU. Therefore, if there is ubiquitous or major opposition to antibiotic use reduction among producers, I expect to find limited interaction between consumer groups and government actors consistent with a strong iron triangle.

Even if chicken producers do not voice direct support for legislation, I expect that chicken producers who have already reduced their AMU are less willing to expend resources to block legislation than beef and pork producers. Consumer advocacy groups monitoring producer groups may see this change in preferences as a window of opportunity to introduce new legislation that would have been unworkable if all meat producers were opposed to the regulation of AMU. An implication of this hypothesis is that states with a high composition of chicken production compared to beef and pork allowed greater consumer group advocacy during the legislative process. In Maryland and Georgia, I expect to find increased collaboration between legislators representing the agricultural industry and/or Agriculture agency officials and members from consumer advocacy groups. I also expect that the dominant chicken industry in Maryland facilitated more collaborative policy debate and design between producer and consumer groups than large beef and pork groups allowed in California.

Due to the high levels of chicken production in Maryland and the domination of beef and pork production in California's meat industry, I hypothesize that Maryland producer groups were

more supportive and constructively involved in policy design and adoption than California producer groups, leading to Maryland's 2019 improvement on their original Keep Antibiotics Effective Act. Because multiple policy loopholes exist in the California law that allowed lenient agency implementation, I expect that powerful producer groups opposed strict legislation and instead pushed for lenient policy writing or were not consulted in the policy design process.

Research Design: Case Comparison

I will use a qualitative, interview-based approach to construct a most-similar comparative case analysis of the U.S. states of Maryland, California, and Georgia. These three states share similarities regarding the intended independent variables of consumer advocacy and producer group strength but differ in AMU policy outcomes. All U.S. states share the same federal rules and VFD requirements dictated by the FDA, and Maryland, Georgia, and California all have prominent food animal agriculture industries. Agriculture is Maryland's "largest commercial industry" and "remains the largest single land use in the State" ("Maryland at a Glance" 2024), and "broilers and eggs are Georgia's two largest agricultural commodities, making up nearly 40 percent of the state's production value" (University of Georgia Extension 2024). In California, cattle and calves are the third largest commodity[58] (California Department of Food and Agriculture 2022). An important difference between these groups that will be studied is differing dominant species sector between states, with Maryland and Georgia having a dominant poultry industry and California having a dominant beef industry. Another similarity between states is that a large portion of active state consumer advocacy groups and producer groups in the three states share the same national parent organizations. This similarity in membership structure and

[58] Dairy and milk products are the largest commodity in California (CDFA 2022). Although dairy cows are also administered antibiotics, the production and monitoring process differs greatly between milk production compared to meat production; therefore, this project will focus on analyzing the major meat producer groups for beef, pork, and poultry.

overall group motivation derived from a parent organization, such as the American Farm Bureau or the U.S. PIRG, provides a baseline for comparing the differences in strength and activity of state producer and consumer advocacy groups.

To test my hypotheses of the relationship between consumer advocacy and producer group strength and policy strength, I will focus on changes in consumer advocacy group and producer group strength between 2015 and 2019 because the first piece of legislation from the states selected was introduced in October of 2015 and the most recent legislation was enacted in May 2019 (Bliss *et al.* 2023:4 & Wellington 2019). I will use the within-state analyses to inform cross-state comparisons on the most important drivers of effective policy design. The cross-state comparison will center around explaining two specific policy outcomes that I theorize are caused by the differential strength of consumer and producer group:

1) Policy is introduced to legislature: Maryland and Georgia have a similar market composition of high levels of chicken production and low levels of beef and pork production (USDA-NASS 2017). Georgia has never introduced legislation while Maryland contains the strongest in the country.
2) Policy is strengthened: Maryland and California passed very similar legislation in 2017, but only Maryland enacted a 2019 legislative addition that mandated stricter enforcement of the law and added new reporting requirements.

I will test if a weakened iron triangle model can explain how consumer advocacy and producer group strength (including government influence) impacted policy outcomes in each case. Although there is not sufficient literature (to my knowledge) on categorizing the spectrum of strong to weak iron triangles, I use indicators of industry capture from Carpenter & Moss, Heclo's literature on policy communities and subsystems, and past evidence of iron triangles in

food safety mentioned previously (drawn from Cuellar 2014) to support the characterization of each state's iron triangle through the following main indicators:

- The presence of a closed versus open policy community receptive to new actors and ideas, especially from consumer groups (Termeer & Werkman 2011:283 & Howlett & Ramesh 2003:148-149).
- Intergovernmental lobbying between agencies and state legislatures, especially agency involvement in policy design on behalf of industry (Ainsworth, Godwin & Godwin 2016:350)
- The extent of fragmentation or cohesion of producer group actors (Cuellar 2014:357 and Howlett & Ramesh 70)
- Strong vs weak industry capture and extent of agency autonomy (Howlett & Ramesh 2003:70 and Carpenter & Moss 2014).

Maryland and California are the only states who have successfully passed laws including AMU data collection provisions, however Maryland has a high composition of chicken producers and a low composition of beef and pork producers, while California has the opposite composition. California and Maryland both passed an almost identical law in 2017 to reduce AMU and collect data from producer groups and veterinarians, but Maryland added a legislative addition in 2019 that compelled action from state agencies and closed loopholes that marred the 2017 policy (Bliss *et al* 2023 & Wallinga 2022:344). Both Maryland and California have active consumer advocacy groups in AMR policy vocal about reducing AMU, offering an opportunity to study the influence of consumer groups on policy outcomes. Closer analysis of these cases could reveal what (and who) spurred the improvement in policy design in Maryland but not California.

Georgia, like Maryland, is dominated by chicken production compared to beef and pork production, and it houses the headquarters of one of the earliest adopters of antibiotic-free meat in the fast-food industry (McKenna 2017:276). Given the chicken industry's growing self-regulation of antimicrobial use in IFAP and their use of antibiotic-free chicken as a marketing

tool[59], it is curious that Georgia (and other states with large chicken production markets) have not introduced any policy regarding AMU data collection. Although IFAP corporations surely do not crave more government regulation or interference in meat production, many of the top chicken producers in the United States have allowed data collection from their associated farms for pilot studies and programs headed by the FDA to assess AMU and AMR in broiler production (Singer *et. al* 2023:5 and FDA-TRACK 2023). Studying each state case, and comparing their results to each other, could elucidate the role of meat producers, consumer groups, and their relationship with government actors in dictating AMU data collection policy.

I will utilize stakeholder and policy process schematics tailored to antibiotic use data collection policy to elicit information about the strength of producer and consumer groups and investigate how these groups interacted with government agencies and legislators. Interviewees will be asked open-ended prompts regarding these schematics and will be encouraged to edit or critique the schematics based on their experience (see Appendix Figures 4 & 5 for schematics). Additionally, interviewees will be shown the "State AMU Data Collection Policy Design Strength Checklist" and prompted to comment about which provisions consumer and producer groups emphasized, and if there were any important provisions considered or passed in the law that were not present.

Interviewees will include members of federal and state agencies, consumer advocacy group staff, academics, journalists, and trade association representatives primarily from Maryland and Georgia. The interview process seeks to establish whether consumer and producer groups affected or blocked policy design and the mechanisms for doing so, including whether the diverging preferences of the chicken and beef/pork industries decreased the overall strength of

[59] See McKenna's 2017 novel *Big Chicken,* "Chapter 13: The Market Speaks."

opposition toward AMU data collection legislation. This research study obtained IRB approval (Emory University Study #00007282)[60].

I will use responses from stakeholder interviews supplemented by other sources to quantify the independent variables of consumer group strength and producer group strength of support for AMU reduction. Because I plan to focus my analyses on why Maryland passed the 2019 addition and why Georgia has never introduced AMU policy despite its high level of chicken production, most of the interviews conducted will be with stakeholders from Maryland and Georgia. I will use secondary sources to supplement information from these interviews and inform the California case study. Secondary sources include campaign finance and lobbying data from Follow the Money and Cal-Access Search, bill drafts and transcripts/recordings of legislative hearings, and statements and website material from trade associations and advocacy groups.

When performing within-state and cross state analyses of California, Maryland, and Georgia, confounders that may affect producer and consumer group strength and influence the strength of data collection policy design will be addressed in each case study. A confounder that could impact both the independent and dependent variables is pharmaceutical company activity. Pharmaceutical companies that make animal drug products are vehemently opposed to reducing AMU in agriculture because it would greatly reduce their profits; indeed, over 60% of total antibiotics sold are used in farm animals (Alliance to Save Our Antibiotics 2023). Campaign contribution records for relevant legislators in each state will be analyzed, and interviewees will be asked open-ended questions about the role of the pharmaceutical industry in the policy

[60] Interviewees gave verbal consent to be recorded and consented in written form to being cited within the thesis as "employee from X organization interviewed on X date."

process to help distinguish pharmaceutical influence from meat producer and consumer group strength.

To contextualize each case and explore multiple possibilities of why policy outcomes differed between them, I will also research the state institutional and political context over the study period and design open-ended questions for interviewees to discuss the impact of other political variables on policy outcomes. The context of each state includes the state's partisanship and attitudes towards pro-business legislation, which could align with legislators' belief that private business practices should be minimally regulated to maximize economic returns (Carpenter & Moss 2014:64-67). A question that will be asked to interviewees surrounding partisanship is whether AMU policy preferences or knowledge differs along party lines in their states, and how their state's partisanship has affected AMU policy.

Construction of Variables

Dependent Variable: Strength of Policy Design

State AMU Data Collection Policy Strength Checklist		
Definitions of Key Concepts	**Reporting Requirements**	**Enforcement Mechanisms**
Defines nontherapeutic use	Requires livestock producers/owners to submit VFDs and prescriptions to dept. of rule	Civil penalties for failure to submit/provide records
Defines medically important antimicrobial	Requires veterinarians to send annual report/submit VFDs and prescriptions to dept. of rule	Funding allocated for data collection and analysis
Defines disease prevention/prophylaxis	Require disaggregated AMU data to be publicly available (with exceptions to protect producer privacy)	
Defines livestock producer/owner	Directs department to release annual reports on specific AMU metrics[61]	

[61] These specific metrics include: the total number of animals given the antimicrobial, animal species, type of antimicrobial, the total weight of antimicrobials used, the indication (reason) the drug was administered, and duration of use. All these metrics have been cited by academics and consumer advocacy groups as vital to analyzing changes and patterns in agricultural AMU. (Pew Charitable Trusts 2021 and Davis & Rutkow 2012).

Defines disease control	Legend Included in 2015 California Law (SB 27)* Included in 2019 Maryland Law (SB 471)
Defines "regular pattern of use"	
Defines "elevated risk" of disease	

*Boxes colored green also appeared in the Maryland law.

This study will analyze the variation between state policy passage and content as the dependent variable rather than directly analyzing changes in AMU data collection rates. It would be pertinent to study the changes in farm antibiotic use - or the rates of foodborne AMR infections- before and after legislation was passed in states – but current data collection and reporting infrastructures among states and the federal government[62] are insufficient to accurately assess changes in AMU (Patel *et. al* 2020:1653). In California, AMU data points vital to assessing changes in antibiotic use, including "total masses of each antimicrobial approved for use in livestock production" gathered through SB-27 implementation has not been made available to the public (Quaade et. al 2024). A 2023 epidemiological study cited the lack of available AMU data as a major barrier to establishing causality between antibiotic use monitoring policies and changes in human AMR infection rates (Casey *et al.* 2023). The difficulty in accessing and analyzing data collected from SB-27 underscores the need to evaluate how various stakeholders influenced the policy's design and enforcement capabilities. Key informants interviewed in Bliss *et al* 2023 stated that it is too soon to tell if the 2019 legislative addition in Maryland was successful in reducing AMU in livestock (8). Due to these limitations,

[62] On the federal AMU data collection level, Davis and Rutkow note: "data that are collected by the FDA on specific indications for usage (I.e., disease conditions by species), species, or month of distribution are not in the public report. Public provision of these data would harmonize reporting with that of NARMS, which is reported by species and month. Data on actual usage (I.e., amount consumed by species versus amount distributed to all food-producing animals)… are not collected, but could enhance surveillance efforts" see pg. 409 of "Regulatory Strategies to Combat Antimicrobial Resistance of Animal Origin: Recommendations for a Science-Based U.S. Approach".

this research assumes the most available and direct measure of legislative efficacy is the quality of written policy content.

To provide a measure of the strength of policy content, I have compiled recommendations for state AMU policies from Bliss *et al.* 2023[63] and commentary on the strengths and weaknesses of state AMU data collection policies from Wallinga 2022 and Casey *et al.* 2023. Through analyzing the six state AMU policy bills (from California, Maryland, New York, Illinois, Oregon, and Pennsylvania), I have included common attributes in policy writing that reflect recommendations from policy literature (PA SB246 2018, OR SB920 2015, IL SB3429 2018, NY SB0574 2019, MD SB471 2019, CA SB27 2017). Although none of the bills were passed except California and Maryland, they were all either introduced or re-introduced during the study time frame and provide examples of how policy recommendations from advocates have been included in other state laws.

Analysis of the Maryland and California bills show that both the Maryland Department of Agriculture and the California Department of Agriculture were insufficient in their implementation of antibiotic use data collection when they were given discretion over how to collect data from farm stakeholders and how to share that data in publicized reports (Bliss *et al* 2023). Specifically, strong legislation would require reporting on specific AMU metrics and require disaggregated data to facilitate research with AMU data and establish geographical AMU profiles (Cooper & Silbergeld 2017, Bliss et al. 2023, Quaade et. al 2024). The close working relationship between meat producers and departments of agriculture- and the primary goal of agriculture agencies to promote farm economic success- can contribute to lenient agency

[63] See Table 3 and Figure 2 of Bliss *et al* 2023.

interpretation of bills regulating the meat industry (McKenna 2017:181, Nestle 2010[64]). Therefore, I assume that stringent and specific policy design increases the quality of policy design because clear agency directives are necessary to prevent state agriculture agencies from leniently interpreting written data collection policies.

Independent Variables: Producer and Consumer Group Strength of Support

I will use interviews with state stakeholders and secondary sources, including lobbying data, journalism related to producer groups, and legislative data and transcripts, to quantify the strength of consumer and producer groups. I will use indicators of group strength to measure the power of each group based on results from these data sources. The indicators of group strength that I will use are visualized in the table below. I will focus on assessing the main producer and consumer groups in each state, their internal cohesion and resources, and their partnerships or coalitions with surrounding stakeholders, including academic groups, veterinary groups, farmer groups, and food supply chain actors (see Figure 3). Reasons for the inclusion of certain indicators of strength are discussed below; these indicators will be used to categorize the strength of these groups on a dichotomous scale of strong or weak. Although there are surely medium-strength interest groups, I define a strong interest group as those with a demonstrated influence on the ideas and/or actions of government actors, and weak interest groups as those that do not influence the ideas or actions of government actors on the antibiotic use issue.

[64] See Chapter 2 of Nestle's 2010 Edition of *Safe Food: The Politics of Food Safety* for examples of lenient agency interpretation of food safety laws such as their support of industry in *American Public Health Association vs Butz*.

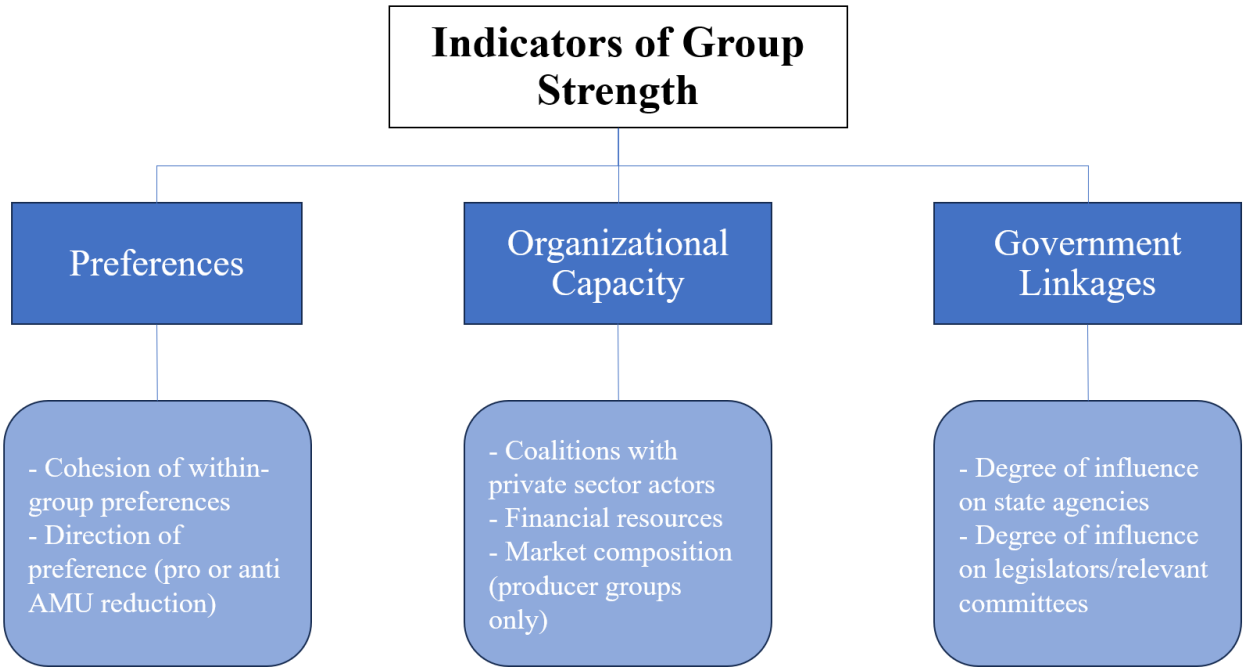

Figure 3. Independent Variable Construction: Indicators of Group Strength.

Preferences

The homogeneity of preferences within consumer groups studied in this thesis is indicated by agreement among group members that greater antibiotic use data is vital to reducing antibiotic-resistant human infections through improved public policy. Agreement among group members about the goal of the group's advocacy builds a strong foundation to develop and implement advocacy strategies facing consumers, the media, food supply chain actors, and legislators. There is evidence to assume that many chicken producers prefer a reduction in the use of medically important antibiotics, given many top industry integrators' voluntary reduction of AMU and their high levels of participation in production process verification and antibiotic

use labeling with the USDA compared with beef and cattle producers (Singer *et al* 2023 & USDA Agricultural Marketing Service)[65].

Because the beef and pork producer group AMU preferences have become increasingly different from chicken producer groups, it would be insufficient to try to compile the strength and preferences of beef, chicken, and pork producers into one measure. Therefore, I will analyze producer group strength within each state through measuring the state's chicken producer group(s) strength with beef and pork producer group strength. Experts in the field will be asked about the preferences of beef and pork sectors as compared to chicken groups, and how they have evolved over time. Even in the chicken industry, there still exist some differences in preferences around AMU reduction, so interviewees will be asked to describe the cohesion and homogeneity of large chicken producer AMU preferences for each state case. Research on the AMU and policy preferences among large beef and pork producers using public statements from producer groups and companies will also be done for each state.

Organizational Capacity

Organizational capacity reflects a group's '"ability to perform work' or the enabling factors that allow an organization to perform its functions and achieve its goals" (Cox *et al.* 2018). The aspects of organizational capacity most relevant to the political activity of producer and consumer groups, and the aspects that I will focus on in this thesis, are the group's financial resources and level of centralization, coalitions with relevant actors such as veterinarians, farmers associations, pharmaceutical companies, and linkages with state legislatures and agencies (Carpenter & Moss 2014, Termeer & Werkman 2011, Loomis & Cigler 2020). The

[65] The USDA Agricultural Marketing Service runs Process Verified Programs and the Certified Responsible Antibiotic Use (CRAU) certifications, both of which oversee the labeling and certification of producers regarding their antibiotic use.

presence of a centralized or peak association representing all chicken producers or all beef or pork producers could direct the group's political activities and speak with a cohesive voice when advocating for or against policy, increasing their strength and ability to influence policy design (Howlett & Ramesh 2023:71). Additionally, a large consumer advocacy group with considerable resources and large membership would be better able to organize and voice their preferences than multiple smaller advocacy groups.

Leveraging support from other involved actors besides food producer groups, including veterinarians, farmers, academics and scientists, and food retailers such as fast-food chains and grocery stores, increases group strength by expanding the possible resources and expertise they can draw on to assist in policy advocacy. For consumer and producer groups, linkages with these actors may make the group's policy ideas more attractive in the eyes of legislators and government officials. Additionally, partnerships with veterinarians and farmers would greatly increase the strength of a producer or consumer because these actors are key to implementing any resulting policy and often enjoy close relationships with state agricultural agencies and legislative committees.

The financial resources of species producer groups are greatly impacted by each species' levels of production within each state; dominance of one species sector would provide greater membership and financial resources for that producer group. I will use the relative market share of each commodity (chicken versus beef + pork products) in the strength variable to contextualize the weight of organizational capacity and preferences on chicken or beef/pork producer groups' ability to dictate policies. Including market share reflects economic value the respective industries provide to the state in terms of revenue and employment, which would in turn affect their treatment by legislatures and officials who have a stake in the economic well-

being of the state (Howlett & Ramesh 2023:40, 71). This is especially important for states like Maryland and Georgia, where the size and revenue of chicken production dwarfs that of beef and pork, and in California, where the market share is opposite with beef production dominating over chicken. The market composition of chicken versus beef and pork producers in a state could also lead to one producer groups' strong access and influence over government officials and legislators. Therefore, in each state case study it will be crucial to measure the extent that state institutions are "captured" by producer groups because tight iron triangles with government add greatly to the ability of an organization to get their preferences translated into action and favorable policy (Carpenter & Moss 2014:13).

Government Linkages

I will also measure group strength through the linkages between consumer/producer groups and government actors such as state legislatures and agencies. Strong linkages provide groups consistent access points to influence legislators and officials in the state departments of health and agriculture, increasing the group's ability to influence the design and implementation of AMU policies (Nestle 2013). I will also use lobbying and campaign finance data to detect changes in relationships between consumer/producer groups and government actors over time. To detect producer group capture of the state legislature and/or department of Agriculture, I will use a framework laid out by Dr. Daniel Carpenter in *Preventing Regulatory Capture: Special Interest Influence and How to Limit It* (Appendix, Figure 2). This framework gives a set of necessary and jointly sufficient conditions that would be observed in an institution captured by an industry interest *I*.

An important aspect of group linkages with state institutions in this study is the autonomy and capacity of state departments of agriculture and health, and the relationship and allocation of

resources between these two departments. Competition for resources between these two main players in AMU data collection operations could cause them to oppose legislation that gives the departments shared responsibility over an issue instead of complete ownership. Insufficient financial, organizational, and political resources also make agencies more vulnerable to capture by industry interests, so analyzing changes in the preferences and strength of state agricultural and health agencies within each state is necessary to measure the impact of producer and consumer group influence on government behavior (Howlett & Ramesh 2023:68,83)[66]. I will include questions to interviewees surrounding the extent of collaboration or disagreements between state agencies.

Results

Maryland

Outcome: Policy Strength

Maryland AMU Data Collection Policy Strength Checklist		
Definitions of Key Concepts	**Reporting Requirements**	**Enforcement Mechanisms**
Defines nontherapeutic use	Requires livestock producers/owners to submit VFDs and prescriptions to dept. of rule	Civil penalties for failure to submit/provide records
Defines medically important antimicrobial	Requires veterinarians to send annual report/submit VFDs and prescriptions to dept. of rule	Funding allocated for data collection and analysis
Defines disease prevention/prophylaxis	Require disaggregated AMU data to be publicly available (with exceptions to protect producer privacy)	
Defines livestock producer/owner	Directs department to release annual reports on specific AMU metrics	
Defines disease control	**Legend**	

[66] I can only gather preliminary information on the preferences/capture of agencies and legislature because I am mostly interviewing consumer and producer groups, not government officials. However, I will analyze recordings and publications from legislative committees and involved agencies to assess their preferences.

Defines "regular pattern of use"	Yellow: Included in 2017 Keep Antibiotics Effective Act Blue: Included in 2019 Addition
Defines "elevated risk" of disease	

The 'teeth' of Maryland's Keep Antibiotics Effective Act derive from the provisions added to the original legislation in 2019. Provisions were added that specified the intended limits on agricultural AMU[67] and fixed agency implementation problems from the earlier 2017 Keep Antibiotics Effective Act, or SB-422. New provisions required veterinarians to send AMU prescriptions and VFDs to the Department of Agriculture annually and required the Department of Agriculture to publish annual reports sharing and summarizing AMU data. Language was added to disaggregate data by county (with exceptions for counties where there were very few food animal operations to ensure data privacy) and include specific metrics so that AMU data could be used by consumer groups and academic researchers to monitor and analyze changes in agricultural antibiotic use patterns (MD SB-471 2019). Interviewees validated the importance of these provisions in directing the Maryland Department of Agriculture's implementation of the law and in the quality of resulting data (Interviewees 1, 2, & 3).

My theory predicts that the strength of Maryland's policy can be explained by strong consumer advocacy groups that pushed the introduction of the bill combined with producer groups that supported AMU reduction and who participated constructively in policy design. I expect to observe fragmentation of preferences between chicken producers (who supported legislation) and beef and pork producers (opposed to legislation) that weakened the iron triangle dynamic between meat producer groups, the state legislature, and the Maryland Department of

[67] Antibiotic use to prevent an undiagnosed disease was banned in 2017, but the 2019 laws added definitions of the terms to limit the possible interpretations of terms such as "regular pattern of use" and "elevated risk" of disease. Additionally, language was changed so that "administration of an MIA for purpose of prophylaxis may not exceed 21 days unless federal label directions REQUIRE a longer period of use" (MD SB-471 2019).

Agriculture.

Consumer Advocacy Group Strength

Stakeholder interviews and hearing recordings showed that the main Maryland consumer groups, MD PIRG and NRDC, had strong organizational capacity stemming from a broad and active network of environmental, academic, human healthcare, and food supply chain groups. Consumer advocacy groups showcased AMU reduction commitments from corporate food retailers and engaged Maryland restaurants to add economic perspectives to their public health argument (Interviewee 1)[68]. MD PIRG and NRDC also built off success and coalition ties from previous environmental advocacy surrounding farm runoff and waste. Maryland consumer advocacy groups also had influence and strong policy alignment with the primary bill sponsor, Senator Paul Pinsky, in both 2017 and 2019 and collaborated with his staff on policy design (Interviewees 1 & 2). This coalition, combined with policy learning from prior California state legislation, facilitated the 2017 introduction and passage of the Keep Antibiotics Effective Act (and its 2019 addition) in Maryland.

A previously unaddressed question asked to interviewees was why Maryland included provisions in their state law, such as a ban on growth promotion and requirements for veterinary supervision of AMU, that duplicated the federal rules for antibiotic use finalized in 2017. Consumer and producer group representatives from Maryland responded that after the election of former President Donald Trump in 2016, consumer advocacy groups worried that the Trump administration would roll back the federal VFD rule or delay its implementation. MD PIRG and NRDC wanted to codify in *state* law that use of antibiotics for growth promotion was illegal and put all medically important antibiotic use under veterinary supervision due to fears that the

[68] See the Appendix for a list of interviewee organizations/expertise.

federal administration would remove or weaken existing antibiotic use regulations (Interviewees 1, 2, & MD Senate EHE 2017).

In 2017 when state legislation was first passed, the data reporting provisions directing the collection and analysis of VFD records were not the key priority for MD PIRG and were removed from the final 2017 bill due to opposition from producer groups and their allies in the state legislature (Interviewees 1 & 2). However, between 2017 and 2019 when the Maryland Department of Agriculture did not collect state antibiotic use data as the law had intended, it became apparent that consumer groups' primary goal of reducing overprescribing and overuse of antibiotics for disease prevention *could not be achieved* without provisions specifically directing the Maryland Department of Agriculture to collect VFD data from farm veterinarians (Interviewees 1 & 3). This validates the assumption and previous findings from Bliss et al. 2023 that specific agency requirements and definitions in policy writing enhance the quality of AMU data collection legislation because state Departments of Agriculture tend to take lenient interpretations of written AMU data collection provisions when given the opportunity.

Consumer advocacy groups used their partnerships with business interests to frame an increased supply of antibiotic-free meat as an unmet consumer need that would support Maryland businesses and keep citizens safe at the same time. Chapters of U.S. PIRG including Maryland PIRG worked to get corporate targets like McDonalds to commit to source chicken raised without medically important antibiotics (Interviewee 1). The McDonalds' commitment and many other fast food retail commitments occurred over the three years that MD PIRG introduced the Keep Antibiotics Effective Act into the Maryland legislature (2015, 2016, and 2017) (Wellington 2017 & MD SB-463 2015, MD SB-607 2016, MD SB-422 2017). Additionally, MD PIRG involved local restaurants and chains like Elevation Burger who

advocated for an improved antibiotic free meat supply. In the 2017 Senate committee on Education, Health, and Environmental Affairs (EHE) hearings for MD SB422, the bill sponsor showed a video containing advertising from major food retailers including McDonalds, Panera, and Subway about their use of antibiotic-free chicken (MD Senate EHE 2017). The bill sponsor and other speakers, including representatives from Elevation Burger and Fair Farms, emphasized that legislation to curb antibiotic overuse in meat production would incentivize greater production of antibiotic free meat to meet growing consumer and food retailer demand (Interviewee 1 & MD Senate EHE 2017).

For the bill's third introduction in 2017, MD PIRG involved more public health and healthcare groups, adding to the groups' organizational capacity and influence on legislators (Interviewee 1). Representatives from the Maryland Nurses Association, Nurse Practitioners' Association of Maryland, the Maryland Academy of Family Physicians, the Maryland State Medical Society, and the Healthcare Workers Association explained in hearings how agricultural antibiotic overuse creates resistant bacteria that put citizens and healthcare workers in danger (MD Senate EHE 2017). This testimony established human healthcare workers and physicians as primary constituents for legislation and supported consumer groups' assertion that agricultural antibiotic use was contributing to resistant infections in humans.

Legacies from past collaboration between state government, consumer advocacy, public health, and environmental groups from other issue campaigns were also cited as a factor that made Maryland consumer groups more active in state antibiotic use policy than other states (Interviewee 1)[69]. Producers and consumer advocates in interviews and public testimony

[69] An employee from Maryland PIRG shared, "Because Maryland has these large industrial chicken farms, there had been other advocacy before I was working in Maryland on runoff from farms and other issues related to factory farms. There were environmentalists that were interested from that perspective for sure, of if we stop antibiotic use does that create a ripple effect" (Interviewee 1).

acknowledged that Maryland has a history of tackling public health issues beyond federal standards and used Maryland's action on arsenic and chemicals for termite control as examples (MD Senate EHE 2017). Environmental groups that previously pushed reform to limit waste and chemical runoff from factory farms on the Eastern Shore in Maryland also supported the Maryland Keep Antibiotics Effective Act, adding further to the coalition of healthcare workers and business interests (Interviewees 1 & 3). Although environmental groups did not provide large financial resources to consumer advocacy groups (an employee from MD PIRG stated that the campaign was funded by small grants and donations), experience across time working to reform other farm management practices at the state level supported the informational and strategic resources available to consumer groups.

Policy learning *across states* also benefited Maryland consumer advocacy groups and contributed to the improved strength of the Maryland law. MD PIRG, CALPIRG, and staff at the NRDC collaborated closely on policy proposals across states (Interviewees 1, 2, & 3). California consumer advocacy group lessons from their 2015 AMU state policy were applied in Maryland and feedback on the California policy was shared between producer groups in Maryland and California (Interviewees 1 & 3). Although the Maryland 2017 law did not significantly 'update' the original California proposal, consumer advocacy groups had enough information by 2019 on "what we needed to fix and why the California law wasn't providing researchers with the data they needed" to propose the Maryland legislative addition with effective data reporting and collection provisions (Interviewee 3).

The established networks and expertise from environmental groups, human healthcare professional organizations, food retailers, business owners, and other state consumer advocacy groups is indicative of (and contributed to) the increased collective action capacity of MD PIRG

and NRDC. This increased capacity facilitated their strong presence and influence on the policy process through legislative hearings, working closely with the bill sponsor on policy design, and responding to producer group arguments. However, consumer groups also benefitted from changes in producer group strength and preferences regarding antibiotic use and data collection in Maryland.

Producer Group Strength

I hypothesized that the divergence in AMU preferences between chicken and beef/pork producers, with chicken producers largely supporting AMU reduction and beef/pork producers opposing it, weakened the iron triangle between the state meat industry, Department of Agriculture, and the state legislature. However, the preferences of chicken producer groups in Maryland varied widely at the time when legislation was introduced, and the support for state AMU legislation and data collection exhibited by Perdue Farms seems to be the exception and not the rule for chicken producers in the state (Interviewees 2 & 7). Poultry producers were *not* cohesive in their support for AMU reduction and data collection legislation; rather, most producers in Maryland *regardless of species sector* initially opposed legislation but became involved in policy design to ensure that the state law did not overstep the federal VFD rule (Interviewees 1 & 2).

Interviews with producer group representatives indicate that many poultry producers acknowledged that antibiotic use for growth promotion purposes created resistant bacteria in farm animals (Interviewees 2 & 5). However, producers felt unfairly blamed for human infections and “superbugs” like MRSA, which they attributed to human antibiotic overuse and

misuse, not agricultural antibiotic use[70] (Interviewee 2 & MD Senate EHE 2017). Producers felt that state government monitoring and supervision was unnecessary because the federal VFD rule moved all medically important antibiotic use under veterinary supervision, which (in their view) ensured the judicious use of important antibiotics (Interviewees 1 & 2[71]). Large animal veterinarians, feed manufacturer associations, and representatives from animal pharmaceutical groups shared this opinion in testimony and opposed the 2017 bill (Interviewee 1 & MD Senate EHE 2017). Producer groups also claimed that state-level policies would put state meat producers at a competitive disadvantage compared to producers in other states where use of antibiotics for disease prevention was unrestricted by state law (Interviewees 2 & 4)[72]. A representative from the Maryland Farm Bureau stated that they originally advocated against the Maryland legislation because they wanted to give the FDA a chance to implement the VFD rule at a federal level so that Maryland producers would not be singled out (Interviewee 2).

Interviewees shared that Perdue Farms' voluntary decision to go antibiotic-free and the 2017 federal limits restrictions on AMU for growth promotion forced most other chicken integrators to reduce their antibiotic use (Interviewees 1, 2, & 7). In committee hearings,

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[70] To be sure, superbugs like MRSA have originated from both human and animal misuse and overuse of antibiotics (McKenna 2017:234). Based on responses from interviews with producer representatives and speeches given in the Maryland Senate EHE committee, producers generally disagree that the use of antibiotics in animal agriculture for disease prevention contributes significantly to antibiotic resistant bacterial infections in humans (Interviewees 2 & 5). However, multiple peer-reviewed studies have confirmed scientists' assertion for decades that agricultural antibiotic use has a significant effect on how humans acquire, and can be treated for, resistant bacterial infections (Hoelzer *et al.* 2017, Patel 2020, & Holmes *et al.* 2015).

[71] When discussing producer group stances on state VFD data collection and antibiotic overuse, an employee at MD PIRG shared, "When they're [producers are] saying, "oh the veterinarians say…" they're basically saying the problem has been solved. We don't need this because it's all under a prescription order from the veterinarians so they're being responsible and there's no issue. And that's where it's like, we just fundamentally disagree because the veterinarians are overprescribing them still" (Interviewee 1).

[72] Growers and producer groups still use antibiotics routinely under the disease prevention indication, so limiting the use of disease prevention to times when there is an elevated risk of contracting a disease would hinder producers' ability to prevent infections in herds. A decrease in medicated animal feed administered for disease prevention would require nutritional supplements and farm management strategies to improve animal health and living conditions to maintain production outputs (Ekakoro 2019:5-6). This change in production (and a loss in efficiency, at least in the short term) credibly raises concerns about competitive disadvantages for states where AMU regulations are proposed.

producer groups, allied veterinarians, and pharmaceutical stakeholders argued that the elimination of AMU for disease prevention would negatively impact animal health and the profitability of poultry companies (MD Senate EHE 2017). However, Perdue Farms (which is headquartered in Maryland) showed that antibiotic free production could be a boon for Maryland poultry producers by filling a growing consumer niche and demonstrated that their production (and their animals) had not suffered from removing AMU for disease prevention (Interviewees 1 & 7).

Another finding was that economic and market characteristics of producer companies impacted their preferences over AMU reduction. For example, interviewees shared that Perdue Farms was able to prioritize animal welfare and make farm management change practices that may have costed them short-term profits partly because they are a family-owned and private company, compared to public companies like Tyson and JBS with a mandate to constantly increase shareholder value (Interviewees 2 & 7). Additionally, Perdue only raises and sells poultry, compared to other companies that have production lines for multiple species sectors (Interviewee 7 & Perdue 2024). Coordinating AMU reduction across cattle, swine, and poultry operations introduces more variables that may have made these producers less receptive to U.S. federal or state policy (Interviewee 7).

Heterogeneity of preferences among chicken producers and the significant opposition to state policy from groups like the Maryland Farm Bureau indicate that policy support from producer groups was not as strong as originally hypothesized. However, chicken producers' *capacity to comply with proposed laws* was significantly greater than most beef and pork producers. As proposed by previous literature, interviewees emphasized that the vertical integration of chicken production and the shorter life span of chickens compared to cows and

hogs made it relatively easier for to reduce AMU in the poultry industry. The fact that chicken producers "were already moving that way" led to decreased policy opposition from chicken producers and facilitated policy concessions in the form of the 2019 data collection provisions in Maryland[73] (Interviewees 1, 2, & 3). Although most producer support of AMU data collection policy in Maryland was not enthusiastic and evolved over multiple years, producer group support for legislation was significantly stronger in Maryland than California due to the dominant presence of the chicken industry (Interviewee 3).

Policy Process: Assessing the Iron Triangle

I find evidence that a weak iron triangle relationship between producer groups, the Maryland Department of Agriculture, and the Maryland State legislature facilitated the success of consumer groups in pushing the 2017 and 2019 Keep Antibiotics Effective Act. Although the Maryland Department of Agriculture worked closely with producer groups and exhibited similar policy preferences through their lenient implementation of the 2017 bill, the Department had very limited influence on state legislation during the policy design and adoption process. Under a strong agricultural iron triangle, Departments of Agriculture are expected to formally or informally lobby state legislators and committees on behalf of meat producers during the initial steps of the policy process. However, the Maryland Governor at the time discouraged state departments from giving input or working with legislators on policy design (Interviewees 1 & 2).

[73] When discussing the policy debates over strengthening the original 2017 Maryland law, an employee from the Maryland Farm Bureau shared, "We were butting heads because we were trying to say, let's wait and let the federal thing [the VFD rule implementation] go, but because the federal thing was delaying and delaying, we finally agreed to say, hey go ahead and put it into place. We're going to follow the rules anyway, Perdue had already gone to NAE and Mount Aire was headed that way" (Interviewee 2). An employee from NRDC explained that [among other variables including the support of the Maryland legislature] "It basically came down to the power of the agricultural industry in both scenarios. In Maryland, the major agricultural industry is the chicken industry, and we had a response that they had already made a commitment to get out of this stuff, so it shouldn't be that big a deal kind of thing... And in California, you're talking about a lot of beef production, a lot of dairy production, beyond chicken. And so, there are other industries that are at the table" (Interviewee 3).

Although the Maryland Department of Agriculture implemented regulations in a favorable manner to the industry after the 2017 Keep Antibiotics Effective Act was passed, respondents did not observe systematic influence from the Department on the legislature during policy writing and adoption (Interviewees 1 & 2).

Additionally, a strong iron triangle would exhibit policy alignment and closed debate between relevant state legislative committees, the state Department of Agriculture, and industry actors. However, one of the main reasons for the 2019 addition of data collection provisions and stricter definitions for AMU was the Maryland *legislature's "*political will"[74] to enforce stricter agency implementation of the 2017 act (Interviewee 1). Maryland legislators were "upset at the Department of Ag for writing the regulations they thought to undermine their legislative intent and they therefore no longer trusted them to enforce the law" (Interviewee 1).

My theory posits that fragmentation between producer groups weakened the existing iron triangle between industry and government actors, but these results highlight the importance of state institutions and intergovernmental relationships in dictating how producer group influence affects government actors. The present characteristics of a weakened iron triangle - legislature disagreement with industry and Department priorities, and the Department of Agriculture's limited influence over the content of the Maryland laws – do not seem to be caused by an increase in producer group support for legislation. However, there is preliminary evidence that producer groups collaborated with legislators and consumer advocacy groups to improve the efficacy and quality of data collection policy (Interviewees 1 & 2).

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[74] When asked why Maryland was able to pass the 2019 legislative addition, the interviewee responded, "Political will, right? I don't know what was going on in California, but again it was the window. It was the fact that the legislature was upset at the Department of Ag for writing the regulations they thought to undermine their legislative intent. And they therefore no longer trusted them to enforce the law, and our sponsor could say 'hey we need this data to make sure you're enforcing this law now.' But it was mostly that we had the political power too at that point" (Interviewee 1).

Maryland producer groups used insights from California producers to advocate for veterinarians as the producer actor responsible for reporting AMU prescriptions and VFDs instead of livestock/farm owners (Interviewee 2). Although requiring farm owners to submit copies of VFD and logs of antibiotics administered to herds or animals could provide insight onto the use of antibiotics on farms, veterinarians are better able to accurately report metrics required for the analysis of antibiotic use, including the volume of antibiotics administered by injection, feed, or water, duration of use, and the class and name of antibiotic (Interviewee 2 & 5). Consumer and producer actors both viewed the decision as beneficial to collecting more accurate AMU data (Interviewees 2, 3, & 4).

Producer groups also expressed concerns over data privacy and anonymity to prevent "particular farms or companies being targeted with AMU data to hurt their brand" (Interviewee 1). However, consumer advocacy groups wanted disaggregated data to facilitate research connecting antibiotic use with local incidences of antibiotic resistance (Interviewees 1 & 3). The 2019 legislative addition directed the Department of Agriculture to include specific AMU data metrics disaggregated by county in publicly available reports. However, exceptions were made to provide regional or statewide reporting for counties with two or less operating farms to protect individual growers from public scrutiny (MD SB-471 2019:7). Evidence of constructive feedback from producer groups in the Maryland policy indicates that producer support, in addition to consumer group advocacy, is necessary to create strong AMU data collection policy.

California

Outcome: Policy Strength

California AMU Data Collection Policy Strength Checklist		
Definitions of Key Concepts	**Reporting Requirements**	**Enforcement Mechanisms**
Defines nontherapeutic use	Requires livestock producers/owners to submit VFDs and prescriptions to dept. of rule	Civil penalties for failure to submit/provide records
Defines medically important antimicrobial	Requires veterinarians to send annual report/submit VFDs and prescriptions to dept. of rule	Funding allocated for data collection and analysis
Defines disease prevention/prophylaxis	Require disaggregated AMU data to be publicly available (with exceptions to protect producer privacy)	
Defines livestock producer/owner	Directs dept. of rule to release annual reports on specific AMU metrics[75]	
Defines disease control		
Defines "regular pattern of use"		
Defines "elevated risk" of disease		

Compared to the Maryland 2019 legislation, California's SB-27 was less specific on rules for producer data reporting and failed to assign implementation responsibilities to specific stakeholders (Bliss et al. 2023 & Wallinga 2020). This caused confusion and a delayed release of implementation guidance for producers from the California Department of Food and Agriculture (CDFA) (Bliss et al 2023:9 & Casey et al 2023:6). Additionally, the law did not contain guidelines for what metrics public reports from the CDFA on state AMU data should include, such as the total masses of antimicrobials approved for use through VFDs and the number of treated animals, hindering researchers' and consumer groups' ability to assess patterns of AMU among California producers (CA SB-27 2015 & Quaade et al. 2024). Although the CDFA has collected VFD orders quarterly from feed manufacturers and distributors since 2017, the data

[70] See footnote 61 for descriptions and source material for specific metrics.

published from summaries of these orders lacks key metrics required for data analysis (CDFA 2022). When comparing the California law to the Maryland law, a representative from the NRDC stated, “While we asked for the same kinds of data, we didn't have the same degree of specificity on exactly how they [the Department of Agriculture] should go about doing it” (Interviewee 3).

Based on the weaknesses in the California policy, I expect to find that although consumer groups had strong organizational capacity, producer groups’ opposition to AMU reduction legislation maintained a tighter iron triangle process than exhibited in Maryland. I also expect to find that the dominance of beef and pork production in California contributed to the weak levels of producer group support for legislation. My theory predicts that tighter iron triangle process between these producer groups, the Department of Agriculture, and state agriculture committees led to less acceptance of consumer group input during policy writing.

Consumer Group Strength

California’s history of setting consumer advocacy standards past federal law was mentioned as a driver for state consumer advocacy groups’ involvement in state antibiotic use data collection policy (Interviewees 2 & 5). California “leads food policy in the U.S. for reasons having to do with its strength in primarily crop agriculture” (Interviewee 7). An employee at the Georgia Poultry Federation shared that California consumer group and state government initiatives to regulate producer groups are common topics of discussion at national meetings of poultry producers (Interviewee 5). The history of collaboration between consumer and environmental groups like CALPIRG, NRDC, the Sierra Club, and the Consumer Union may have aided the coalition’s ability to influence the policy process and include limits on routine antibiotic use for disease prevention. However, there is also evidence that consumer groups in

California were weaker than their Maryland counterpart due to decreased support from human healthcare associations and the primary bill sponsor.

An observed difference between Maryland and California coalitions was that human health and medicine groups were less supportive of consumer advocacy group proposals during California's policy process, indicating that the California coalition lacked sufficient support from human healthcare actors. California consumer advocacy groups, especially NRDC, secured support from individual medical doctors, public health associations, and some small medical associations, but were not able to get larger human healthcare groups to sign on to the bill (Interviewee 3). In addition, some of these groups publicly disagreed with consumer advocacy groups on policy content.

An amendment to the 2015 bill allowing the legal use of antibiotics for disease prevention was supported by groups such as the California Academy of Preventive Medicine, the California Society of Health-System Pharmacists, and the Infectious Disease Association of California (Francovich 2015:5). Consumer groups including CALPIRG, the Johns Hopkins Center for a Livable Future, and the California Public Health Association opposed the amendment, claiming that it "explicitly authorizes the routine use of antibiotics on animals that are not sick through the exception for prophylactic use" (Francovich 2015:5)[76]. This disagreement over policy design provides evidence that California consumer advocacy groups were less aligned with human healthcare groups than those in Maryland, possibly contributing to California consumer groups' inability to later improve legislative design to include stricter data

[76] This amendment was added to the bill, and consequently, the use of antibiotics for disease prevention was allowed in the California bill under conditions of elevated risk of contracting a disease. This policy language was used in the Maryland 2017 bill as well. Although this specific disagreement did not result in variation in the limits for antibiotic use between the Maryland and California bills, it is important that key healthcare actors present in the Maryland consumer advocacy coalition were opposed to analogous advocacy groups in California.

reporting requirements. The bill sponsor in the California state senate was also less supportive of consumer advocacy groups than his Maryland counterpart.

The California bill sponsor Senator Jerry Hill was only partly aligned with consumer advocacy and their allied environmental and public health groups; this fragmentation contributed to weaker linkages between consumer advocacy groups and California state legislature when compared to the Maryland case. An employee at NRDC characterized the bill sponsor as "supportive to some degree. He wanted to act on the issue, but there were a lot of things in the bill that he wasn't necessarily amenable to making big changes to" (Interviewee 3). Although Senator Hill's stated motivation for introducing the bill was for California to lead the United States in tacking the drivers of antimicrobial resistance, disagreements over the goals and content of antibiotic use policy occurred throughout the policy process (Interviewee 3). Senator Hill previously disagreed with NRDC and other consumer advocates over appropriate legal limits on agricultural antibiotic use in 2014 (Zuraw 2014 & Hill 2014)[77].

Additionally, Hill received over $135,000 in pharmaceutical industry contributions towards his 2008 and 2010 campaigns for California Assembly and 2012 California Senate campaign (Follow the Money 2024)[78]. Given the pharmaceutical industry's financial stake in - and advocacy to protect- agricultural antibiotic use at the federal level (Armbruster & Roberts 2018:307), these state financial contributions may have influenced Senator Hill's stances on proposed data provisions by NRDC, CALPIRG, and their allied coalition to limit the use of

[77] Senator Hill introduced a SB-835 in 2014 in California, but CA Governor Jerry Brown vetoed the bill, claiming that it was duplicative of the federal FDA guideline for industry #213 and did not provide for the collection of new information to curb antibiotic overuse (Food Safety News 2014). NRDC, the Sierra Club, and the Consumers Union supported this veto, mainly because it allowed the use of antibiotics for disease prevention purposes (Francovich 2015).

[78] Senator Pinsky (the MD bill sponsor in 2017 and 2019) only received $5,050 in campaign contributions from pharmaceutical interests throughout his career, and $3,300 of this total was for his 2022 election, after both the 2017 and 2019 versions of the MD Keep Antibiotics Effective Act were enacted. (Follow the Money 2024: Paul Pinsky).

animal antibiotics for disease prevention. Pharmaceutical groups like the Animal Health Institute also contributed to the strength of the producer group coalition in California (Interviewee 3).

Producer Group Strength

Results from interviews and secondary sources indicate that although beef and pork producer groups supported initial legislation and have since publicized their commitment to reduce AMU and comply with SB-27 (California Cattlemen's Association 2024), producer groups were strongly opposed to consumer advocacy group proposals to improve legislation (Interviewee 3). One reason given for strong producer group opposition was the high composition of beef and pork producers compared to poultry producer groups (Interviewee 3).

Additionally, based on evidence from SB-27 bill analyses, the California Veterinary Medical Association (CVMA) played an integral role in the producer group coalition and was involved throughout the policy design process. The CVMA expressed concerns over the feasibility and financial costs of an antibiotic use tracking program supported by consumer advocacy groups, as well as similar concerns to Maryland producer groups regarding the confidentiality of data collected (CA Senate Committee on Agriculture 2015) The CVMA also opposed consumer advocacy group proposals to prohibit the routine use of antibiotics on a herd to prevent disease, stating that this limit could prevent them from "making the best medical decisions for the health and welfare of their patients" (Ibid.)[79].

Interviewees from all three states (and prominent literature on antibiotic use policy) concurred that veterinarians, especially large animal veterinarians, are an integral part of

[79] In correspondence with the Senate Committee on Agriculture regarding SB-27, CVMA stated, 'If antimicrobial use is restricted then veterinarians would be prevented from "making the best medical decisions for the health and welfare of their patients. There are many instances where it is important to administer antibiotics prophylactically... Veterinarians must have the flexibility to provide scientific and medically appropriate treatment for animals under their care.'" (CA Senate Committee on Agriculture 2015).

producer group strength in opposing further AMU regulation (Interviewees 1, 3, 6, & 7). Veterinary associations expressed concern that data collection and limits on AMU prescribing would shrink their scope of practice and therefore their ability to maintain animal health (Interviewee 3). As one interviewee explained,

> *"They [veterinarians] went to school a long time learning how to use antibiotics. It's a very basic tool that they're trained in, and they were trained to use them in an industrial manner." (Interviewee 6)*

Policy alignment between veterinary and producer groups, combined by decreased willingness and capacity of beef and pork producers to provide data compared to Maryland chicken producers, provide strong evidence that most producer groups were not supportive of AMU reduction and data collection provisions within the SB-27 policy. This coalition was aided by producer groups' strong linkages with the CDFA and state agriculture committees:

> *"They [producer groups] have a lot of political clout and more so than almost any other group that I've encountered...So even in California, we can make progress on a lot of these [public health] issues in states that are more progressive a lot of the time. But on Ag issues, that doesn't necessarily translate all the time." (Interviewee 3)*

The sequence of events and attitudes of the legislature in California also indicate a tighter iron triangle among California state actors that reduced the ability of consumer groups to include data collection provisions like Maryland did in their 2019 addition to their initial law.

Policy Process: Iron Triangle?

The introduction of legislation by producer group actors, as well as decreased openness of the state legislature and agriculture committee to consumer advocacy group proposals, provides evidence of a more closed iron triangle process in California than Maryland. I predicted that consumer advocacy groups would play a key role in designing and introducing the initial legislation, and then producer groups would respond by supporting or opposing the design. However, preliminary evidence from interviewees and bill analyses shows that consumer

advocacy groups did not work closely with the bill sponsor to introduce SB-27 and opposed the bill when it first was introduced because it was not strong enough on limiting AMU for disease prevention (Interviewee 3 & CA Senate Committee on Agriculture 2015).

Industry groups initially supported the bill, whose first draft included general data reporting provisions but only prohibited the use of antibiotics for growth promotion purposes as the FDA VFD rule planned to finalize two years later in 2017 (Interviewee 3 & "CA 2015 SB-27-Introduced")[80]. Consumer advocacy groups then worked to include a ban on routine preventive use and supported the bill when this language was included, however the language on what AMU metrics CDFA should collect were ultimately taken out of the bill (Interviewee 3 & CA SB-27 2015). Direction of initial legislation by producer groups within the proposed iron triangle rather than from outside forces bringing new ideas indicates a relatively closed policy process, and the demonstrated attitudes of the CDFA and state legislature in the subsequent implementation of the law support these findings.

During the policy implementation process, consumer advocacy groups including NRDC and CALPIRG pressed the CDFA to release timely guidance for producer groups on new AMU rules and begin designing the data tracking program. Consumer advocacy groups claimed that "in implementation, the specifics around data reporting and disease prevention were largely neglected" by CDFA (Interviewee 3). California consumer advocacy groups then approached the state legislature with evidence that the data collection provisions and specific definitions in the

[80] In an email explaining the sequence of the CA SB-27 bill, an employee at NRDC stated, "The original bill as you noted was supported by industry, but opposed by our groups, because it simply codified FDA guidance on growth promotion and did not address disease prevention uses. Our input on incorporating disease prevention uses was largely ignored. We came on in support when the language was broadened to include disease prevention and to authorize collection of VFDs, primarily through engagement with the governor's office. However, in implementation, the specifics around data reporting and disease prevention were largely neglected." (Interviewee 3)

2019 Maryland addition had improved the Maryland Department of Agriculture's implementation, but the legislature showed no interest in amending SB-27:

> *"In California, we pointed to the Maryland law and said that's the kind of reporting you should be doing because that's clear that...you're asked to do the same thing and it was just clarified in Maryland. And we basically never got that and there wasn't any interest in pursuing further legislation in California." (Interviewee 3)*

The lack of "traction" consumer groups received from the California legislature in clarifying and directing CDFA implementation highlights the differences in government support for antibiotic use data collection between Maryland and California (Interviewee 3). Although evidence from this thesis is insufficient to inform how the state legislature and CDFA influenced each other in policy design or implementation, the legislature was significantly less receptive and supportive of consumer advocacy group proposals than their counterpart in Maryland. Some indicators of a strong iron triangle are present in this case, namely the introduction of weak policy aligned with industry interests and the California bill sponsor and larger legislature's lukewarm attitudes toward consumer advocacy group proposals. However, consumer advocacy groups were able to infuse important provisions that improved the strength of policy design, including direct authorization for the CDFA to collect VFDs and language prohibiting the routine use of antibiotics for disease prevention purposes (Interviewee 3 & CA SB-27 2015). For these reasons, the California case reflects a 'medium' strength iron triangle process that allowed the passage of the first state AMU legislation but blocked significant improvements to the policy proposed by actors outside the iron triangle.

Georgia

Outcome: Policy Strength

Interviewees from the Georgia Department of Agriculture and the Georgia Poultry Federation confirmed that no state policy was ever introduced or passed in Georgia regarding

AMU data collection for food-producing animals (Interviewees 4 & 5). Interviewees did not recall the topic of state-level AMU data collection being addressed in conversation among the Georgia Department of Agriculture, relevant legislative committees, or producer groups (Interviewees 4, 5, & 6)[81].

However, a representative from the Georgia Poultry Federation added that most commercial poultry producers participate in voluntary AMU data surveillance through the U.S. Poultry and Egg Association (Interviewee 5). Although this cooperative project with the FDA [mentioned in the literature review] represents approximately 85% of broiler chickens produced annually and provides yearly masses of specific antibiotics used in poultry production, the publicly available data from the dashboard offers no insight onto the indications of use, duration of use, or state-specific trends (Mindwalk Consulting Group 2022). It also does not include data from beef or pork producers, to whom more than 80% of all medically important antibiotics for livestock are sold (FDA CVM 2023)[82].

Officials from the Georgia Department of Agriculture do contract with the FDA to monitor VFD compliance through the FDA's Comprehensive Animal Food Inspection Compliance Program (Interviewee 4 & FDA CVM 2021). VFD compliance compares VFD orders from veterinarians to the characteristics of medicated feed that is distributed from feed

[81] When asked about discussions of AMU data collection or policy at the state level, interviewees responded:
"It has just never been proposed by any group" (Interviewee 5).
"On antimicrobial use, no. Not to my knowledge I have not, again I have been with the department a little over ten years... I'll get called in to provide – respond to questions if a bill is under consideration. I don't recall any conversations coming from the legislature regarding information on or interest in AMU data. If our policy team were getting questions to that end, they would bring that to me or to our veterinary team here and I've not had that question" (Interviewee 4).

[82] FDA publishes metrics on medically important antibiotics (MIAs) sold by drug manufacturers for intended use by species sector. The above 80% metric is based on their 2022 data showing that cattle producers bought 41%, and swine producers bought 43%, of the total MIAs sold for agricultural antibiotic use. Chicken producers bought 2 percent and turkey producers bought 12 percent (FDA CVM 2022).

mills to the veterinarian's farm client (Ibid.). VFD compliance ensures that feed manufacturers fulfill VFD orders correctly including the type, volume, and labeling of antibiotics included in animal feed (FDA CVM 2021:92-93)[83]. Additionally, Georgia has its own state Meat and Poultry Inspection (MPI) program, run through a cooperative agreement with the USDA FSIS. The Georgia MPI monitors meat and poultry establishments for compliance with federal laws[84], including the levels of dangerous *Salmonella* and *E.coli* bacteria throughout the production process (Interviewee 4 & USDA 2022:9). Bacterial isolate samples collected through this program are sent to the NARMS program for analysis of antibiotic-resistant bacteria in food animals (Interviewee 4). California and Maryland do not have a state Meat and Poultry Inspection (MPI) program; meat and poultry growers, slaughterhouses, and processing facilities are inspected for the same characteristics by *federal* USDA officials (USDA FSIS 2023).

Although these programs demonstrate the Georgia Department of Agriculture's and poultry producers' collaboration to monitor levels of dangerous bacteria in food products, state-level antibiotic *use* data is not collected or analyzed through any of these programs (Interviewee 4 & Mindwalk Consulting Group). I hypothesized that due to the high composition of poultry producers in Georgia, producer groups would support or tolerate state-level AMU data collection. However, there is evidence that poultry producer groups would not support state AMU data collection efforts even if a consumer advocacy group pushed this topic; producer groups in Georgia cohesive in preferences across species sector and were mostly disinterested in (or opposed to) state-level AMU data collection (Interviewees 4, 5, & 6). Preliminary evidence

[83] It is unclear from federal and state records whether California and Maryland Departments of Agriculture also have contracts with the FDA to implement VFD compliance inspections through a Comprehensive Animal Food Inspection Program.

[84] According to the USDA FSIS, "states may operate their own MPI programs if they meet and enforce requirements "at least equal to" those imposed under the Federal Meat Inspection Act, Poultry Products Inspection Act and Humane Methods of Slaughter Act of 1978" (USDA FSIS 2023).

shows that beef and pork producer groups in Georgia, although relatively small, have had a significant voice in state policy (Interviewee 4) and worked closely with poultry producer organizations on VFD-related policy in the past, contributing to the overall strength of producer groups in directing the state agenda surrounding AMU (Interviewee 5).

As expected, indicators of a strong iron triangle are also present in Georgia, including cohesive producer groups with connections to many parts of the Georgia legislature (Interviewee 5). However, it is difficult to analyze whether an iron triangle relationship was the mechanism that prevented new ideas and actors from entering the AMU policy space without the 'test' of a new actor or idea pushing state AMU regulation and government data collection.

Consumer Group Strength

Interviewees did not know of any state consumer advocacy groups active in the animal agricultural AMU space[85] and stated that most of the consumer pressure for reduced AMU has been at the federal level (Interviewees 4, 5, & 6). A representative of the Georgia Department of Agriculture shared that although consumer advocacy groups are involved with the food safety division of the department, they have not approached animal health teams about agricultural AMU: "I'm sure if we asked our food safety division if the questions have come up through their avenues, probably, but it hasn't risen to the level of making it to the animal health side" (Interviewee 4). Additionally, consumer advocacy is expected to come from "everyday

[85] "I think the consumer groups and advocates have really operated more at the federal level. You know, they've been part of the dynamic of, you know, rule development, but also companies, restaurants or grocery stores making decisions on products they're gonna sell. But it hasn't really been focused at the state level. It's just that Georgia is, you know, a large producer of chicken... But no, nothing really specific to Georgia from consumer groups" (Interviewee 5).

consumers in grocery stores or restaurants"[86] exerting pressure through purchasing behavior rather than participation in state advocacy groups (Interviewee 4).

Georgia PIRG has not released any statements regarding antibiotic use in agriculture (GA PIRG), and (to my knowledge in 2024) no other Georgia-specific advocacy groups have published online media or articles about potential Georgia agricultural AMU policy (GA PIRG 2024). I infer from producer and government officials' lack of interaction with consumer advocacy groups on AMU, and from the extremely limited online presence of organizations like PIRG whose counterparts were extremely active in the California and Maryland policies, that consumer advocacy group organization regarding agricultural AMU is weak. One possible reason for a lack of consumer advocacy group push is due to the strength of producer groups in influencing the state agricultural policy agenda.

Producer Group Strength

Although it is difficult to ascertain how producer groups would respond in a counterfactual situation where Georgia consumer advocacy groups exerted pressure on this topic, interviews with producer groups indicate that they view AMU data collection policy as a federal concern that their national organizations direct policy on, while state groups focus on lobbying for state-specific policy and help producers implement federal policies or guidance from their parent organization (Interviewees 5 & 6).

> *"Because antibiotics have been, you know, they're common issues across state lines and because it's been primarily regulated by the feds, our national groups have taken on the kind of heavy lifting on that, because it just makes more sense from our small staff's resources...We focus on different things...We put a lot of resources and time into*

[86] When asked about consumer or stakeholder groups interested in the regulation of antibiotic use in Georgia, the Department of Agriculture official shared, "When it comes to practices like reducing or eliminating the use of antibiotics, that's driven by you and me, everyday consumers in grocery stores or restaurants and things like that. And then, companies – either companies or individual producers – are adopting their practices to fit that market. It kind of comes back to dollars and cents." (Interviewee 4)

> *education materials on biosecurity.. in other words, keeping disease off the farms in the first place." (Interviewee 5)*

State producer groups and the Department of Agriculture's main priorities are to prevent animal disease and ensure the economic viability of food animal production (Interviewees 4[87] & 5). Food animal producers feel that "tools" to achieve these goals "are being removed from their toolbox over time with these various feed directives moving things from over the counter to prescription" (Interviewee 4). Interviewees also echoed producer concerns regarding data privacy and producers' reputation if AMU data were published at the state level, especially if AMU data from producers is not exempt from public records acts[88] (Interviewee 4). This evidence highlights producer groups' unwillingness to propose state AMU regulatory policy and indicates a very weak level of producer group support for possible state data collection legislation. In addition, beef producer groups who are likely more opposed to AMU reduction and data collection than interviewed poultry producers (Interviewees 1, 2, & 3)[89] have significant strength at the state level due to consistent interaction with government officials and legislators (Interviewee 4).

> *"Our beef cattle producers, the average herd size of cows in Georgia is 25. That's not that big, but they're certainly an active group and have a good voice through their entities and organizations…Alot of it is who is taking the most interest, you have to kind of show up and speak up for the things that matter to you if you want to see policy*

[87] "If the stakeholders want to see use data, then that's the avenue that makes its way up the chain to become a policy. So I would say in Georgia, what I hear more from stakeholders is again, more conversation about what am I gonna do now that these products are not available in a way that I've been used to for 20 or 30 years? What are other tools in my toolbox that I can manage my herds effectively for health? But there's not been a lot of discussion about actual use, use practices, you know it's more about regulations that have already been passed and implemented." (Interviewee 4).

[88] An official from the GA Department of Agriculture shared, "I think regardless of [aggregated vs. disaggregated data], a lot of states- and Georgia is one of them- we have very sunshine-y open records laws and public records act. So the only thing we can reasonably exempt from an animal health standpoint is information directly related to our reportable or potentially reportable disease investigations because obviously that data, it's really critical that we get it and do our work…But outside of that, antimicrobial use data, whether that requirement was in there or not, anyone could do an open records request and get that data. I don't believe that would be exempt. So I think that that's another reason why producers and farmers would be cautious." (Interviewee 4)

[89] Interviewees 4, 6, and 7 also mentioned the differing structures of the poultry vs. cattle and pork industry as factors significant to producer approaches to AMU reduction and the possible obstacles faced for data collection.

> *changes across the board. If you're a larger farm or group, you potentially could have more of a voice, but we do see those smaller entities that are quite successful as well because they show up and speak up." (Interviewee 4)*

Beef producer groups (the main group discussed was the Georgia Cattlemen's Association (GCA), although Georgia milk and pork producers were also mentioned) also have close relationship with the Georgia Poultry Federation (GPAF), a group that represents 100% of commercial poultry producers in Georgia (Interviewee 5). Although AMU data collection policy has not been addressed by these groups, the GPAF and GCA worked together on legislation in 2017 to clarify the ability of veterinarians to prescribe antibiotics and order VFDs on behalf of clients without physically visiting the farm. According to an official from the GPAF, after the federal VFD rule was finalized in 2017, there was debate over veterinarians' power in state code to order a VFD through an online/electronic consultation with their farm client without visiting the farm in-person (Interviewee 5). The GPAF worked with the Georgia State Board of Veterinary Medicine and the primary sponsor of the bill to clarify the definitions of "immediate" and "indirect" supervision in the 2017 Georgia Veterinary Practice Act to amend state code (Georgia State Board of Veterinary Medicine 2017 & GA HB-956 2018)[90]. Georgia Cattlemen's Association the Georgia Farm Bureau worked with GPAF to support the design and passage of this bill (Interviewee 5).

This coordination illustrates two indicators of strong producer groups in Georgia: 1) a history of producer groups across species working together during the time where fragmentation was expected to occur, and 2) the group's ability to influence policy through links with legislators and access to the state veterinary board. Another sign (and driver) of producer group

[90] A representative from the Georgia Poultry Federation (GPAF) served on the Veterinary Practice Act Review Committee of the Georgia State Board of Veterinary Medicine (GA State Board of Veterinary Medicine 2017).

strength in Georgia is their frequent lobbying on a wide range of business issues and state congressional committees, not just agricultural policy.

The wide scope of GPAF's (and other producer groups like it) lobbying portfolio also indicates strong ties and support for producer interests from the Georgia legislature. According to a representative from GPAF, GPAF lobbies on behalf of poultry companies and the growers that contract with them on diverse state legislation and committees:

> *"Larger companies have an interest in things beyond agriculture or beyond anything related to animal agriculture. You know, it's tax policy, environmental policy, workers' compensation, anything. Any kind of policies or legislation that would affect businesses. And so, we get engaged on a really a broad array of topics, not just agricultural. It's kind of unusual or not that common that bills that we work on or rules that we work on have anything to do with chickens, the animal itself. It's, you know, more broad business policy." (Interviewee 5)*

These legislative ties, combined with industry cohesion on AMU policy preferences (Interviewee 5), indicate that producer groups would be extremely effective at blocking or reducing the efficacy of proposed consumer advocacy policy. Additionally, the Georgia Department of Agriculture works closely with producer groups to monitor animal health through meat inspection, VFD compliance, and a laboratory network funded by industry, but the cooperation between the groups could also signal a productive partnership of embedded autonomy where the private and public sector share resources and expertise in an organized fashion (Evans 1995:47). It is difficult to distinguish whether the relationship between producers, legislators, and the Georgia Department of Agriculture represents capture or a lack of agency autonomy without the presence of a significant pressure from state groups that (in Maryland and California) came from consumer advocacy organizations like state PIRGs and NRDC.

Policy Process: Iron Triangle?

I theorized that the lack of policy in Georgia could be explained by consumer advocacy groups' inability to garner support from the government and producer group actors within a strong state agricultural iron triangle. Although consumer groups were found to be weak and producer groups were found to be strong in their opposition to state policy, it is unclear whether policy has not been introduced due to a strong iron triangle mechanism. The consistent lobbying activity and participation in business-related legislation from beef producers and commercial poultry producers (Interviewees 4 & 5) certainly demonstrates a large industry influence on Georgia legislative priorities, but it also reflects how differences in economic sectors and citizen demographics affect a state legislature's potential willingness to act on behalf of consumer advocacy groups.

Interviewees expressed that rural citizens and groups take "more interest in what's going on with policy and legislatively actually than some of our urban counterparts because it [agricultural policy] more directly impacts them and their livelihood" (Interviewee 4). Therefore, citizens aligned with producer group preferences may affect their representative's opinions on agricultural policy significantly more in Georgia than California or Maryland because a higher proportion of the population has some economic stake in local farms' success and animal health.

Another issue in analyzing the strength of iron triangle for agricultural AMU policy is uncertainty over which state department would take 'ownership' over a proposed AMU data collection policy (Interviewees 1 & 4). A Georgia department of Agriculture official expressed that departments of health, whose purview in this space is ensuring food safety and prevention of

human illness from agricultural practices, could be a main advocate for state animal antibiotic use data collection (Interviewee 4)[91].

Unfortunately, the department of health in Georgia, as is the case in Maryland and California, has demonstrated little to no interest in the design and implementation of AMU data collection policies (Interviewees 1, 3, & 5). Although food producer groups and the Georgia Department of Agriculture work with the Georgia Department of Public Health (GDPH) to trace possible cases of foodborne illness (Interviewees 4 & 5) and GPAF voluntarily worked with public health officials to create guidance for farmworkers during the COVID-19 pandemic, this relationship has not been used by either actor to discuss animal antibiotic use practices (Interviewee 5)[92]. The GDPH Antibiotic Stewardship website, although relatively robust in monitoring human antibiotic use through programs like their "Antibiotic Stewardship Program Honor Roll" for acute care facilities, contains only links to other state department materials about veterinary antibiotic stewardship (Georgia Department of Public Health 2024). The lack of focus on AMU in Georgia public-private partnerships may indicate a policy agenda and limits on government monitoring that are tightly controlled by the poultry industry, but it is also indicative of fragmentation between state departments of Agriculture and Health on what issues, and which actors, they feel qualified to engage with. Without the pressure of a consumer advocacy group or movement within the state to prompt activity on state AMU policy, it is difficult to distinguish how government actors might respond to consumer and producer group influence.

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[91] "If you're talking about policy on antimicrobial use, ultimately the focus on that type of work has more to do with human health, I'll be honest, than animal health. I would see DPH kind of taking a little bit more of a role potentially than us [the Department of Agriculture]." (Interviewee 4)

[92] "We [GPAF] did become really connected to public health during the [COVID-19] pandemic. That was more because of you know, worker safety - protecting workers… I just reached out to them and said, can you help us, we're being told we should do traceback … I mean, how do you, you know, how do you do all these things?... It was a good, good relationship we had and we're continuing that now." When asked whether this relationship was ever applied or used for antibiotic use, the interviewee shared, "No, that never really came up. It was really about protecting workers." (Interviewee 5).

State-Level Antibiotic Use Policies: Obstacles and Opportunities

Comparing AMU data collection policies in these three state cases also led to new evidence for the merits and difficulties of state policies and the obstacles and opportunity that federalism presents for AMU policy. Producer groups argued that state level AMU policy is largely ineffective at dealing with a nationalized food production industry because the meat consumed by citizens in one state is often produced in a different state (Interviewees 2 & 5). Therefore, meat eaters within a state are not expected to have a significantly reduced risk of resistant foodborne illness due to policy governing AMU in their state. Additionally, tightening state standards past federal rules may put state food production industries at a competitive disadvantage compared to other states (Interviewee 2). Additionally, veterinarians often have imperfect information on how antibiotics prescribed and medicated feed ordered through VFDs are actually administered to animals by farmers (Interviewee 4 & Ekakoro 2019:5). The potential data inaccuracies with veterinary reporting of antibiotic use are especially prevalent in rural areas where the veterinarian for a farm lives hours away and can not visit the farm regularly or when animals become sick (Interviewee 7[93] & Ekakoro 2019:5). However, even if the data collected by state AMU policies is not a perfect representation of on-farm AMU and state rates of foodborne illness would likely stay constant even in the presence of such laws, there is evidence that state AMU policy is beneficial for other reasons.

State AMU policy could improve state citizens' health due to positive impacts on the reservoir of AMR bacteria that spreads from animal waste and farm runoff into nearby water and

[93] On the topic of veterinarian reporting on antibiotic use data, Interviewee 7 shared: "There are not very many large animal vets left in the US anymore west of the Mississippi. It's a narrowing profession, people mostly want to be small animal vets and live in cities and not be large animal vets and have to drive hundreds of miles. The question of how much are veterinarians actually seeing versus how much they're just signing off for is something I have heard people discuss a lot." (Interviewee 7).

food sources. Environmental contamination of AMR bacteria significantly affects the resistance profiles of bacteria found in communities living near industrial farms (Rinsky *et al.* 2013 & Casey *et al.* 2013), so monitoring on-farm AMU and enforcing judicious use could reduce the presence of dangerous AMR bacteria in state soil, water, and reduce the risk of human infection from environmental contamination (MD Senate EHE 2017). One of the key motivations for the Maryland Keep Antibiotics Effective Act was to codify a federal rule at the state level to protect the new restrictions on animal AMU from insufficient federal regulation and possible federal deregulation (Interviewees 1 & 2). The use of state policy to protect public health advances from an unfriendly federal administration could protect state citizens from negative public health consequences of deregulating industry behavior. Additionally, the lessons from California applied to the Maryland 2017 addition prove that previous state policy attempting to regulate the same (or an extremely similar) issue assists new states in adopting more effective policies. Therefore, lessons from the Maryland and California policies could help consumer advocacy coalitions prepare for future battles over AMU policy and monitoring at both the state and federal levels.

Conclusion

Interview evidence and analyses of legislative documents and hearings show that most producer groups across species sectors have not experienced fragmentation based on their *preferences* opposing state AMU regulation, enhancing their ability to direct policy with a cohesive voice in California and Georgia (Interviewees 2, 5, 6 & 7). However, when pushed by consumer advocacy groups and progressive producer groups like Perdue Farms in Maryland, the differing *capacities* of poultry compared to cattle and swine producers increased poultry producer groups' willingness to accept (and inform the design of) data collection policy

(Interviewees 1, 2, & 3). Consumer group strength in advocating for agricultural AMU data collection was greatly improved through creating a coalition with supportive environmental, human healthcare, and food retail groups and through leveraging previous advocacy experience from on similar agriculture and environmental issues in the same state (Interviewees 1, 2, 3, 5, & 7). Interstate policy learning between California and Maryland consumer and producer advocacy groups show that, in addition to informing future federal policy, states can serve as laboratories for *each other* (Interviewees 1-4).

The addition of strong data collection provisions and stringent implementation directions in the Maryland law was also driven by the weaker iron triangle relationship between legislative committees, Departments of Agriculture, and producer groups demonstrated in Maryland compared to California. A main indicator of this weakened iron triangle was the Maryland legislature's greater affinity toward directing their Department of Agriculture's implementation than observed in the California legislature (Interviewees 1 & 3). The sequence of consumer groups sponsoring bill introduction in Maryland as opposed to the industry introduction of a weak law in California provides additional evidence of stronger industry influence over the policy agenda in California than Maryland (Interviewee 3).

In the Georgia case, there is sufficient evidence to say that no consumer advocacy group was pushing AMU data collection policy and producer groups did not exhibit fragmentation based on AMU preferences (Interviewees 4-6). Evidence from interviews also show that some of the fragmentation of responsibilities and priorities evident at the federal level between the USDA and the FDA are mirrored in relationships between state departments of agriculture and public health (Interviewees 1, 4, & 5). State agriculture agencies in Georgia, Maryland, and California did not push to enact new state antibiotic use regulation, focusing on implementation of existing

federal and state laws and responding to proposals brought up by stakeholders and legislators about new policies and issues (Interviewees 1-5). In all three state cases, the Department of Public Health has been largely absent from conversation or policy debates surrounding animal AMU data collection policy (Interviewees 1- 5).

Ultimately, interview evidence suggests that unless state-level producer groups are prompted by an outside force to engage in AMU policy, they would not support strong state-level AMU policy (Interviewees 1, 2, & 4-7). The most likely outside force: strong consumer advocacy groups and consumer demand for better data (Interviewees 3-7). As a former USDA economist writes, "the imperfect information about the risk associated with food means that neither the legal system nor the marketplace may be able to provide adequate economic incentives for the production of safe food" (Roberts 2013 as cited in Buck 2018:329). Evidence from this project reveals that although some strong consumer advocacy coalitions have pushed to serve better information through data collection policy, most state producers and government actors won't take a bite.

Limitations

As a biology major, I often feel a knot form in my stomach when I ask a question in a political science class and someone says, "it depends". But now *I* must say that in answering which group or mechanism drove what action (or inaction) in the Maryland, California, and Georgia cases, *it depends*. Unfortunately, I did not have sufficient time or resources to thoroughly address the numerous possible variables that factor into state AMU data collection policy outcomes. There are a few variables that deserve more attention than I could give them in this thesis; namely, the insufficiently explored impact of pharmaceutical stakeholders, partisanship, and state government actors on AMU data collection policy outcomes.

The participation of pharmaceutical companies, and their relationship with state government actors and producer groups, was difficult to ascertain. A consumer advocacy representative from Maryland shared that "The pharmaceutical industry was certainly opposed as well, but they quickly learned that they couldn't be so public" (Interviewee 1). Therefore, the absence of public opposition to legislation from pharmaceutical companies and organizations could point to weakened producer group opposition to antibiotic use laws in Maryland or California, but it could also mean that the industry used other, more covert methods to influence state antibiotic use policies. One of these methods is pharmaceutical company pressure on veterinarians and veterinary associations to support the continued routine use of antibiotics in animal agriculture (Ekakoro 2019:6 & Interviewee 6):

> *"I don't want to ignore the influence that the pharmaceutical companies would have on veterinarians. They hire bright young salesmen to go out and call on these veterinarians and explain to them the benefits of using it in ways that sell the drug. Pharmaceutical companies want to sell the drug." (Interviewee 6)*

Therefore, although I tried to uncover pharmaceutical lobbying and donations directed at bill sponsors and relevant legislation, it is difficult to measure the extent of pharmaceutical companies' or associations' involvement in each state case. Due to its focus on producer groups and consumer advocacy groups, this thesis also did not explore some reasons besides pharmaceutical pressure for why farm animal veterinarians may oppose and mobilize against state AMU data collection.

Large animal veterinarians are a dwindling profession, and policy to monitor and reduce animal AMU can present a threat to their scope of practice and ability to make a living from prescribing and advising on antibiotics for animal disease prevention (Interviewees 3 & 4). Policy solutions to assist large animal veterinarians, like greater investments and incentives for veterinary students to pursue rural and farm animal medicine, as well as government financial

and technical support for changing veterinary and farm management practices, were also not discussed in the thesis (Ekakoro 2019:9-10). These policies are vital to ensuring that farm owners and veterinarians avoid significant personal costs when attempting to reduce antibiotic use on farms.

State partisanship and institutional rules also played a role in each state case, but I have insufficient information and expertise to describe the magnitude and nature of these variables. Interviewees pointed out that California and Maryland are both blue states with large urban populations (Interviewees 2, 5, & 7), and the partisanship of citizens and legislators can influence which states pursue state environmental health policy and whether they succeed in creating strong policy. Additionally, the role governors in shaping policy outcomes in these cases remains largely unexplored. Research revealed that Governor Jerry Brown pushed Senator Hill in California to improve SB-27 and a previous version of the AMU bill in 2014 (Interviewee 3 & Zuraw 2015) and revealed that Governor Hogan in Maryland generally prevented his departments from providing input during the policy writing and design process (Interviewees 1 & 2). Both Governors' roles, if more thoroughly researched, could have provided further support or contradiction to my findings.

It's also difficult to parse the relationship of the independent variables to each other, especially how the strength of consumer advocacy groups affected the strength of producer groups and vice versa. Consumer advocacy group strength was indicated by participation and influence in the policy process, but under a strong iron triangle with strong, opposed producer groups, even a strong consumer advocacy group may not exhibit the levels of participation and influence on government actors that I used to evaluate consumer advocacy strength. I attempted to address these concerns by using an iron triangle model to capture the complexity of

relationships between industry, government, and new actors such as consumer advocacy groups, however the interdependence of these different groups made it difficult to assert that one group's strength played a more significant role in policy outcomes than the other.

Future Directions

Through this research, it has become increasingly clear that there is a data dead zone concentrated around a particular part of the food supply chain: farm operations. State policies to address this dead zone, specifically for antibiotic use, are not limited to the cases discussed in this thesis: four other states (New York, Illinois, Pennsylvania, and Oregon) introduced state AMU antibiotic use regulation and data collection that could be studied using the theory and methods in this thesis (Bliss *et al.* 2023). Additionally, industrialized aquaculture ("the farm-raising of fish, crustaceans, shellfish, or aquatic plants") poses threats to the stability of animal ecosystems and could expose humans to antibiotic residues from production if fish farming practices are not monitored for compliance with standards (Neff 2014:292).

Antibiotic overprescribing and misuse are also a concern in shelter animals and household pets; these animals' constant contact with humans provides many new opportunities for the spread and evolution of antibiotic-resistant bacteria that could cause illness in humans (Dall 2016). As an official at the Georgia Department of Agriculture noted, antibiotic use in shelter animals is particularly concerning because "you've got large populations of animals that are being prescribed often the same type of drugs for respiratory infections and things like that for long periods of time, or they [the animals] get them [antibiotics] for two days and they are adopted and never finish a course of medicine" (Interviewee 4). AMU data collection and analysis from animal shelters and small animal veterinarians is evolving at the state and federal

level as state veterinarians, microbiologists, and CDC officials uncover more information about the spread of drug resistance through our furry friends (Interviewee 4, Dall 2016, & CDC 2022).

Perhaps the biggest area where research on antibiotic use data collection policy could be applied is surveillance of pesticide use on agricultural crops. Pesticides, like antibiotics in food animals, are spread over fruit, vegetable, and cereal crops to reduce disease, control weeds, and increase crop yields (Tudi *et al.* 2021). The industrialized use of toxic pesticides has serious human, animal, and environmental health effects when "pesticide contamination moves away from target plants" (Ibid.) and can exert selection pressures on bacteria found on crops and farms that results in the development of AMR (Kelbrick, Hesse, & O'Brien 2023). Therefore, the EPA approves pesticide company registration applications based on "the ingredients of the pesticide; the particular site or crop where it is to be used; the amount, frequency, and timing of its use; and storage and disposal practices" (EPA 2024). Sound familiar? Clearly, FDA and state AMU policies regarding AMU can inform and predict state and EPA initiatives to collect data on and regulate pesticide use to protect human health.

Additionally, state agricultural, public health, and environmental protection laws are constantly targeted (for better or for worse) by lawsuits, federal agency scrutiny, and legislation through Congress. A current example is the Ending Agricultural Trade Suppression (EATS) Act introduced in U.S. 118th congress that could "void over a thousand state and local laws and regulations concerning public health and safety" through language prohibiting any state or local "standard or condition on the preharvest production of any agricultural products sold or offered for sale in interstate commerce" (Harvard ALPP 2023:3). Analyses of state policies and how government and private sector groups can support them are instrumental to maintaining state governments' capacity to enact laws and rules to protect our food, and therefore our health.

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Appendix

List of Interviewees

Interviewee #1: Employee at Maryland Public Interest Research Group (MD PIRG) interviewed on 1/31/2024.

Interviewee #2: Employee at Maryland Farm Bureau interviewed on 1/29/2024.

Interviewee #3: Employee at Natural Resources Defense Council interviewed on 3/05/2024.

Interviewee #4: Employee at Georgia Department of Agriculture interviewed on 3/05/2024.

Interviewee #5: Employee at Georgia Poultry Federation interviewed on 3/15/2024.

Interviewee #6: Employee at White Oak Pastures interviewed on 3/13/2024.

Interviewee #7: Independent Journalist interviewed on 1/26/2024.

Background Interview #1: Employee at Centers for Disease Control and Prevention Division of Foodborne, Waterborne, and Environmental Diseases interviewed on 11/08/2023.

Background Interview #2: Two employees at Centers for Disease Control and Prevention Division of Foodborne, Waterborne, and Environmental Diseases involved with the NARMS program interviewed on 11/29/2023.

Figures

Figure 5: Interview Schematic: Agenda Setting and Introduction.

Figure 6: Interview Schematic: Policy Design and Editing.

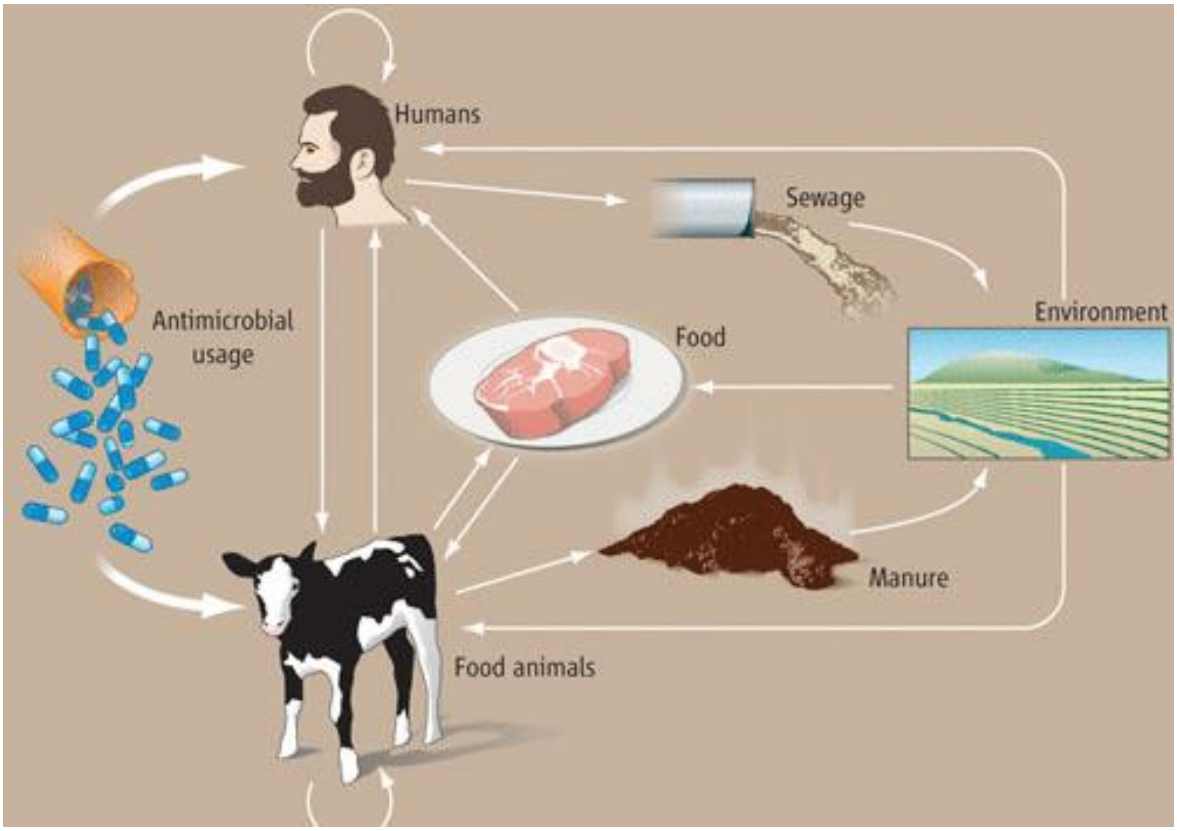

Figure 1. Spread of Antimicrobial Resistance Between Humans, Animals, and the Environment. *American Society for Microbiology*[94]

[94]Antimicrobial resistant genes and bacteria are introduced to humans through three major routes (Figure 1): healthcare-associated (involving humans taking antibiotics and/or being infected with drug-resistant bacteria during a hospital visit), foodborne infection (through eating infected meat or produce), and environmental contamination from animal waste and excess antimicrobial agents produced in pharmaceutical plants (Holmes et al 2016:179-180). Figure Photo Source: Antimicrobial Resistance: a OneHealth Perspective. McEllen & Collignon 2018. https://journals.asm.org/doi/10.1128/microbiolspec.arba-0009-2017

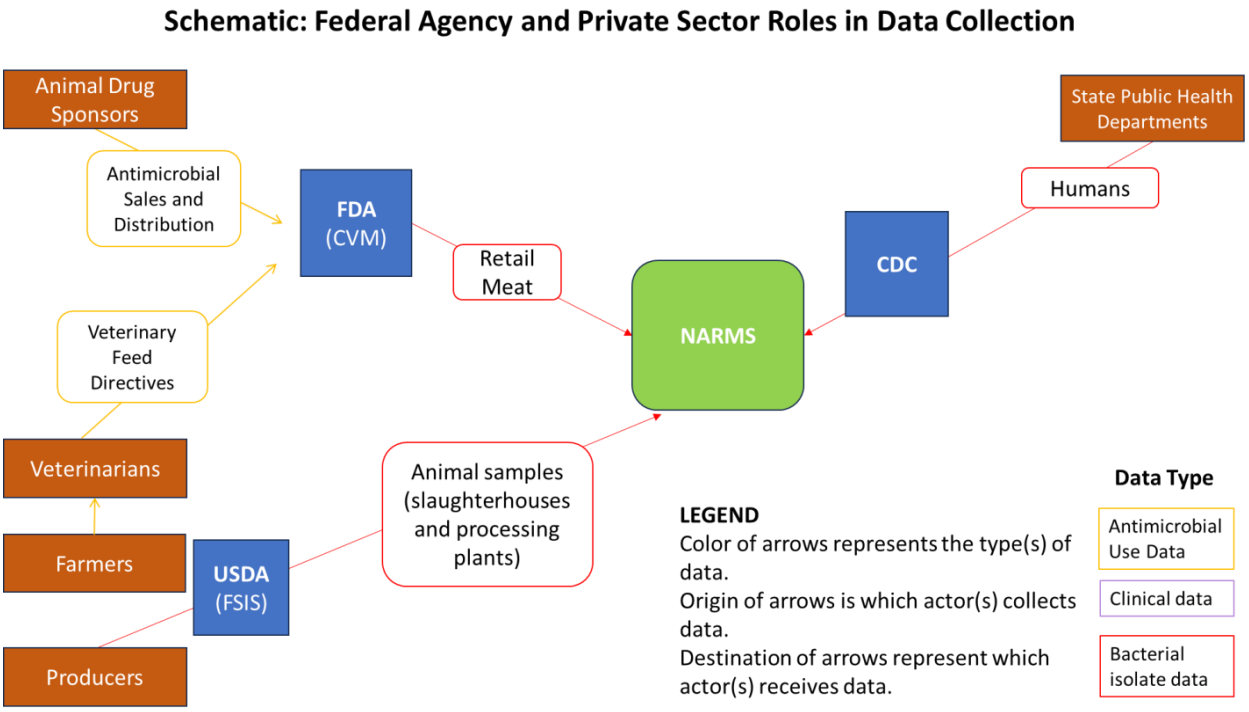

Figure 2. Schematic: Federal Agency and Private Sector Roles in Data Collection.

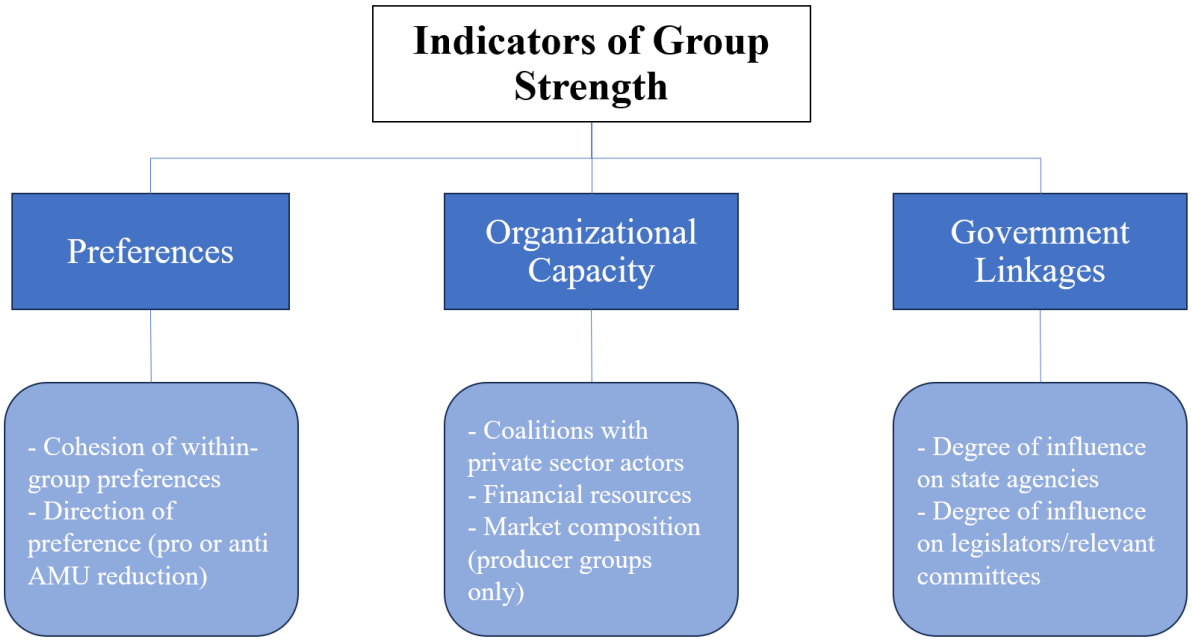

Figure 3. Independent Variable Construction: Indicators of Group Strength.

Conditions to Satisfy for Capture (*Detecting and Measuring Capture:* Daniel Carpenter)

A1. There exists an identifiable "general interest" or "public interest", or goal for which a regulation could, in theory, be created. Call this the people's welfare [W].
A2. There exists an identifiable interest or goal of the "industry" or "producers" in an industrial sector, or within an industry, there exists an interest of dominant or particular firms. Call this industry interest (I).
A3 [conflict of industry and public interest]: W and I conflict... in the minimally sufficient sense that for a set of possible laws created, the public interest statutory obligations of the agency and the producer/special interest do not coincide.
A4 [capture mechanism]: There exists some mechanism of undue or disproportionate influence or capture (C) whereby the industry wishes to induce the legislature to choose I over W.
A5 [deterministic capture]: Given capture, the legislature repeatedly chooses I over W... and the resulting statute or regulatory regime is enforced or implemented in way that preserves the dominance of I over W in the original legislation. Without capture, this pattern would not hold, as the legislature would choose W repeatedly over I. **To the extent that the agency's choice of producer/special interest over public interest is more ingrained or patterned, we say that the agency is *more* captured.**
A5 [probabilistic capture]: A weak probabilistic condition is that the legislature's choice of I comes with a higher probability with capture than without.

Figure 4. Conditions to Satisfy for Institutional Capture.
Source: Carpenter & Moss. 2014. *Preventing Regulatory Capture: Special Interest Influence and How to Limit it. The Tobin Project.* Chapter 3: Detecting and Measuring Capture pg 59.

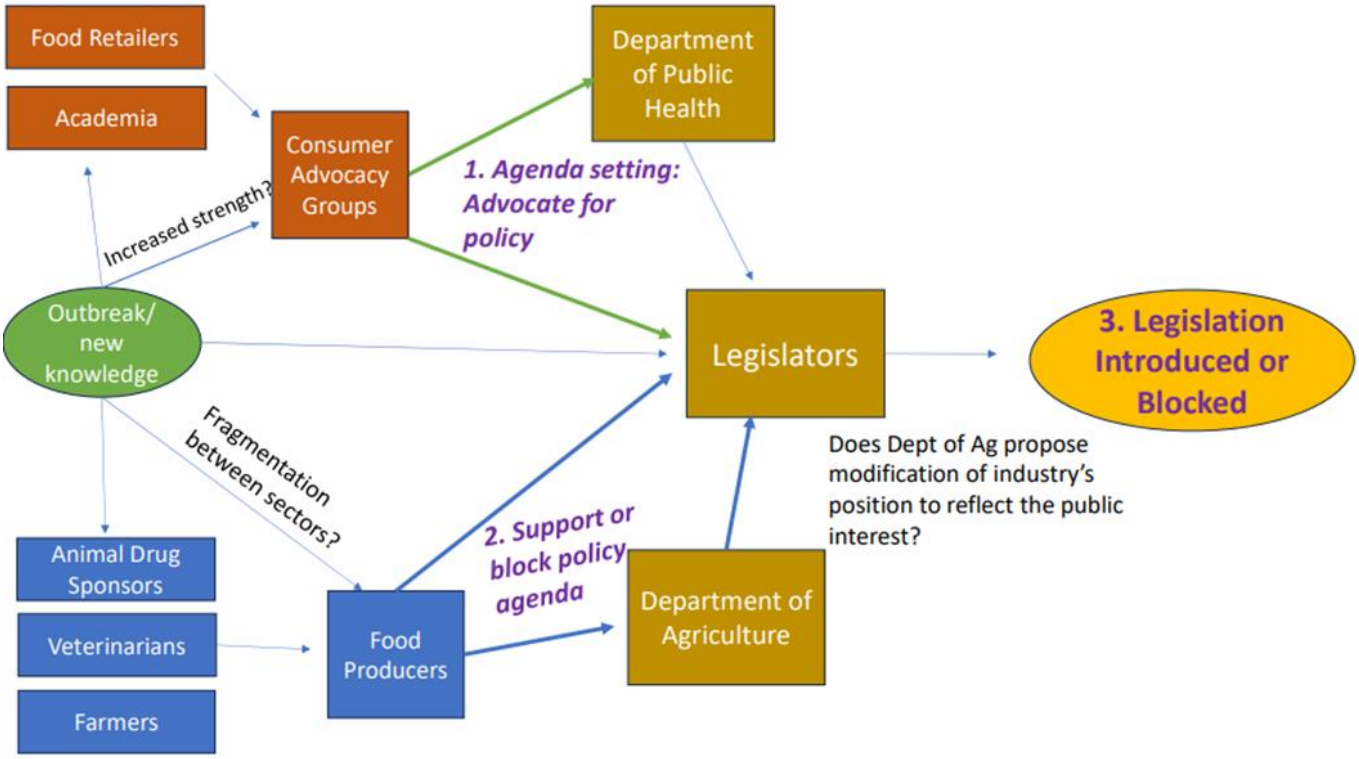

Figure 5. Interview Schematic: Agenda Setting and Introduction.

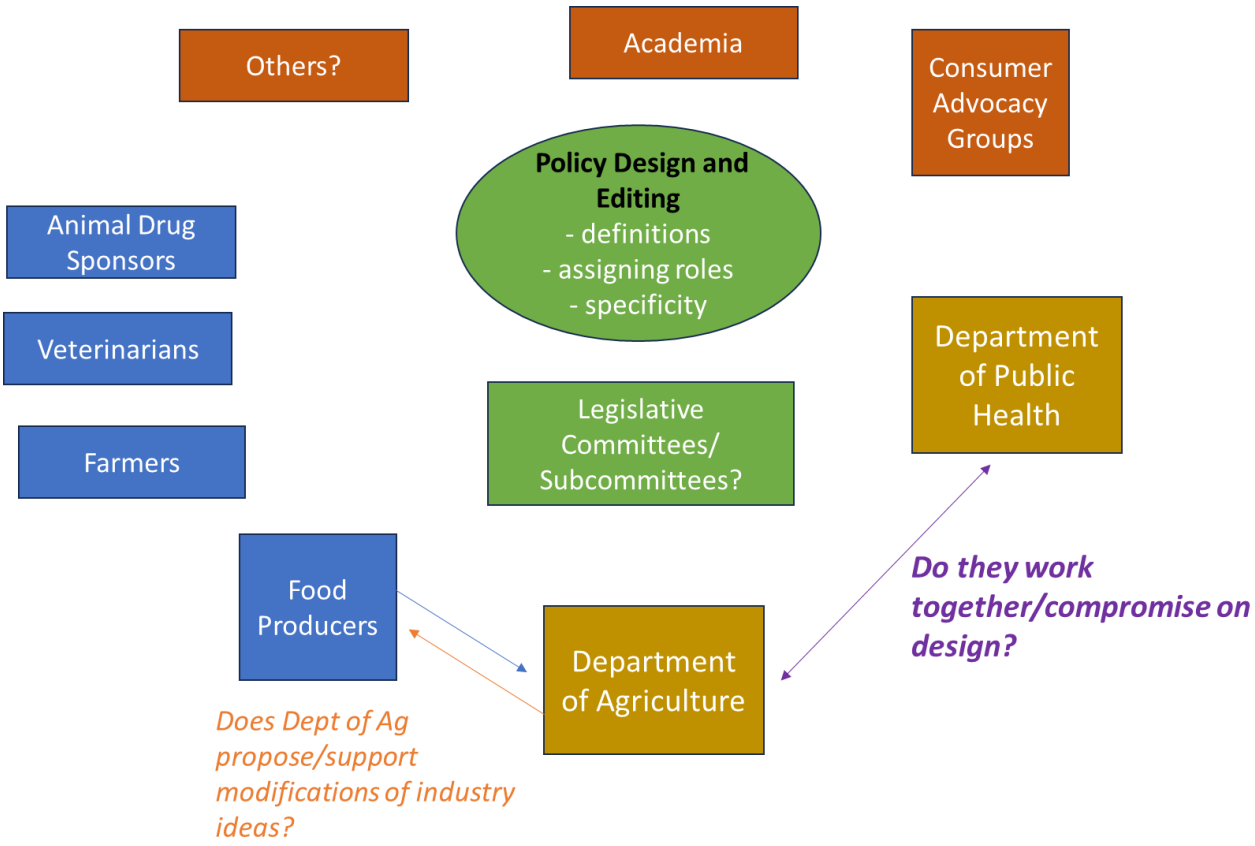

Figure 6. Interview Schematic: Policy Design and Editing.