Reducing Animal Product Consumption in the United States with State Interventions: Possibilities, Limitations, and Recommendations

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Reducing Animal Product Consumption in the United States with State Interventions: Possibilities, Limitations, and Recommendations

By
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University of Colorado at Boulder
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Abstract

Animal product consumption is environmentally inefficient, destructive to wildlife habitat, and a large contributor to climate change. However, animal product consumption is expected to increase per capita with a growing world population. In order to understand state actor interventions to reduce animal product consumption in the United States, I conducted a literature review on past interventions to affect dietary behavior domestically and abroad and conducted correlation analysis on agricultural subsidies, environmental regulations, and nutritional guidelines. Acknowledging the U.S. context, I ultimately recommend three phases for state actor intervention. Between now and 2020, civil society and market actors should build awareness about connections between animal agriculture and negative consequences starting with health. Starting in 2020, state actors, including the federal government, should utilize newfound political support from the public to build awareness, including factually accurate 2020 Dietary Guidelines for Americans, climate- and health-friendly public procurement standards, and potentially even health labels on animal products. Starting in 2024 or 2029, depending on levels of public support, the federal government should update its Farm Bill to decrease subsidies for animal operations and feed crops while increasing subsidies for climate- and health-friendly specialty crops, in conjunction with transitional programs to assist farmers. Furthermore, the federal government might consider food-specific taxes that tax products based on their climate or health impacts, in which the revenue supports healthy food access for low-income communities. Interventions by state actors will promote large-scale dietary shifts that support climate change mitigation and improved human health.

Keywords: animal agriculture, food policy, agricultural subsidies, food taxes, dietary guidelines, public procurement, environmental regulations, regulated labels.
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Preface

This thesis is a culmination of my undergraduate education motivated by a deep appreciation for evidence-based work that serves to better the world we live in, whether for the betterment of people, the environment, or animals. I am eternally grateful for the individuals that supported me in the process of writing this thesis.

First and foremost, I would like to extend my gratitude to my incredible thesis committee. Dr. Peter Newton, the committee chair, supported me through the development of my thesis idea, provided guidance for resources and direction for methodology, and offered thorough feedback for multiple drafts. He shared his passion for evidence-based approaches to sustainable food systems with me and never waivered in his dedication to my academic and professional success as his advisee. Dr. Alastair Norcross supported me through the process with feedback on drafts and laughter to lessen the emotional toll of the issues this thesis brings up. Dale Miller helped me maintain continuous progress on the thesis process and posed thoughtful critiques to improve the presentation of the thesis. I truly could not have written this thesis without their support.

I would like to thank Dr. Eve-Lyn Hinckley and Phil Pendergast for assisting me with the statistical methodologies for this thesis. They helped me to improve the integrity of this thesis with insightful suggestions that I might have overlooked.

I thank my friends and family for their support throughout the process. From weekends with me at the library to encouraging me amidst setbacks, this support system kept my eyes focused on the end goal. Special thanks to: Camille Zwaan, David Bright, Carol Pozen, Anna Dorovskikh, and Udval Altangerel.

Last, but far from least, I want to extend my gratitude to my favorite nonhuman animal, Ollie Sigle, and my personal luminary, the late Lisa Shapiro, for inspiring my unfaltering commitment to compassion today and always. Her memory will be with me always.
Introduction

Food sustainability is an incredibly necessary and complex field of study, encompassing issues as diverse as human health, global hunger, food justice, agricultural greenhouse gas (GHG) emissions, international structural adjustment programs, overexploitation of fisheries, agriculturally-sourced oceanic dead zones, and resource scarcity, to name a very select few areas of study. The immediate ubiquitous implications of food sustainability issues, and especially the connection between U.S. dietary habits and global-scale environmental degradation, motivated the journey of this thesis.

The purpose of this thesis is to explore and recommend state interventions to reduce animal product consumption in the U.S. by investigating existing interventions to alter dietary behavior conducted by governmental institutions both domestically and abroad. This analysis is important and urgent given the significant anthropogenic environmental degradation from farmed animal production that negatively impacts today’s society as well as future generations. I discuss why policymakers should prioritize a reduction in animal product consumption in order to curb GHG emissions and environmental degradation. I utilize a policy instrument framework to organize and discuss interventions in the U.S. and around the world that have aimed to influence the public’s dietary habits.

In order to evaluate interventions, I conduct a literature review on policies that directly or indirectly alter dietary behavior utilizing a policy instrument framework. I focus on agricultural subsidies, food-specific taxes, environmental regulations, regulated labels, public procurement, and dietary guidelines. I then compare available empirical data from agricultural subsidies, environmental regulation enforcement, and dietary guidelines with a nation’s consumption of the targeted food group. I analyze data with correlation analysis for correlation coefficients and significance. The $r$ and $p$-values indicate interventions that have potentially historically impacted consumer food choices. I
then compared strength of empirical relationships with existing literature discussing specific interventions’ effectiveness.

After conducting a literature review and empirical data analysis, I discuss the various interventions potential effectiveness in the U.S., including consideration for the limitations of applying specific interventions to animal products given the current U.S. context. Ultimately, I recommend a state actor pathway to reduce animal product consumption within the context of the U.S.
Background

To provide context for my thesis, I discuss how agriculture has serious environmental implications, and animal products have disproportionate environmental impacts compared to plant-based products. I then explore trends in animal consumption both spatially and temporally, which speak to the need to redirect future trends of animal product consumption. I compare the environmental impacts of animal products with other food sustainability issues to establish a priority for efforts in food sustainability. I review arguments in the literature for which influencing actors should hold responsibility for intervening in unsustainable rates of animal product consumption. Lastly, I detail the frameworks utilized in the rest of this paper, defend the novelty of this study, and conclude the section with the driving research question.

Animal Agriculture and the Environment

The contemporary global food system threatens the long-term wellbeing of the biosphere because of its contributions to climate change, ecosystem degradation, and biodiversity loss (Foley et al., 2011). Agriculture is responsible for an estimated 30% of global anthropogenic GHG emissions when including emissions from agricultural fuel use, land use change, and fertilizer production (Bellarby et al., 2008). These emissions contribute to the global warming of the atmosphere, resultant climatic changes, and impacts on a biosphere that may not be capable of adapting to the rapidly changing environmental conditions (Bellard et al., 2012).

Agriculture-related land use change contributes not only to GHG emissions, but also ecosystem degradation and biodiversity loss. Agriculture occupies 38% of Earth’s ice-free land surface and is expanding particularly in the tropics (Foley et al., 2011). For example, cattle production is associated with up to 75% of Amazon rainforest deforestation (Walker et al., 2013). Land use change increases GHG emissions not only by burning biomass, but also by altering how
much carbon the ecosystem can sequester. It also equates to habitat loss, altering ecosystem structure and function, threatening biodiversity, and reducing an ecosystem’s resiliency (Chapin III et al., 2011). The sixth mass extinction in the history of the Earth is already underway, evident by a rate of vertebrate species loss that is 100 times higher than the background rate over the last century (Ceballos et al., 2015). Aquatically, nutrient inputs into agricultural systems pollute waterways and have created dead zones in 66% of the world’s estuaries through the process of eutrophication (Chapin III et al., 2011b). GHG emissions, biodiversity loss, and aquatic dead zones are only a select few impacts of global agricultural expansion.

Not all agricultural products have equal environmental impacts; the carbon, water, and land footprints of different food products vary significantly (Fig. 1). These variations are particularly apparent among different forms of protein. Vegetable proteins have a 100 times smaller carbon footprint per unit protein weight than protein from grazing or confined cows (Nijdam et al., 2012). Vegetable proteins also use the least amount of land per unit protein weight, while cow meat\(^1\) uses the most (Ibid.). Finally, bean and lentils have a water footprint of 19 liters per gram of protein compared to 112 for cow meat (Mekonnen & Hoekstra, 2012).

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\(^1\) Because “cows” are generally thought of as both female cows and male bulls, “cow meat” in this text refers to both genders.
Figure 1. For selected food products of animal and plant origins: (a) Carbon equivalent footprints based on meta-analysis of life-cycle assessment studies. Graph from Ripple et al. (2013). Dairy excluded due to Ripple et al. (2013) focus on the comparison between meat and vegetable proteins. Meta-analysis by Nijdam et al. (2012) indicates that liquid dairy milk uses 1 to 2 kg CO$_2$-eq per kg product and cheese uses 6-22. The same meta-analysis elaborates that milk uses 28-43 kg CO$_2$-eq per kg protein, compared to 58-643 for extensive beef, 6-17 for plant-based meat substitutes, and 4-10 for dry pulses. (b) Water footprints based on global averages. Table from Mekonnen & Hoekstra (2012). (c) Land footprints based on meta-analysis of life-cycle assessment studies. Graph from Nijdam et al. (2012).
The significant differences in resource inputs per protein output between animal and vegetable products stem from the large amount of feed that animals consume before slaughter. Animals raised as livestock consume 36% of global crop calories (Cassidy et al., 2014). Animal products vary significantly in the efficiency with which they convert these vegetable calories to protein, with cow meat at 5% efficiency, pig meat 10%, chicken meat 40%, eggs 35%, and dairy 43% (Ibid.). Due to the low efficiency of converting vegetable calories to animal calories, humans ultimately consume only 12% of feed calories (Ibid.). This inefficiency is not unexpected; Lindeman’s (1942) 10% Law explains that 90% of energy is lost through each trophic level. Ultimately, 32% of global crop calories – and the nutrients, water, and energy used to produce these calories – are lost in the production of animal products. This loss of crop calories as a result of the inefficiency of animal production isn’t included in standard estimates of food waste.

The large water, land, and carbon footprints of animal agriculture, driven by inefficient conversion of plant protein, are reflected in the disproportionate impact of animal agriculture on the environment. Animal agriculture alone accounts for 14.5% of global GHG emissions (Gerber et al., 2013), drives worldwide habitat loss more than any other factor (Machovina et al., 2015), is associated with up to 75% of Brazilian Amazon deforestation (Walker et al., 2013), has degraded 20% of the world’s grazed lands, and is the most water-polluting sector, contributing to oceanic dead zones, coral reef degradation, and antibiotic resistance (Steinfeld et al., 2006). The cascading impacts of animal agriculture on the atmosphere, land, and water demand attention and action by decision-makers.

**Trends in Animal Consumption**

The World Resources Institute (2013) has analyzed Food and Agricultural Organization of the United Nations (FAO) projections of meat consumption. Meat consumption is projected to increase 23% per capita worldwide between 2006 and 2050. However, trends vary enormously by
region. For example, the U.S. is expected to see a 2% decrease in meat consumption by 2050.

However, contemporary baseline rates of meat consumption also vary enormously. In the U.S., per capita animal production consumption is 907 daily kilocalories, compared to 144 in Sub-Saharan Africa, 303 in the Middle East, 561 in China, and 864 in the European Union (EU). Further, small decreases in per capita animal product consumption may still lead to a net national increase, as a consequence of population increase. A 2% meat consumption reduction per capita in the U.S. will result in an increase in absolute meat consumption depending on the degree of population growth. If poor nations consume an equal amount of animal products, meat consumption reductions by wealthier nations are “probably necessary” to meet FAO’s conservative consumption projections in 2050, because the FAO does not incorporate sufficient (and what the World Resources Institute considers to be likely) income and resultant meat consumption per capita increases into its projection calculations. (World Resources Institute, 2013)

Overall meat consumption in the U.S. decreased by 6.7% between 2007 and 2011 (the most recent available data) (Fig. 2.a). The World Resources Institute (2013) hypothesizes that this recent decline stems from the 2007-2009 economic recession. However, an overall decline in caloric intake per capita decline between 2003 and 2011 continued steadily before, during, and after the 2007-2009 recession (Ng et al., 2014). Differing analyses indicate that the recession may or may not have impacted meat consumption, leaving a knowledge gap in the explanation for meat consumption declines post-recession.
Figure 2. Data is from FAO (2015b) regarding the food supply quantity (kg/capita/year) of animal products. (a) Total meat supply (and resultant consumption) per capita in the U.S. has steadily risen between 1960 and 2007, but has seen a reduction from 126.07 kg/capita/year in 2007 to 117.61 kg/capita/year in 2011. (b) Trends for consumption of specific (but not an exhaustive list of) animal products in the US. Note the different scales for each product. “Bird meat” refers to meat from chickens, ducks, turkeys, and geese.
While overall U.S. meat consumption has declined between 2007 and 2011, FAOSTAT (2015b) data indicate that specific animal products have different trends (Fig 2.b). U.S. cow meat consumption declined between 1976 (58.8 kg/capita/year) and 2011 (37.0 kg/capita/year). Bird (defined as chickens, ducks, turkeys, and geese) meat consumption has been increasing since data collection began in 1961 (16.4 kg/capita/year) to 2011 (51.4 kg/capita/year), although the rise may be leveling off as seen by consumption hovering around 50 to 52 kg/capita/year for the past decade. On very general levels, milk and pig meat consumptions appear to fluctuate, egg consumption appears to have slower fluctuations in the past three decades, and cheese consumption appears to steadily increase.

Prioritizing Animal Product Consumption Reductions

Given the environmental impacts and global increases of meat consumption, a variety of food system scholars and institutions agree that reduction of meat and dairy consumption should be a high, if not the highest, priority in developing a sustainable food system. A sustainable food system needs to address multiple significant environmental concerns, including high animal product consumption, but also food distance, food waste, and nonrenewable resource scarcity (Reisch et al., 2013; Suh, 2011; Sabaté & Soret, 2014; Dorward, 2012; Pirog & Benjamin, 2003; Coley et al., 2009). Garnett et al. (2011) identifies the act of reducing meat consumption, along with not overeating, as the highest priority behavior to reduce food-related GHG emissions. Sabaté & Soret (2014) call for policies that advance plant-based diets worldwide to enhance the environmental outcomes, among other important concerns such as food supply, social justice, and health. Machovina et al. (2015) prioritizes a move from animal-based to plant-based foods in order to conserve biodiversity. Foley et al. (2011) does not rank interventions to the unsustainable food system, but emphasizes that shifting 16 major crops, many of which feed farmed animals, to entirely human consumption would increase worldwide food availability by 28%.
State actors and non-governmental organizations across the world have also indicated a need for reductions in meat and dairy consumption motivated by environmental concerns, including (a select few large actors): the FAO (Steinfeld et al., 2006); Greenpeace International (Bellarby et al., 2008); the U.S. Departments of Health and Human Services and Agriculture’s 2015 Dietary Guidelines Advisory Committee (Millen et al., 2015); the Royal Institute of Public Affairs (Wellesley et al., 2015); and the Food Climate Research Network (Garnett et al., 2015). While reductions in animal consumption face social, cultural, and political challenges (O’Riordan & Stoll-Keemann, 2015), scholars, some NGOs, and some state actors view this behavioral change as a high priority for a sustainable food system.

Placing Responsibility for Animal Consumption Reductions

Scholarly perspectives differ over whether responsibility lies in the civil society, market, or state’s hands for interventions to reduce animal product consumption. These three influencing actors introduce and implement interventions that can impact various interacting elements of the supply chain, namely producers, processors and packagers, distributors and retailers, and consumers (Newton et al., 2013). Arguments exist for and against civil society, market, and state accountability.

*The Omnivore’s Dilemma* is a popular book read by the general U.S. public that advocates that the consumer should drive the needed change toward a sustainable food system (Pollan, 2006). However, other scholars critique this neoliberal approach to solving food system imbalances because of the deep political and economic complexities that simple consumer action cannot fix (Guthman, 2007). Furthermore, a universal consumer-based approach doesn’t acknowledge the sociological interactions with food that change based on race, culture, and income level (Guthman, 2010). While social media and marketing campaigns may aim to change consumer behavior, it may not be the best methodology for sustainable change.
Some scholars claim that the private sector has the power to change the unsustainability of the food system. While governments secured food system power in the past, the private sector now holds the power (Vinnari et al., 2012). Some evidence supports the idea that meat consumption is actually supply-driven due to a passive consumer lacking substantial economic power (Rivera-Ferre, 2009). Ultimately, corporations may have more power in the food system than governing agencies or consumers.

Some scholars suggest placing responsibility on governing actors. The neoliberal idea of voting with our dollars does not create substantial change due to the “Prius paradox,” in which the idea that being environmentally responsible now justifies future irresponsibility, and the “behavior-impact gap,” in which individual behaviors simply aren’t enough to create substantial impact (Leonard, 2012). Policy change and fundamental economic restructuring provide a pathway to a more environmentally sustainable system (Ibid.). In the context of food systems, policy can promote plant-based dietary change (Sabaté & Soret, 2014).

The actors that implement the interventions do not necessarily act independently of each other. There are at least three approaches to achieving such behaviors: a top-down regulatory approach, a bottom-up grassroots approach, and a combination approach in which grassroots lobbying and advocacy efforts demand regulatory action (Ockwell et al., 2009). Hall (2013) advocates for the effectiveness of the Ockwell et al. (2009) combination approach because it recognizes and attempts to breakdown the structural, educational, and political barriers of meaningful behavior change. While there is no reason why actors cannot collaborate on each other’s progress, this thesis will focus specifically on state interventions into animal product consumption based on the strong arguments for policy-based change.
Framework

Delving into the interventions by state institutions, a policy framework can describe the variety of policy forms available for change. Kraft & Furlong (2012) describe five “policy instruments,” or ways that governments attempt to solve a problem through policy. The five categories of policy instruments are regulation, government management, taxing and spending, market mechanism, and education, information, and persuasion (EIP). Regulation either mandates citizens to take, or outlaws citizens from taking, a certain action. Government management involves the provision of services or management over a resource. Taxing and spending is used to raise funds, discourage certain actions, and directly or indirectly return funds to citizens. Market mechanisms utilize the market to reach policy goals, such as through cap-and-trade programs. EIP works to empower citizens with knowledge as means to achieve behavioral change. (Kraft & Furlong, 2012)

Reisch et al. (2013) have utilized a policy framework similar to Kraft & Furlong (2012) to organize potential policies to promote sustainable food systems. Some of their policies to reduce meat consumption include: regulation policy examples include meat and dairy production quotas and stealth marketing limitations for unhealthy foods; public procurement (or government management) policy examples include reducing meat and increasing plant-based fare in public cafeterias and school lunches; taxing and spending mechanisms such as taxing high-emission products; a market mechanism policy example such as a cap-and-trade program on nitrogen; and information-based (or EIP) policy examples include carbon labeling (Reisch et al., 2013).

Combining the strengths and relevant aspects of intervention analysis, societal behavior change, and policy instrument frameworks can assist in understanding how state actors can influence a reduction of meat consumption in the U.S. Such an understanding involves: identifying the relevant range of interventions; examining each intervention’s success or failure in impacting large-
scale food choices in cases where they have been tried; and recognizing the possibilities and limitations in adopting plant-based food behavior change interventions to reduce animal product consumption. This research into animal product consumption reduction may provide valuable gains in efforts to curb GHG emissions and environmental degradation in the U.S.

Novelty of This Study

Two recently published studies by the Chatham House have sought to answer a similar question to this thesis. Chatham House released a report about potential pathways for reduced meat consumption with a focus on Brazil, China, UK, and U.S. (Wellesley et al., 2015). The Chatham House report discussed interventions under the framework of those that: (1) educate, such as campaigns, nutritional guidelines, and regulation of advertisements; (2) influence, such as providing plant-based foods as default options; and (3) “incentivize, discourage or restrict,” such as banning or taxing unsustainable foods and subsidizing sustainable foods (Ibid.). Based on focus groups in the four selected nations, Wellesley et al. (2015) emphasized the necessity and specific logistics of raising awareness of the climate-meat connection through collaboration between the state, market, and civil society in each nation in order to enact comprehensive policies. By utilizing a “cycle of inertia” theory (Fig. 3), Wellesley et al. (2015) explain how to break the cycle given the demographics, trust towards specific actors, and public response to particular interventions of each nation in order to reach the initial agenda setting stage of the policy process (Kraft & Furlong, 2012). The Chatham House and Food Climate Research Network published a report regarding effectiveness of policies to change dietary trends (Garnett et al., 2015). The report posed a similar research question to this thesis and conducted a thorough literature review to answer the question.
While this thesis pursues a similar question to the two Chatham House reports, this thesis is novel in its quantitative analysis of the effectiveness of policies. In this thesis, correlation analyses provide quantitative data on how certain policies correlate with nation-level consumption trends, offering further insight into potential causal relationships and further research questions in the reasoning behind different relationships in different nations.

Research Question

This thesis asks: How do past efforts by state actors to affect dietary behavior, globally, inform future state interventions to reduce animal product consumption in the United States? I hypothesize: with an appropriate (combination of) intervention(s), policymakers can assist in the reduction of animal product consumption in the U.S.
Methods

To evaluate interventions, I utilized Kraft & Furlong’s (2012) policy instrument framework to identify and organize state-based interventions that affect dietary behavior both in the U.S. and in other developed countries around the world [defined by the World Bank’s (2015) list of high-income OECD members].

Once identified, I conducted a literature review to understand how and why these state-based interventions (policies and programs) did or did not achieve their dietary goals. I searched for peer-reviewed articles on Google Scholar regarding six state-based interventions: agricultural subsidies, food-specific taxes, environmental regulations affecting agricultural operations, regulated labels (specifically on cigarettes due to a consumption behavior change similar to food), public food procurement, and nutritional guidelines. Often times, citations in more general peer-reviewed articles led to country-specific peer-reviewed case studies. Some literature came from professional NGO reports. The literature did not always provide conclusive evidence of whether a dietary shift in the population occurred, but it provided a starting point for empirical data analysis.

Finally, I explored empirical data behind select interventions to further inform the degree to which the identified and quantitatively measured interventions might work. For all empirical analysis, I retrieved consumption data from FAOSTAT (2015b). FAO food balance sheets show supply of a food product taking into account import, export, and food waste before the retail level (Allievi et al., 2015). While formally labeled as “supply” and thus not distinguishing between consumption and consumer food waste, the food balance sheet data is representative of population-wide food consumption levels and shows trends in food consumption over time (FAO, 2015a; FAO, n.d.). Food system scholars have used these datasets for insights into demand and consumption patterns at a national level (Allievi et al., 2015; Tilman & Clark, 2014; Wirsenius et al., 2011). Within the food balance sheets, I utilized data from the food supply sheets on crops and livestock and fish primary
equivalents, taking data on different food products in kilograms per capita per year or grams per capita per day, depending on the analysis. For “animal product” consumption data, I added the aggregated items for “Meat,” “Fish, Seafood,” “Milk (excluding butter),” and “Eggs” to respect this thesis’ definition of animal products.

**Agricultural Subsidies**

I conducted correlation analyses with agricultural subsidy data as one variable and animal product, specific meat, and dairy consumption as the other variables (Fig. 4.a), for the years 1986-2011 (constrained by subsidy data in the early years and consumption data in the later years). I conducted analyses on all of the World Bank (2015) high-income countries with subsidy data (Fig. 4.b), although the subsidy data source grouped all EU nations together (n=12). The available subsidy data resulted in empirical analysis at both a national and transnational resolution. State support for agricultural commodities comes in various forms, from direct payments to crop insurance to price supports. The complexities of agricultural subsidies are best summarized by the Organisation for Economic Co-operation and Development’s (OECD’s) data on Producer Support Estimates (PSE)\(^2\) for each commodity as Producer Single Commodity Transfer (PSCT)\(^3\) (OECD, 2010). I matched PSCT data on corn, soy, and animal products with FAOSTAT data on animal products. I chose to explore corn and soy crop support relationships with animal product consumption because the animal agroindustry provides farmed animals with large proportions of the world’s corn and soy supply for feed, such as 60% of corn and 47% of soy in the U.S. (Olson, 2006; Cassidy et al., 2008).

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\(^2\) A PSE is the estimated “value of transfers from domestic consumers and taxpayers to producers resulting from a given set of agricultural policies” including payments based on inputs, commodity outputs, area, quantity of animals, receipts, income, and non-commodity criteria (Cahill & Legg, 1990; OECD, 2010).

\(^3\) A PSCT is the PSE for a specific commodity not including support for the commodity within a group, for all commodities, and other transfers to producers (OECD, 2010).
To account for lagging effects, I also repeated the above analysis with a singular change of matching subsidy data with consumption data lagged by one year (Fig. 4.b). In this lagged analysis, each correlation had one less data point as the years now spanned from 1987 to 2011 to account for the lag.

I reported all data in terms of correlation coefficient (r) and significance (p-value). Due to the multiple comparisons, the level of significance for each commodity consumption association changed as per Bonferroni corrections. Cow meat, milk (excluding butter), bird meat, and egg consumption correlations were tested at a p=0.0100 level of significance; pig, sheep, and goat meat at a p=0.0125 level; and total animal products at a p=0.0167 level. Significant and strong correlations

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Figure 4. (a) Subsidy analysis ran correlation analysis of the PSCT for a specific product against each of the corresponding quantities of products consumed. For example, Cow Meat PSCT was analyzed with Cow Meat Consumption in one correlation, and Cow Meat PSCT was analyzed with Milk (excluding butter) in a second correlation. (b) Nations and their n-values used in the subsidy analysis.
for specific countries and specific relationships provided insight for further research on why the specific country’s or product’s agricultural subsidies.

Environmental Regulations

To analyze the association between animal product consumption and environmental regulations, I conducted correlation analyses of a metric strength of environmental enforcement and associated animal product consumption in the same year and lagged by one year. The U.S. Environmental Protection Agency (EPA) maintains open records of civil and criminal prosecutions and enforcement of environmental regulations. To obtain civil enforcement data, I used the EPA (2015b) ECHO Enforcement Case Search function to search federal EPA cases in the “Agricultural Production – Livestock” industry. This search provided data on 1,271 civil cases. To track criminal prosecutions of animal agroindustry operations, I searched the EPA (2015a) Enforcement and Compliance History Online’s (ECHO) Summary of Criminal Prosecutions database for violations to all environmental statutes and with the keywords: animal(s), cow(s), chicken(s), hog(s), pig(s), livestock, poultry, beef, pork, manure, feces, dairy, milk, egg(s), hen(s), calf, and calves. My searches resulted in 1,271 civil cases, but only 32 criminal cases. Many of the criminal cases did not apply to the livestock industry, so I considered the criminal data negligible and did not include criminal data in the analysis. I ran analyses for both civil enforcement annual settlements and total annual costs of environmental regulation enforcement against FAO U.S. animal product consumption data per year for both the same year and lagged by one year to obtain correlation coefficients ($r$) and significance ($p$-value). In secondary analyses, I excluded outliers based on their $z$-scores compared with a critical $z_{0.05}=1.645$. As per the Bonferroni correction, the significant value for the correlation analyses was $p=0.025$.

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4 Total annual costs of environmental regulation enforcement are costs incurred by the defendant, including federal penalties, costs incurred from a voluntary environmentally beneficial project to reduce penalty, and costs incurred to attain compliance with the law.
Nutritional Guidelines

To analyze the effects of nutritional guidelines, I studied the correlation between recommended intake over time and the actual animal product consumption in a country. Collecting data on nutritional guidelines involved retrieving each nation’s nutritional guidelines over time, converting guidelines into daily recommended intake based on the context (nation and year) of serving sizes, and using Google Translate and/or my non-English language skills to translate non-English guidelines. This process was extremely time-intensive, so I collected data only for ten countries with both the largest range of animal product consumption per capita per year over all years of data collection and available, quantifiable nutritional guidelines. I also included the U.S. as the focal country of this study. FAO (2015c) provides a library of nations’ most recent dietary guidelines. Some countries, like the U.S., have long histories of nutritional guidelines changing over time, while other countries do not. I encountered challenges accessing some nations’ historical dietary guidelines and in translating those written in other languages. To help resolve the consequent variation in data quality, I set a confidence score for each nation’s primary data based on a rubric (Appendix A). For each of the selected nations, I standardized guidelines over time into serving sizes in grams. I then ran correlation analyses between the recommended intake of meat and dairy and actual meat and dairy consumption in each country studied. The correlation coefficients ($r$) along with $p$-values indicate significance of associations.

Eleven nations, including the U.S., were ultimately selected for dietary guideline analysis (Fig. 5). The following nations were excluded for the following reasons. Italy’s recommendations were in macronutrients, as opposed to the food group differentiations used in this study. Denmark and the Republic of Korea’s recommendations were qualitative and not objectively quantifiable. I could not access Sweden nor Finland’s pre-2011 recommendations. As a result, I collected information and
analyzed nutritional guideline data for Greece, Portugal, New Zealand, Spain, Estonia, Iceland, Netherlands, Hungary, Austria, and Japan, as well as the U.S. as the focal nation of this study.

Figure 5. The ten countries were selected for empirical study of nutritional guidelines based on two criteria: (1) the largest ranges of animal product consumption between 1961 and 2011 (years with available data) and (2) an accessible history of dietary guidelines with quantitative recommendations. The stars indicate countries that fit both of these qualifications, as well as the United States as the focal country of this thesis.

Based on the initial results, Portugal had the most significant results. In order to understand why, I plotted the recommendations and consumptions trends against time with the years of new recommendations marked. The visualization of the timeline provides key information on whether the recommendations or consumption changes happened first or simultaneously. I repeated this process for the two other remaining nations with significant correlations (U.S. and Hungary).

Lastly, I plotted the recommendations as the independent variable against consumption as a dependent variable on a transnational scale for each subgroup of recommendations (general protein foods, animal-based foods, and dairy milk). Although this correlation analysis incorporated several hidden variables, such as culture and socioeconomic status, it provides visualization for differences between countries’ trends.
Results

State Interventions to Affect Dietary Behavior

I mapped out interventions implemented by state actors to affect dietary behavior that could also potentially be used in the U.S. to alter animal product consumption behavior, utilizing the policy instrument framework from Kraft & Furlong (2012), combined with the frameworks developed by Newton et al. (2013) and Reisch et al. (2013) (Fig. 6). The federal U.S. government can intervene in animal product production through agricultural subsidies and environmental regulations. These actions could in turn affect the price of animal products, altering consumption patterns. The federal U.S. government can also intervene in animal product consumption through food-specific taxes, dietary guidelines, regulated labeling of products, and public procurement of plant-based alternatives to animal products in public facilities. While this list of interventions is not exhaustive, they represent some major actions that federal governments have taken to affect dietary behavior with respect to certain food groups in different countries. Understanding how each of these interventions has historically influenced dietary behavior, at any scale, and the degree of reaching objectives, and how policymakers or civil society could adopt and/or adapt these interventions to alter animal product consumption behavior, may provide valuable gains in efforts to curb GHG emissions and environmental degradation in the U.S.
Figure 6. This framework illustrates interactions between state actors and the animal product supply chain, focusing on possible interventions for animal product consumption. The policy instrument framework developed by Kraft & Furlong (2012) helped map examples of interventions, with some examples listed on the arrows derived from Reisch et al. (2013).

**Taxing and Spending: Agricultural Subsidies and Food-Specific Taxes**

**Agricultural Subsidies**

Federal governments across the globe have engaged in agricultural subsidies and taxes to either directly or indirectly affect dietary behavior. These state interventions may indirectly affect animal product consumption by changing the costs to producers and thus driving up prices for consumers. In 2012, the world’s 21 most food-producing nations collectively spent $486 billion in agricultural subsidies (Potter, 2014). The U.S. spent $30 billion of this (Ibid.). These subsidies range in form from direct payments, to crop insurance, to price supports; they involve governments directly intervening in the agro-economy (Ibid.). Some scholars propose a reallocation of subsidies away from animal products and towards fruits and vegetables as an economic solution to reduce
meat consumption (Vinnari et al., 2012). While Vinnari et al.’s (2012) suggestion may be popular, other scholars have unraveled counterintuitive aspects of economics in relation to animal product consumption. Rivera-Ferre (2009) suggests that the meat industry is supply-driven, because consumers of agro-industrial meat have become “passive consumers” due to imperfect information about social, health, and environmental consequences of meat consumption and the limited options available. This finding makes the subsidized production of animal feed especially relevant to animal product consumption, because subsidized inputs into the animal product industry can reinforce the economic influence it holds. Further, economic analysis indicated that the elimination of all agricultural subsidies would slightly reduce prices for meat and dairy and resultantly cause a very modest increase in meat and dairy consumption (Alston et al., 2008). Because U.S. agricultural subsidies have negligible impacts on food prices for consumers, they also have negligible effects on consumption patterns (Ibid.). These conflicting viewpoints on the economics of the agroindustry result in a lack of clarity on how to produce the most change.

In the U.S., the Agricultural Act of 2014, also known as the 2014 Farm Bill, controls agricultural subsidies. The Farm Bill eliminated direct payments to farmers and increased crop insurance subsidies (USDA, 2014). In terms of animal production, the 2014 Farm Bill brought back livestock disaster assistance programs and created the Dairy Margin Protection program (Lubben, 2014; USDA, 2014). In terms of fruits and vegetables, the 2014 Farm Bill provides US$100 million over five years to boost fruit and vegetable consumption among Supplemental Nutrition Assistance Program (SNAP, formerly referred to as “food stamps”) participants, US$150 million annually for the Fresh Fruit and Vegetable Program, and US$250 million annually for the Department of Defense’s Fresh Program, both with purchase fresh produce for schools (USDA, 2014; Agricultural Act of 2014). Overall, the 2014 Farm Bill budget exceeds US$956 billion over ten years, 79% of which goes toward nutrition programs such as SNAP (Agricultural Act of 2014).
Not all crops receive equal subsidies in the U.S. Between 1995 and 2012, corn subsidies cost the U.S. US$18.6 billion, wheat US$9.5 billion, soybeans US$8.7 billion, and cotton US$7.9 billion (Environmental Working Group, 2012). Altogether, these four crops accounted for 77% of crop subsidies. Of these crops, 60% of corn and 47% of soybeans grown between 2000 and 2004 served as feed for livestock (Olson, 2006). In terms of crops, the government heavily subsidizes feed for livestock while leaving 16% of agricultural subsidies to other fruit and vegetables, often referred to as “specialty crops” (Environmental Working Group, 2012). Because the subsidies appear enormous in absolute terms, popular media suggests the elimination of subsidies can alter supply and consumption habits (Pollan, 2006). Conversely and as mentioned before, a model phasing out agricultural subsidies in the U.S. between 2007 and 2016 suggested a small increase in meat consumption because of the relatively small economic impact of the subsidies per unit product (Alston et al., 2008).

Food-Specific Taxes

Denmark and Hungary have implemented taxes on specific foods or products. Popular in environmental economics, Pigouvian taxes increase prices of products to match the true cost of the negative externality, which may also reduce consumption as if a sin tax (Pigou, 1932). However, Pigouvian taxes are critiqued for disproportionately negatively impacting low-income communities as well as increasing consumption of potentially environmentally worse products if consumers do not know the range of nor have appropriate access to acceptable substitutes (Wellesley et al., 2015). Implementing complementary policies to improve access to and education about substitutes may counteract some of the negative consequences of taxation (Ibid.).

---

5 Due to the recent rise of biofuels, 45% of U.S. corn in 2015 was fed to animals, while 44% was used for biofuels, and 12% was used for food, seed, and industrial uses (USDA Economic Research Service, 2015). Rounding causes percentage sum to exceed 100%.
The saturated fat tax in Denmark provides an opportunity to understand why and how food taxes might fail. Denmark established a tax on saturated fat – including animal products – in 2011 but eliminated the tax fifteen months later (Jørgensen et al., 2014). The tax had negative effects on the domestic economy. It caused artificial prices increases in meat (3.8%) and milk, cheese, and eggs (2.6%), compared to overall EU price increases of 1.2% and 0.8% respectively (Ibid.). Furthermore, the tax and price increases encouraged Danish consumers to travel abroad for taxed purchases, doubling trans-border trade (Ibid). The tax may have had positive impacts on health. In the short-term, the tax reduced consumption of fats (butter, margarines, and oils) by 10-15% (Jensen & Smed, 2013). The tax reduced consumption of high-fat minced beef by 9% while increasing consumption of low- and medium-fat minced beef by 8% and 5% respectively, although overall saturated fat intake from minced beef decreased by 1.3% (Jensen et al., 2014). Both of these health studies, however, recognize that the impacts of a fifteen month tax may not be indicative of the impacts of a long-term tax, as dietary change may take time as people adapt to new foods, recipes, and dietary behavior.

Scholars have different opinions on why policymakers repealed the Denmark’s saturated fat tax. The negative economic impacts without obvious immediate health impacts may have led to the tax’s demise (Petkantchin, 2013). A review of the policy process revealed that policymakers established the tax with a primarily economic, as opposed to health, motive for increased revenue (Vallgårda et al., 2015). The impact of the tax on dietary behavior did not guide the repeal of the tax, indicating that the health motive played a secondary and less important role in the policy process (Ibid.).

In 2011, Hungary introduced the Public Health Product Tax, referred to as the “junk food tax” that taxed packaged foods with high salt, sugar, or caffeine contents (Biro, 2015). Unlike the Denmark saturated fat tax, Hungary’s junk food tax continues today. Like the Denmark saturated fat
tax, however, Hungary’s junk food tax has led to dietary behavior change. The junk food tax led to a significant 3.4% decrease of taxed processed food consumption, and poorer households had the most dietary improvement (Ibid.). There is no literature describing the policy process for the junk food tax, but one (among many) difference between the two taxes lies in the destination of tax revenue. In Denmark, the saturated fat tax would offset lower income taxes (Vallgårda et al., 2015). In Hungary, the junk food tax supported the health care system (World Health Organization, 2012). A potential difference in political motives for food taxes may have influenced the different outcomes. France and Finland have also established taxes on sugary food and drinks that still exist today (ECORYS, 2014).

Health has motivated actual food taxes to date, but several scholars have modeled hypothetical scenarios in various countries regarding meat and dairy taxes motivated by GHG reductions. In the EU, a tax at €60 per metric ton CO₂-equivalent on animal products is projected to reduce EU agricultural emissions (not including emissions from regions the EU imports from) by 7%—or 32 million metric tons CO₂-equivalent (Wirsenius et al., 2012). In Denmark, a €20-230 per metric ton CO₂-equivalent tax would decrease the average household carbon footprint by 2.3-8.8% in the most efficient scenario, and a €473-925 per metric ton CO₂-equivalent tax would decrease the average household carbon footprint by 10.4-19.4% in the most effective scenario (Edjabou & Smed, 2013). In Sweden, livestock emissions reductions could reach 12% given an 8.9-33% tax on animal products, depending on the product (Säll & Gren, 2015). The Swedish scenario is projected to lead to a 19% reduction in demand for cow meat, 8% for pig meat, and 5% for chicken meat (Ibid.).

Successful implementation of food taxes requires genuine health or environmental motives, appropriate taxation rates, and accompanying educational policy. Based on the experience of the

6 Based on October 2012 – when Food Policy received the article in the revised form – conversion rate of 7.46 DKK per € and 1,000 kilograms per metric ton.
Denmark saturated fat tax, Vallgårda et al. (2015) recommends policymakers garner political support for health motives before economic motives to increase the likelihood of a long-term food tax. Furthermore, taxes must be substantial enough to make a real difference in GHG emissions and that careful economic models should be conducted to determine appropriate tax rates for specific food items and nations (Vinnario & Tapio, 2012). Lastly, guidance from tobacco taxation in the U.S. informs policymakers that taxation should be accompanied with other policy instruments, such as education (Alemmano & Carreño, 2013).

Regulations: Environmental Regulations and Regulated Labels

*Environmental Regulations*

The U.S. adopted major environmental regulations in the 1970s that affect agriculture and have the potential to affect consumption due to supply and demand. The animal agroindustry most commonly violates the Clean Water Act (CWA) and the Clean Air Act (CAA) of all environmental regulations (EPA, 2015b) (Fig. 7). Of the 796 violations of CWA, 262 violated §301 and another 465 violated §301 and §402, both of which concern permits that legalize the discharge of pollutants into U.S. waters from a point source. Of the 371 CAA violations, 354 violated §173, which explains requirements that major stationary sources of air pollution emissions must meet before receiving a permit for emissions. Despite the interactions between environmental policies and the animal agroindustry, no literature explains widespread impacts of environmental regulation on the animal agroindustry in the U.S.
Federal U.S. Environmental Regulations Violated by the Animal Agroindustry

<table>
<thead>
<tr>
<th>Statute Name</th>
<th>Abbreviation</th>
<th>Year Established</th>
<th>Number of Settled Civil Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Water Act</td>
<td>CWA</td>
<td>1972</td>
<td>796</td>
</tr>
<tr>
<td>Clean Air Act</td>
<td>CAA</td>
<td>1970</td>
<td>371</td>
</tr>
<tr>
<td>Emergency Planning and Community Right-to-Know Act</td>
<td>EPCRA</td>
<td>1986</td>
<td>25</td>
</tr>
<tr>
<td>Resource Conservation and Recovery Act</td>
<td>RCRA</td>
<td>1976</td>
<td>22</td>
</tr>
<tr>
<td>Safe Drinking Water Act</td>
<td>SDWA</td>
<td>1974</td>
<td>15</td>
</tr>
<tr>
<td>Federal Insecticide, Fungicide, and Rodenticide Act</td>
<td>FIFRA</td>
<td>1947</td>
<td>13</td>
</tr>
<tr>
<td>Toxic Substance Control Act</td>
<td>TSCA</td>
<td>1976</td>
<td>13</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>1271</strong></td>
</tr>
</tbody>
</table>

Figure 7. Statutes sorted by settled animal agriculture-related civil cases since the establishment of statutes through September 2015. Data retrieved from EPA (2015b).

Beyond the U.S., some literature evaluates the interactions between environmental regulations and the animal agroindustry. In 1991, the European Directive introduced regulations on nitrate input into waterways from agriculture (Piot-Lepetit & Moing, 2007). France’s pig industry, however, found a way to increase efficiency alongside the new nitrate regulation, illustrating how the industry reduced its harm to the environment while economically benefitting (Ibid.).

**Regulated Labels**

The regulation of product labels has created significant awareness and consumption changes in the case of cigarettes in the U.S. The federal U.S. government began regulation of health labels on cigarette packaging in 1965 with the Federal Cigarette Labeling and Advertising Act (Center for Disease Control, 2012). Since then, the federal government has passed and implemented: clearer and diversified labels; restrictions on advertising; tobacco excise taxes; bans on certain flights and in Women, Infants, and Children clinics; and the authorization of the Food and Drug Administration (FDA) to regulate tobacco products (Ibid.). These anti-smoking efforts by the state, alongside civil society and market interventions, led to the prevention of an estimated 8 million premature deaths.
and lifespan expansion of about 20 years (Holford et al., 2014). In order to alter smoking behavior, the U.S. utilized mandated labels alongside taxation, bans, and educational initiatives, which affected the cost, convenience, and culture of smoking tobacco products.

Expanding focus abroad, cigarette labels alone have affected people consuming tobacco products. A study comparing the effect of cigarette health labels in four developed countries found that when the UK drastically increased the label size on the packaging, significantly more smokers felt discouraged to smoke compared to the other countries (Hammond et al., 2007). In Canada, the introduction of full-color health labels that covered over half the front and back packaging led 19% of smokers to smoke less, 44% to experience fear, and 58% to experience disgust (Hammond et al., 2004). Together, the UK and Canada studies conclude that large graphic labels elicit strong emotional responses without damaging credibility and that replacing old labels with new ones consistently draws more attention from consumers (Hammond et al., 2004; Hammond et al., 2007). A study on label effectiveness in the U.S. over time suggested alterations to labels on a regular basis to improve effectiveness (Hitchman et al., 2013).

Health labels on cigarettes may be effective, but this does not necessarily translate into effective environmental labels on animal products. In the study of environmental labels, such as Rainforest Alliance Certified and Carbon Footprint, consumers used labels for their food choices if they were already concerned about sustainable food production (Grunert et al., 2014). However, these symbolic environmental labels differ drastically from the health labels on cigarettes that directly state the consequences of consumption. Direct statements on animal products about their environmental consequences may not affect consumption as much as health information. German survey respondents revealed that content about animal welfare is most likely to lead to reductions in meat consumption, followed by health and climate content (Cordts et al., 2014). These results are specific to Germany, which had has high media attention toward factory farms and animal welfare
(Ibid.). Similar studies in the U.S. revealed that media attention on animal welfare significantly decreases meat demand and reallocates demand to non-meat products, and information on health decreases short-term demand (Tonsor & Olynk 2010; Tonsor et al., 2010; Tonsor & Olynk, 2011). Given the effectiveness of health tactics, labeling the carcinogenic effects of processed meat (International Agency for Research on Cancer, 2015) can potentially reduce meat consumption while also obtaining a beneficial environmental impact.

**Government Management: Public Food Procurement**

Public sector food procurement, such as for government cafeterias, military, prisons, or schools, have standards for which foods agencies must comply. In the United Kingdom, agencies must inspect and certify that at least 10% of its food purchases come from farms that manage environmental concerns, such as biodiversity, pollution, energy, water, and waste (Dept. of Environment, Food, and Rural Affairs, 2014). The historical implementation of UK’s sustainable food procurement policies led to a focus on the social and economic instead of environmental aspects of sustainability (Walker & Brammer, 2009). With updated food procurement policies, the focus during actual implementation may change. In Israel, the military provides plant-based meals and non-leather attire to soldiers who abstain from animal products, reflecting the growing demand for plant-based options (Ginsburg, 2014).

The U.S. has Health and Sustainability Guidelines for federal cafeterias’ food procurement, in which the sustainability guidelines focus on environmentally friendly operations, organic and local food, sustainable seafood, and tap water (General Services Administration). These U.S. guidelines include free-range meats as “above standard” for sustainability (Ibid.), despite the greater GHG emissions from extensive, as opposed to intensive, cow meat production (Nijdam et al., 2012).
Education, Information, and Persuasion: Dietary Guidelines

In order to educate residents and citizens about healthy eating, many nations provide dietary guidelines to the public. These guidelines have historically focused solely on nutrition, but some scholars and even dietary guideline advisory committees argue that environmental considerations should be included in national dietary guidelines (Lang & Barling, 2013; Millen et al., 2015). Despite such recommendations, the U.S. Departments of Agriculture and Health and Human Services Secretaries Vilsack and Burwell (2015), respectively, announced in October 2015 that they would not address sustainability concerns in the 2015 U.S. Dietary Guidelines.

Most U.S. Americans’ diets do not meet the dietary recommendations, and the consumption discrepancy reflects a food supply discrepancy. A demographic study found that most U.S. Americans’ diets were not similar to the dietary guidelines (Kirkpatrick et al., 2012). Specifically, low- and middle-income and non-Hispanic black subgroups were not consuming sufficient produce, whole grains, and milk (Ibid.). In a study of the U.S. food supply and dietary guidelines, Miller et al. (2015) found that the U.S. has had a virtually consistently sufficient (healthy eating index score of 5 of 5) supply of “total proteins” since 1970 while fruits and vegetables have consistently scored below a healthy eating index score of 3 of 5. Furthermore, whole grains have scored below 3 of 10 since 1970 and dairy has scored below 5 of 10 since 1990 (Ibid.). The U.S. food supply has consistently not matched dietary guidelines, resulting in a general public not consuming ideal proportions of food groups.

Concluding Thoughts

The impact of any one intervention on human consumption may not be significant alone, but may be essential to a broader complex food policy that reduces animal product consumption. U.S. Americans choose food based foremost on taste and cost, but also based on nutrition, convenience, and weight control (Glanz et al., 1998). Certain policies alone, such as food taxes, do
not encompass the entirety of why people eat what they eat and therefore are not likely to change consumption drastically on their own. Specifically, incorporating education, such as well-distributed and factual dietary guidelines, can increase effectiveness of other policies (Biro, 2015). Incorporating education into food policy will likely decrease public backlash as compared to a more regulatory policy on food choice: “demanding or even subtly reframing consumer behaviour change is anathema to the neo-liberal ethos of consumer choice and sovereignty” (Lang & Barling, 2013).

The interactions between incentivizing (“carrot”) and regulatory (“stick”) policies may be more effective than just the sum of their parts. For example, reducing or eliminating subsidies from the animal agroindustry might be accompanied by financial assistance for the industry to transition to alternative supply chains (Wellesley et al., 2015). As the cycle of inertia (Fig. 3) illustrates, policy that pursues awareness through educational measures first may then rally enough public support for regulatory measures (Ibid.). Ultimately, a combination of policy instruments may provide the most effective effort in animal product consumption reduction.

Empirical Data Analysis

Between 1961 and 2011, animal product consumption increased in aggregate across the 32 developed countries classified as high-income OECD countries by the World Bank (2015) (in 1961, $\bar{x} \pm SD=282\pm120$ kg/capita/yr; in 2011, $\bar{x} \pm SD=349\pm81$ kg/capita/yr). Within this sample, trends in animal product consumption within countries varied widely, from countries with a large net increase (e.g. Republic of Korea; Portugal) to countries with a net decrease (e.g. Iceland; Estonia). Analysis of agricultural subsidies, environmental regulation enforcement, and nutritional guideline recommendations uncover correlations that may advise the policy interventions.
Agricultural Subsidies

The relationships between my measure of government subsidy, Product Single Commodity Transfer (PSCT), and animal product consumption were extremely diverse (Fig. 8). In some countries, the association between levels of subsidy and consumption was statistically significant (either positively or negatively) for the majority of animal products (e.g. Chile: 16/21; Australia: 11/17; Switzerland: 18/24). Conversely, in other countries, the association between levels of subsidy and consumption was not statistically significant for the majority of animal products (e.g. Japan: 2/23; Canada: 2/30). Sheep and goat meat had statistically significant relationships between levels of subsidy and consumption in all countries with available non-zero data. Soybeans and pig meat had no statistically significant relationships between levels of subsidy and consumption in any country.
Figure 8. Correlation analyses between level of subsidies (PSCT) and consumption of different animal product in 11 countries, the EU, and all listed countries combined show diversity in correlation coefficient and significance. For this analysis, “Total livestock-related” subsidies include both subsidies for animal products and feed crops (soybean and maize). Data from FAOSTAT (2015) and OECD (2015).
Maize subsidies relates to animal product consumption more than soybean subsidies.

Maize subsidies were more consistently related to levels of animal product consumption than were soybean subsidies. For example, there was a significant positive correlation between maize subsidies and cow meat consumption in three of five nations that had available non-zero data. However, out of five nations with available non-zero data for soybeans, only the EU had a significant positive correlation between soybean subsidies and cow meat consumption ($r=0.863$, $p<0.0001, n=26$).

In the U.S., there were significant correlations between maize subsidies and cow meat ($r=0.620$, $p=0.0007, n=26$), bird meat ($r=-0.697$, $p<0.0001, n=26$), and sheep and goat meat ($r=0.491$, $p=0.0104, n=26$) consumption, but no significant relationships between soybean subsidies and any animal product consumptions.

Analyses of all nations combined had a significant positive correlation between maize subsidies and total animal production consumption ($r=0.501$, $p<0.0001, n=294$), but a significant negative correlation for soybean subsidies ($r=-0.466$, $p<0.0001, n=294$). Before reading into the stronger correlations between animal product consumption and maize subsidies opposed to soybean subsidies, it is important to recognize that soybean subsidy data was unavailable for Chile and Switzerland, which had significant correlations in most relationships analyzed.

More resource intensive meats have positive associations with subsidies, and vice versa.

Higher livestock-related subsidies were associated with higher levels of consumption for a subset of commodities that included cow meat, milk products (excluding butter), eggs, and sheep and goat meat [significant positive correlations for Australia, Chile (except eggs), EU (only cow, sheep, and goat meat), Norway (only eggs), Switzerland (except sheep and goat meat), and U.S. (only cow, sheep, and goat meat)]. Conversely, higher livestock-related subsidies were associated with lower levels of consumption for a different subset of commodities that included bird and pig meat.
[significant negative correlations for Australia, Canada (only pig meat), Chile, EU (only bird meat), Norway (only pig meat), Switzerland (only bird meat), and U.S. (only bird meat)]. Maize subsidies had similar trends, correlating positively with cow, sheep, and goat meat consumption in all countries with available non-zero data [with significance in EU, Switzerland (only cow meat), and U.S.], but negatively with bird meat consumption (with significance in Chile, EU, Switzerland, and U.S.). This may suggest that some nations choose to eat more cow meat, sheep and goat meat, eggs, and milk when highly subsidized, but replace those products with bird and pig meat when not. However, such conclusions cannot be drawn without a much smaller resolution of nations and particular relationships between subsidies and consumption. Furthermore, these relationships are purely associative as opposed to causal.

*Bird meat and egg consumption have oppositional correlations with subsidies.*

Despite the same species (or even individual animal) of product origin, bird meat and egg consumption have oppositional correlations with subsidies in many nations. In the EU, an increase in soybean subsidies correlates with both a decrease in bird meat consumption ($r=-0.727, p<0.0001, n=26$) and an increase in egg consumption ($r=0.754, p<0.0001, n=26$). In Australia, the EU, and Iceland, an increase in egg subsidies correlates with both increases in egg consumption ($r=0.850, 0.531, 0.579; p<0.0001, =0.0049, =0.0018; n=26$, respectively) and decreases in bird meat consumption ($r=-0.651, -0.911, -0.421; p=0.0003, <0.0001, =not significant; n=26$, respectively). These findings opens up a variety of questions, such as: whether birds raised primarily for either their eggs and/or meat consume soybeans as a major source of feed; whether eggs serve as a substitute for bird meat in regions like Australia, EU, and Iceland; and how nations differ in terms of proportion of bird meat products coming from birds raised primarily for their eggs or their meat.
Lagged analysis did not largely alter results in either direction.

The lagged and non-lagged analyses had minimal differences. While some relationships differed by a degree of significance (as defined in the key of Fig. 8), there was no overarching trend of more or less significance. New Zealand’s correlations between total subsidies and cow meat consumption had the largest change in correlation coefficient (Δ=0.494); subsidies correlated significantly with cow meat consumption of the same year, but there was no significance when consumption was lagged a year. However, this instance was the exception to the rule. A majority of comparisons resulted in no major changes to the relationships between subsidies and consumption.

U.S.’ key findings advise specific areas for extended policy research.

The correlation analyses between subsidies and consumption indicate diversity (and complexity) of relationships for different products and nations. Some nations and some commodities have across-the-board similar relationships in terms of significance and slope of correlation, which deserve further research as to why. As the focus of this study, the U.S. has generally weaker correlations when compared with nations like Australia, Chile, Switzerland, and the EU. U.S. animal product consumption correlates more significantly with maize, as opposed to soybean, subsidies. The U.S. has an overarching trend in which agricultural subsidies negatively correlate with bird meat and positively correlate with cow, sheep, and goat meat consumption.

Environmental Regulations

The total number of annual settlements for environmental regulations in animal agroindustry between 1976 and 2011 was significantly positively correlated with total animal product consumption in the United States when all data were included (r=0.3822, p=0.0214, n=36). When outlier data from 2006 was excluded (z=5.403>zₐ₅), animal product consumption was positively and
more statistically significantly correlated with the number of annual settlements for environmental regulations ($r=0.6058, p=0.0001, n=35$) (Fig. 9).

![Environmental Regulation Enforcement's Association with Animal Product Consumption in the US](image)

**Figure 9.** When excluding data from 2006 as an outlier data point, there is a significant relationship between the number of annual civil enforcement settlements of environmental regulation on animal agriculture operations and the total animal product consumption per capita ($r=0.6058, p=0.0001, n=35$).

The total annual costs of environmental regulation to the animal agriculture operations and total animal product consumption had no significant correlation when all data were included ($r=0.2376, p=0.1630, n=36$). When outlier data from 2001 was excluded ($z=5.740>z_{0.05}$), animal product consumption was positively and statistically significantly correlated with the total annual costs to animal agriculture operations ($r=0.4999, p=0.0022, n=35$) (Fig. 10).
Figure 10. The total annual costs to animal agriculture operations for environmental regulation, including penalties and other associated costs such as the cleanup or restoration, have a significant relationship with animal product consumption per capita when excluding outlier data from 2001 (r=0.4999, p=0.0022, n=35).

When consumption data was lagged by a year to account for potential market effects of environmental regulation, the relation between number of annual settlements and animal product consumption was positive and significant (r=0.4204, p=0.0107, n=36) while the relation between total annual costs and animal product consumption was not (r=0.0520, p=0.7632, n=36). When excluding outlier data (2006 and 2001 respectively), the relation with number of annual settlements (r=0.6249, p<0.0001, n=35) and total annual costs (r=0.4291, p=0.0101, n=35) were both positive and significant.

The significant findings do not necessarily indicate a causal scenario between environmental regulation enforcement and animal product consumption. These correlations may simply report on the phenomenon in which greater animal product consumption (and production) results in more environmental violations and therefore more enforcement of environmental regulations. This hypothesis is supported by how the positive correlation between total annual costs and animal product consumption decreases in value and significance when lagging animal product consumption.
by one year. However, the opposite is true when comparing the non-lagged and lagged correlations between number of annual settlements and animal product consumption. Ultimately, these results present solely correlations and would require further analysis to indicate causation.

**Dietary Guidelines**

Because many countries did not have variation in the recommended levels of animal product consumption before 2011, there were limited results from correlation analyses (Fig. 11). Only three nations (Hungary, Portugal, and the United States) had changes in their dietary recommendations before 2011.

<table>
<thead>
<tr>
<th>Nation</th>
<th>Recommended Daily General Protein vs. Actual Meat + Seafood + Egg Consumption</th>
<th>Recommended Daily Animal Protein vs. Actual Meat + Seafood + Egg Consumption</th>
<th>Recommended Daily Milk vs. Actual Milk Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>N/A</td>
<td>N/A</td>
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*Figure 11.* Results from correlation analyses of selected nations’ dietary recommendations for general protein foods (both plant- and animal-based), animal-based protein foods, and milk versus consumption of animal products (excluding milk) for the general- and animal-protein recommendations and milk for the milk recommendations. In this figure, “N/A” means that there was no correlational coefficient due to no change in recommendations.

**The U.S. has a negative association between milk recommendations and consumption.**

In the U.S., recommended daily milk product consumption negatively correlated with actual milk consumption \((r=0.682, p=0.0163, n=22)\). A timeline visualization of recommendations and
consumption (Fig. 12) appears to suggest that recommendations have very little impact on actual animal product consumption as a whole in the U.S.

**Figure 12.** In the U.S., milk product consumption (depicted by smooth blue line) and recommendations (blue depicted by “x”) do not appear to significantly correlate, although they actually do (see Fig. 11). The dotted vertical lines (on year=1990, 1995, 2000, 2005, 2010) represent years with a shift in dietary recommendations.

*Portugal milk consumption and recommendations have a stronger association than in the U.S.*

Portugal had significant correlations in all three categories tested. A visual timeline (Fig. 13) most heavily supports the positive correlation between milk product recommendations and consumption \( r=0.682, p<0.0001, n=35 \). Approximately 4 years after the 1977 guidelines were published, both the absolute maximum of the second derivative for milk consumption’s smoothed fit line (blue) and the local minimum of the animal product consumption’s smoothed fit line (red) occur. An absolute minimum of the second derivative for the milk consumption smoothed fit line (blue) coincides approximately with the release of the 2003 dietary guidelines. The 1977 guidelines
recommended more milk consumption than actual consumption and were followed by a stark increase in consumption. The 2003 guidelines recommended less milk consumption than actual consumption and were followed by a leveling off on consumption.

Figure 13. In Portugal, animal product consumption (depicted by smooth lines; \( \lambda = 0.05 \)) and animal product or general protein recommendations (depicted by “x” or “+”) do not appear to significantly correlate, although they actually do (see Fig. 11). The dotted vertical lines (on year=1977, 2003) represent years with a shift in dietary recommendations.

The milk product correlation should not immediately be interpreted as causation; other interventions may have been implemented alongside the changes in nutritional guidelines. However, the milk product correlation in Portugal combined with its timeline provides the most support of all countries and all animal products for possible causal relationship.
Like the U.S., Hungary’s recommendations appear to have little impact on consumption.

Hungary had significant correlations between animal product (excluding milk) recommendations and consumption, but a visualization of the timeline (Fig. 14) once again suggests little impact of recommendations on consumption.

![Timeline of Animal Product Dietary Recommendations and Consumption in Hungary](image)

**Figure 14.** In Hungary, animal product consumption (depicted by smooth lines) and animal product or general protein recommendations (depicted by “x” or “+”) have significantly correlations (both $r=-0.555$, $p=0.0040$, $n=25$). The dotted vertical lines (on year=1987, 2004) represent years with a shift in dietary recommendations.

Transnationally, milk recommendations and consumption has the only positive correlation.

On a transnational scale, recommendations for general protein foods and animal-based protein foods significantly negatively correlate with lower animal product (excluding milk) consumption (Fig. 15.a and 15.b; $r=-0.278$, $p=0.0009$, $n=139$ and $r=-0.545$, $p<0.0001$, $n=96$ respectively). However, dairy recommendations and consumption has a significant positive relationship (Fig. 15.c; $r=0.385$, $p<0.0001$, $n=145$). Because this comparison might have hidden
variables ranging from cultural habits to availability of agricultural lands to international trade agreements, this analysis shows only a correlation between recommendations and consumption.
The eleven selected nations have varying recommendations for daily protein food, animal protein food, and dairy food intake that pair with the corresponding consumption levels of a particular year. (a) The relationship between animal- or plant-based protein food recommendations and consumption habits for animal products (with neither variable including dairy milk) is significant ($r=-0.278$, $p=0.0009$, $n=139$). (b) The relationship between animal-based protein food recommendations and consumption habits for animal products (with neither variable including dairy milk) is significant ($r=-0.545$, $p<0.0001$, $n=96$). (c) The relationship between dairy food recommendations and consumption habits for dairy products, excluding butter, is significant ($r=0.385$, $p<0.0001$, $n=145$).
Discussion

This thesis responds to the research question: how do past efforts by state actors to affect dietary behavior, globally, inform future state interventions to reduce animal product consumption in the United States? The literature review and empirical analysis provide important data for policy recommendations. In the U.S., agricultural subsidies do not align with nutritional guidelines; the subsidies heavily support maize, a majority of which is fed to animals raised for food. Increased maize subsidies correlate with increases in more resource intensive and more GHG-producing meats, but also decreases in less resource intensive and less GHG-producing meats. Food-specific taxes have shown most successful at altering dietary behavior when motivated by health as opposed to government revenue. They are likely best implemented with conjunct policies that improve access to and education about substitutes. Environmental regulations likely have negligible, if any, impact on animal product consumption. Regulated labels may be more effective if informing consumers on the health, rather than climate, impacts of animal products. Public procurement can play a role in the government leading by example and educating citizens on appropriate substitutes for animal products. Dietary guidelines may have had a significant impact on milk product consumption in Portugal; further study on this correlation may provide insight on potential causation and how the United States can improve effectiveness of its dietary guidelines.

In this section, I discuss this study’s findings as grouped into interventions that serve to break the cycle of inertia through education and interventions that more heavily involve direct economic shifts. I then delve into detailed discussion of the possibilities and limitations of nutritional guidelines, public procurement, regulated labels, taxes, agricultural subsidies, and environmental regulations within the U.S. context. This discussion leads into the next section, which provides recommendations for state actor interventions to reduce animal product consumption in the U.S.
Awareness Building: Education-Based Interventions

Building awareness of an issue can break the cycle of inertia (Wellesley et al., 2015). State actors can build public awareness of the link between climate change and animal agriculture through interventions altering current nutritional guidelines and distribution, public procurement standards, and regulated labels.

In order to strategically break the cycle of inertia, policymakers should understand the public opinions on issues relevant to the policy issues of animal agriculture and climate change. A Pew Research Center (2016) survey asked U.S. Americans about their high priorities for policymaking. Seventy-five percent of respondents chose the economy and terrorism as high priorities. In comparison, 61% chose reducing health care costs, 47% chose protecting the environment, and 38% chose dealing with climate change (amongst many public issues surveyed). These survey results indicate that a health cost approach to animal product reduction awareness building may be more effective than an environmental or climate change approach. In fact, the global adoption of a “healthy global diet,” 7 diet replacing meat, and diet replacing all animal products would result in annual global health care savings of approximately US$735 billion, US$973 billion, and US$1,067 billion, respectively (Springmann et al., 2016). However, results from the literature review indicate that an animal cruelty approach was most successful at reducing animal product consumption in Germany (Cordts et al., 2014), and that the reporting of animal cruelty in the media does reduce short-term demand for certain animal products (Tonsor & Olynk, 2010; Tonsor & Olynk, 2011). This finding resonates with a Lake Research Partners survey finding that 94% of U.S. Americans believe farmed animals should not endure abuse or cruelty (ASPCA, 2012). However, 97% of U.S. Americans eat meat (Stahler, 2015). After considering environmental, ethical, and health concerns

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7 The “healthy global diet” is defined as at least five servings of fruits and vegetables, less than 50 grams of sugar, less than 43 grams of red meat, and 2,000-2,300 kilocalories per day (Springmann et al., 2016).
Dietary Guidelines

Within the U.S., there was a significant correlation between recommendations and consumption of milk products, but not other animal products. However, visualizing the milk recommendations on a timeline suggests no causation. This implies that dietary guidelines may not effectively advise or convince the population on healthy eating habits and therefore may not be the best priority for building awareness about reductions in meat consumption. However, Portugal's significant correlations, especially for milk products, may be worthy of case studies on the distribution of nutritional guidelines and the national contexts for dietary behavior shifts. Further research can provide evidence for, or disprove, causation. It should be noted that the U.S. had a smaller range of animal product consumption over time than Portugal and Hungary (Fig. 5), which may explain why Portugal and Hungary had more statistically significant results.

The findings for the significant relationship in Portugal pose questions for future research, which does not appear to exist in the literature yet: does the distribution strategy of Portuguese dietary guidelines support a hypothesis that changing dairy recommendations are responsible for changing dairy consumption, as pulled from Figure 13? Alternatively, do other cultural or economic factors describe the dairy consumption trend? Further research on the reasoning behind the Portuguese trends may provide results that have implications for nutritional guideline strategies in the U.S.

Changes to recommendations have political limitations, as seen in the development of the 2015 Dietary Guidelines for Americans. An expert committee produced recommendations that suggested a greater emphasis on plant-based foods motivated by an incorporation of sustainability as well as to further enhance the health outcomes of the guidelines. However, red and processed meats were still
included in the final guidelines. Experts Dr. Marion Nestle, Dr. David Katz, and Dr. Walter Willett blame politics for the discrepancies, referring the animal agroindustry’s lobbying and ties with politicians (Sifferlin, 2016). Political limitations very clearly prevented more sustainable dietary guidelines in the U.S., and this obstacle is likely only surmountable through educational efforts of civil state or market actors. Unfortunately, all interventions discussed in this thesis face political limitations, as discussed in further detail for each intervention.

Public Procurement

Policy that adjusts and enforces public procurement guidelines may assist in building awareness if awareness campaigns are implemented in conjunction with alterations to the guidelines. Because animal product consumption is a norm in the U.S. cultural context, the provision of plant-based proteins in public facilities could be a first step in breaking the gastronomical norm. Not only would this directly reduce GHG emissions by replacing animal-based proteins with plant-based proteins; this would also introduce public employees to more sustainable, healthier food options. A simultaneous awareness campaign may be more effective if expanding focus to the health co-benefits of plant-based products.

The feasibility of altering federal public procurement guidelines for the National School Lunch Program seems fairly low. In 2010, Congress did not pass the Healthy School Meals Act that would have implemented pilot programs for plant-based product options at public schools (H.R. 4860, 111th Congress). This may be due to political influence of the agricultural lobby or the degree to which the USDA has historically respected corporate interests (Schneider, 2013). However, an elementary school in New York has implemented an entirely vegetarian cafeteria, all public schools

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8 Marion Nestle is the Paulette Goddard Professor in the Department of Nutrition, Food Studies, and Public Health at New York University.
9 David Katz is the founding director of Yale University’s Prevention Research Center.
10 Walter Willett is the Frederick John Stare Professor of Epidemiology and Nutrition Chair in the Department of Nutrition at Harvard T.H. Chan School of Public Health.
in Los Angeles serves meat-free meals every Monday, and Baltimore public schools serve meat-free options every Monday (Ibid.). The Humane Society of the United States works with even more school districts around the nation to implement plant-based “Meatless Mondays” and “Lean & Green Days” on a larger scale (K. Dumas, personal communication, 2/26/2016). While various challenges limit federal action, alteration of local public procurement guidelines has proven feasible across the U.S. These local guidelines directly reduce emissions associated with animal agriculture and have the opportunity to expand their health-focus to the environmental co-benefits.

Regulated Labels

Regulated labels may be a powerful intervention in reducing meat consumption, but legal and political limitations pose serious challenges and reduce short-term feasibility. In the case of cigarettes, regulated labels resulted in decreased consumption alongside a host of other policy instruments in the U.S. Findings from cigarette studies indicate the need for large, eye-catching labels that are changed on a regular basis to maintain effectiveness. The cigarette labeling contained health messaging, and this may also be the most effective messaging for animal products compared with climate or animal welfare labels. While reports on farmed animal cruelty in the media have reduced animal product consumption, the animal welfare argument has some degree of moral subjectivity. Animal welfare labels would likely not pass through a policymaking process in the near future.

After the World Health Organization categorized processed meats in the same category as tobacco in terms of the evidence of carcinogenic impacts on humans, there was speculation that California might begin labeling processed meats as carcinogenic under Proposition 65 (International Agency for Research on Cancer, 2015; Polansek & Huffstutter, 2015). However,

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11 California’s Proposition 65 requires the identification of carcinogenic materials and clear warning to consumers about certain products containing the materials.
*American Meat Institute v. Leeman* (2009) ruled that the Federal Meat Inspection Act of 1906 “preempts point of sale warning requirements imposed by Proposition 65 with respect to meat.” This introduces a legal barrier to regulated labels on meat – which can still be legally debated in the courts – that reduces the legal feasibility of labels on meats.

Furthermore, the pushback from the tobacco industry in regards to cigarette labels will likely be paralleled by the animal agroindustry in regards to animal product labels. Such pushback makes regulated labels a politically unfavorable move by elected politicians. Resultantly, if policymakers were to seriously consider regulated labels on animal products at any level, they might want to: (1) legally pursue the overturn of *American Meat Institute v. Leeman* (2009) and/or amend the Federal Meat Inspection Act of 1906; (2) receive heavy political backing from their constituents; and (3) be generally advised by the policymaking process for tobacco labels.

**Post-Awareness Building: Further Policy Interventions**

As per the cycle of inertia (Wellesley et al., 2015), educational interventions lead to greater feasibility in passing policies that utilize economic tactics and regulations. Alterations to taxes, subsidies, and environmental regulations would likely not have political support without a public that is informed on the issue.

**Food-Specific Taxes**

Taxes may be an effective means of altering dietary behavior in the United States, although the impacts will likely not be universal. Denmark and Hungary’s food-specific taxes did impact dietary behavior in at least the short-term; as more time passes, further analysis will indicate the long-term impacts of Hungary’s junk food tax. At the time of this thesis, FAOSTAT (2015b) had not yet released post-2011 consumption data, deeming before-and-after statistical analysis impossible. However, the case studies of Denmark and Hungary suggest that the successful
Implementation of food taxes requires: (1) genuine health or environmental motives, as opposed to political motives; (2) appropriate taxation rates that result in actual consumption behavior change; and (3) accompanying educational interventions that improve access to and public knowledge about substitutes. Further economic analysis will be required to determine appropriate taxation rates for the United States as Säll & Gren (2015) did for Sweden.

Political limitations and challenges to universal effectiveness accompany taxation. Depending on the dominant party in the legislative and executive branches of the federal government, the passage of a food-specific tax may not be politically feasible, especially if there is a climatic motivation behind the tax. The influence of the animal agroindustry on policymakers and department secretaries further dampen the political feasibility. Furthermore, objections to regressive food taxes include the disproportionate impact on low-income communities (Brownell & Frieden, 2009). Without additional interventions that improve access to and education about plant-based cuisine specifically in low-income communities, taxation would have an inequitable impact on the poor by reducing their basic caloric intake while having a smaller impact on communities with more spending money. Because low-income communities are already disproportionately impacted by environmental injustices, an irresponsible food tax would further deepen justice issues.

These limitations, however, should not discount a tax on specific animal products altogether. Accompanying educational and access policies and a public supportive of taxation can improve the feasibility of this intervention. Taxation at a local level as a pilot program may provide needed data for the actual effectiveness of this intervention.

**Agricultural Subsidies**

The literature is not conclusive in regards to how the removal of subsidies may affect animal product consumption in the U.S. due to the passive consumer phenomenon and economic projections, but these arguments can be altered based on the specific set of policy interventions.
Rivera-Ferre (2009) suggests that the economy could shift from supply-driven to consumer-driven if the consumers were informed on the real health, social, and environmental impacts of meat and fish consumption. This resonates with the cycle of inertia (Wellesley et al., 2015), as a public empowered with information can demand both a change in politics and markets. The Alston et al. (2008) analysis modeled a scenario in which all agricultural subsidies were eliminated – not if funds from livestock-related subsidies were transferred to increased production of specialty crops nor if funds were transferred to improved access to fruits and vegetables in low-income communities. These suggestions are purely speculative; economic analysis, and likely a local or statewide pilot program, would be needed to determine whether a transfer of subsidies would truly result in reduced animal product consumption.

Empirical analysis revealed that the U.S. has fewer significant associations when compared with other nations. Understanding why these relationships are lacking in the U.S. but prevalent in places like Chile, Australia, Switzerland, and the EU could be an entirely separate thesis. The high prevalence does not align with high producer support as percent of gross farm receipts (The Economist, 2012; data from OECD), but there are other variables to consider: the portion of subsidies that are single commodity transfers (the variable tested in this thesis) as opposed to general agricultural support services, whether a country is a net exporter or importer of materials, and countries’ decision-making processes to determine how much support each commodities receive, to name a few.

The associations between maize subsidies and cow, sheep, goat, and bird meat consumption suggest that if these associations are causal, then decreasing U.S. maize subsidies will decrease the consumption of more GHG intensive meats while increasing consumption of less GHG intensive meats. From a purely empirical environmental standpoint, the replacement of more GHG intensive cow, sheep, and goat meat with less GHG intensive bird meat would decrease the overall GHG emissions.
impact of the animal agroindustry. A causal scenario makes economic sense: if subsidies reduce the feed input costs for animal operations, then the end animal product would be less expensive for the consumer and would likely be purchased more. However, agricultural subsidies often do not follow this simple economic rationality. Owners of agricultural operations may absorb the subsidies themselves, instead of passing the reduced costs down the food supply chain and ultimately to consumers.

In the U.S., consumption does not reflect the nutritional guidelines, and especially for low-income communities and communities of color (Kirkpatrick et al., 2012). This social inequity extends the discrepancy beyond a solely environmental problem and into the realm of food injustice. If subsidies are found to be a causal mechanism for dietary behavior in the U.S., both environmental and social justice motivations can work towards the redistribution of subsidies toward healthier foods that align with the federal government’s nutritional guidelines.

Limitations to restructuring of the U.S. agricultural subsidies are largely political, but will likely also have deep economic impacts if implemented. While 45% of the maize grown in the U.S. is fed to animals raised for food, 44% is used for biofuels and 12% for other uses (USDA Economic Research Service, 2015). Proposals to reduce support for maize would likely be met with backlash from not only the maize industry, but also the animal agroindustry, biofuel industry, and processed food industry. Furthermore, if such an intervention were to take place, massive restructuring of the industries in terms of employment, procurement, and technology would need to take place. However, this same argument could be made for any market relying on government support. Oftentimes, short-term tension accompanies long-term restructuring programs. Education is, once again, key to this dilemma: the public needs to understand the connection between subsidies, consumption, and environmental impacts in order for there to be support for policymakers trying to change subsidies. Furthermore, transitional programs might help in alleviating negative impacts on
certain people’s (e.g. laid-off workers) livelihoods, emphasizing the need for holistic, multi-policy interventions.

Environmental Regulations

Despite the significance of results, the environmental regulations explored in this thesis are likely an ineffective intervention for reducing animal product consumption in the U.S. If increased enforcement reduced animal product consumption, then there would have been negative correlations. However, there were not. The positive correlations could indicate that as animal product consumption increases, violations and enforcement also increase due to the increased number of animals handled. A policy intervention that increases enforcement of existing environmental regulations of the animal agroindustry shows little to no effectiveness in reducing consumption. However, regulations that were to ban or limit methane emissions might impact animal product supply and ultimately consumption. Other forms of environmental regulations beyond the Clean Water Act and Clean Air Act may provide more opportunities for intervention, but these interventions will face political limitations depending on the federal government’s dominant party in office.

Political Limitations

All six of the interventions explored in this thesis have major political limitations to implementation largely due to the interactions between government and industry. This limitation may prevent immediate state actor action, but it emphasizes the importance of civil society and market actors in food system interventions. Civil society and market actor interventions into reducing animal product consumption are areas worth extensive future research in order to ultimately assist state actors in overcoming the political limitation of policy interventions.
**Recommendations**

In order to reduce animal product consumption in the U.S., I recommend three phases for policy implementations:

1. Civil society and market actors increase public understanding of the connection between animal agriculture, climate change, and rising health care costs before 2020.


3. Federal government implements changes to taxing and spending interventions (taxes and agricultural subsidies) in conjunction with interventions that promote equitable access to plant-based foods.

While these phases are specifically directed at the federal level, certain states may be farther along in the educational process and more interested in expedited implementation of policies. Furthermore, these recommendations recognize the importance of joint efforts from civil society, state, and market actors.

*Phase 1: Civil society and market actors build awareness.*

The political limitations on all interventions discussed in this thesis rely heavily on the animal agroindustry’s connections with the government, but can be overcome when the public demands changes. Government action will unlikely happen without political feasibility, and this is where civil society and market actors can take action. Specifically, these actors should focus on relating animal agriculture to climate change, health, or animal protection depending on which of these issues most U.S. Americans care about. In the short term, these actors should work to increase public awareness of the connection between animal agriculture and health consequences. In the long term and as climate change becomes a more universally recognized and less politically charged issue, they should
put more emphasis on the connection between animal agriculture and climate change. Campaigns for health should certainly be implemented to reach a wide audience before 2020 in order to set up public demand for nutritionally accurate 2020 Dietary Guidelines for Americans.

**Phase 2: Federal government builds awareness.**

Once the public has built a foundation for state actor interventions, the federal government should publish scientifically accurate dietary recommendations in 2020, whether they incorporate sustainability or not. This has a reasonable likelihood of happening because evidence continues to grow for, and the 2015 Dietary Guidelines Advisory Committee recognized, the negative health implications of certain animal product consumption. When final decision-makers for the guidelines choose to keep the U.S. American public’s best health interests in mind, then the 2020 Dietary Guidelines for Americans will, at minimum, promote reduced consumption of red meats – also the most GHG intensive meat. This single policy intervention likely will not cause drastic reductions in consumption, but will support the foundation for other more impactful interventions.

When nutritional guidelines change, public procurement standards have greater support to incorporate healthy and sustainable standards. This particular intervention may be best piloted at local and state levels before the federal level. Federal policymakers can evaluate and choose best strategies and practices from local and state level public procurement standards for public schools, hospitals, and facilities. This intervention will likely make an impact on consumption through both direct government purchasing and indirect education on plant-based alternatives to animal products.

Regulated labels may be the most impactful intervention of the awareness-building interventions, yet the least feasible. Like public procurement standards, regulated labels would benefit from pilot programs at the state level. However, state level regulated labels must follow either the overturn of American Meat Institute v. Leeman (2009) or an amendment to the Federal Meat Inspection Act of 1906 that permits factual health labels on meat products. Again, regulated label
pilot programs can advise the federal government on the effectiveness and best strategies for implementation. Likely, health, as opposed to climate, labels will be most effective. If the labels are frequently updated and occur in conjunction with education about plant-based alternatives, then the labels have the potential to be as effective as tobacco labels.

**Phase 3: Federal government implements taxing and spending interventions.**

As awareness-building interventions might occur starting in 2020, taxing and spending interventions will not likely happen until 2024 at the absolute earliest. Because political limitations prevent food-specific taxes and alterations to agricultural subsidies that promote plant-based foods, the U.S. American public must demand changes before they happen. As the Farm Bill is updated on five-year cycles, the update immediately following the 2020 Dietary Guidelines for Americans will be the 2024 Farm Bill. If public support is great enough for changes to agricultural subsidies that shift money from maize, soy, and animal products to specialty crops, plant-based product research and development, increased equity in geographic access to plant-based foods, and transitional programs for maize, soy, and animal agriculture operations, then subsidies could dramatically change in 2024. However, 2024 is optimistic, and 2029 or 2034 are increasingly more likely.

The feasibility of taxation on animal products depends heavily on the dominant party in the federal government. However, taxation will have strong impacts on health and climate change contributions of the U.S. and is probably the most impactful intervention on reducing animal product consumption. To gain political support, taxation should reflect products’ GHG emissions or related health care costs, depending on whether climate change or health is more prevalent in the public spotlight. Policymakers must not use political gains as motivations for taxation, and instead direct revenue to health care programs or climate mitigation or adaptation programs. Taxation-based interventions are likely not feasible until the mid-2020s at the earliest on a federal level, after awareness-building interventions have been in place for at least a full two-year term of Congress.
Conclusions

Through a literature review and novel correlational analysis on state interventions to reduce animal product consumption in the U.S., I ultimately recommend a platter of policy interventions implemented in a specific order given the current limitations of the U.S. I provide a call to action for civil society and market actors to build awareness in order to improve the political feasibility of federal-level awareness building through the 2020 Dietary Guidelines for Americans, updated public procurement standards, and regulation of health labels on animal products. After state actors build awareness, subsidies and taxes can be altered to support consumption of plant-based products in conjunction with transitional and equitable access programs to reduce negative social consequences. These recommendations take into consideration the U.S. political context and could optimistically be implemented before 2030. Ultimately, these policy interventions aim to reduce U.S. contributions to climate change through reduced GHG emissions and promote efficient use of limited resources given changing U.S. climate and landscapes.

This thesis contributes to the recently growing literature on policies to reduce animal product consumption through correlational analysis on agricultural subsidies and nutritional guidelines on a transnational scale. While correlational analysis does not indicate causation of specific animal product consumption trends, it provides an essential foundation for future research. Future research might further explore the distribution of the Portuguese dietary guidelines to determine whether these played a major role in Portuguese dairy consumption trends. It might explore why subsidies match consumption more strongly in certain countries (e.g. Chile and Switzerland) but less so in others (e.g. Japan and Canada). Focused on the U.S. specifically, future research can determine appropriate taxation rates on animal products based on both climate and health impacts, survey the public for most effective regulated health labels for animal products, model and project the economic impacts of shifts in agricultural subsidies, and evaluate social and
economic policy options to accompany state actor interventions to reduce animal product consumption.

This thesis continues the efforts of civil society actors to educate the public on the connections between animal agriculture and climate change. Reducing animal product consumption is an extremely effective way to live in greater harmony with our biosphere through the reduction of GHG emissions, inefficient water use, inefficient land use, biodiversity loss, and air and water pollution. Leading by example as best we can with our given resources and sharing our knowledge of the interconnectedness of social and environmental issues will help pave the path to highly-effective state actor interventions to reduce animal product consumption in the U.S.
Bibliography


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### Appendix A

Rubric and Confidence Scores for Nutritional Guideline Data Quality

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**Confidence Scores:**

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