

A PIGOUVIAN TAX ON MEAT AND ITS IMPACT ON THE PLANT-BASED MEAT INDUSTRY

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Introduction:

The decision to switch to more sustainable protein sources has gained traction among individuals in the past few years as plant-based products that emulate the taste and texture of ground beef specifically have become more widely available. As of January 2020, almost one in four Americans surveyed reported that they had decreased their meat consumption in the past year compared to years prior.¹ Two of the main reasons individuals look to decrease their consumption of red meat are because of health and environmental concerns. These concerns are justified given that the external cost of beef production and consumption on society is \$3.53/lb.²

This paper will analyze the impact of a Pigouvian tax of \$3.53/lb on beef production as a way to reach a socially optimal quantity of beef produced, and therefore consumed, by raising the price of beef by 8.2% and reducing the market quantity of beef by 14.92%. Using the cross-price elasticity of meat and the next closest meat substitute of fish as a proxy for plant-based substitutes, the increase in the price of meat will likely increase demand of plant-based meat products by 3.13%. A larger demand for these substitutes that are similar in taste and texture is expected to generate an extra \$29.4M in revenue, although likely more if prices are raised to accommodate the increased demand in the short-run. This extra demand, and accompanying

¹ Justin McCarthy and Scott DeKoster, "Nearly One in Four in U.S. Have Cut Back on Eating Meat," *Gallup*, October 29, 2020, <https://news.gallup.com/poll/282779/nearly-one-four-cut-back-eating-meat.aspx>

² Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

revenue, can then allow for economies of scale to be leveraged and better infrastructure built, allowing these products to be offered at a lower, more comparable price to real meat in the long-run.^{3 4}

Background:

The negative externalities imposed upon society as a result of beef production and consumption are extensive and thus have significant costs to the overall economy without providing any form of compensation to make up for them. The consumption of red meat specifically can cause individuals to be more prone to serious health conditions like type 2 diabetes, cancer, and obesity.⁵ These conditions not only reduce an individual's length of life, but can have adverse effects on insurance companies and healthcare systems. Without a way for insurance companies to charge individuals based on their level of beef consumption, as well as the extra costs incurred by healthcare facilities for treating these conditions that cannot always be passed off to the individual being treated, there is no direct compensation as a result of these extra harms incurred as we discussed in class. Compared to red meat, these plant-based meat products can also "lower some cardiovascular risk factors" according to a study conducted by Stanford.⁶ Therefore, due to the added health benefits and lower costs to healthcare systems as a result, they appear to be an even more attractive alternative to beef.

Additionally, the livestock sector is known for their processes that have a substantial negative impact on the environment. These producers are responsible for between 8% and 18%

³ Liz Specht, "Why Plant-Based Meat Will Ultimately Be Less Expensive Than Conventional Meat," *The Good Food Institute*, June 18, 2019, www.gfi.org/plant-based-meat-will-be-less-expensive.

⁴ Olivia Roos, "Is Fake Meat Better for You, or the Environment?" *NBCUniversal News Group*, October 14, 2019, <https://www.nbcnews.com/news/us-news/fake-meat-better-you-or-environment-n1065231>.

⁵ Katare, Bhagyashree, et al. 662, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

⁶ Hanae Armitage, "Plant-Based Meat Lowers Some Cardiovascular Risk Factors Compared with Red Meat, Study Finds," *Stanford Medicine News Center*, August 11, 2020, med.stanford.edu/news/all-news/2020/08/plant-based-meat-versus-animal-meat.html.

of greenhouse gases (GHG) emissions, which harm the environment by contributing heavily to both pollution and climate change.^{7 8} The sector has also come under pressure for animal mistreatment, as well as the exploitation of natural resources like water, soil, and forests.⁹ Impossible Foods, one of the primary producers of plant-based meat alternatives, created a meatless burger that requires 96% less land and uses 87% less fresh water than the production of real meat burgers.¹⁰ Its rival company, Beyond Meat, also managed to create a production process that emits 90% less GHG and utilizes 46% less energy than production of a beef burger of the same size.¹¹ Therefore, not only do plant-based meat substitutes maintain characteristics similar to that of ground beef, but production of these alternatives is significantly better for the environment than traditional red meat.

However, despite the perceived benefits of these alternatives compared to red meat, one of the main reasons plant-based meat products have not gained widespread popularity among the public is due to their high costs. Compared to the market price of ground beef of \$5/lb, plant-based meat costs significantly more at \$12/lb.^{12 13} Part of the reason for these high costs is because their supply chains are “much less established than supply chains for traditional animal protein,” due in large part to the lower demand in comparison.¹⁴ However, if demand for these products were to increase, as a result of a tax on meat that causes consumers to switch to plant-based alternatives for example, it could cause the long-run price to change significantly.

⁷ Katare, Bhagyashree, et al. 662, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

⁸ Nunez, Christina, “Carbon Dioxide Levels Are at a Record High. Here's What You Need to Know,” May 14, 2019, <https://www.nationalgeographic.com/environment/global-warming/greenhouse-gases/>

⁹ Katare, Bhagyashree, et al. 662, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

¹⁰ “Impossible Foods: Creating Plant-Based Alternatives to Meat | Singapore, Hong Kong, USA, Macau,” *United Nations Climate Change*, 2020, <https://unfccc.int/climate-action/momentum-for-change/planetary-health/impossible-foods>

¹¹ “Our Impact,” *Beyond Meat - Go Beyond®*, <https://www.beyondmeat.com/about/>.

¹² Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

¹³ Laura Reiley, “Impossible Burger: Here's What's Really in It,” *The Washington Post*, October 23, 2019, www.washingtonpost.com/business/2019/10/23/an-impossible-burger-dissected/.

¹⁴ Carmen Reinicke, “Beyond Meat Costs More than Traditional Meat, but Data Show Consumers Are Willing to Pay the Premium Price - for Now (BYND) | Markets Insider,” *Business Insider*, July 11, 2019, markets.businessinsider.com/news/stocks/beyond-meat-sales-are-high-but-so-is-price-2019-7-1028346898.

Improvements to the production process and infrastructure to accommodate extra sales, as well as better negotiation for prices of inputs like soybeans and peas, are just a few areas that will likely lead to these companies achieving economies of scale.¹⁵ With expenses lower as a result, the cost to offer these products would also decrease. Due to these improvements, lower prices in the long-run would likely continue to remain even if the tax were to be repealed at some later point, attracting even more individuals to eventually make the switch towards a more sustainable food source for good.

Economic Analysis:

The use of a Pigouvian tax levied on producers in the amount equal to the external costs to society of \$3.53/lb¹⁶ would reduce this market inefficiency by increasing producers' private marginal cost curve so that it is equivalent to the social marginal cost curve.¹⁷ By raising the cost of beef with the tax, consumption will be reduced to the socially optimal level, likely affecting the demand for plant-based meats and their prices given that they are a desirable alternative. The following tables include data from a paper in the *American Journal of Agricultural Economics* as well as other credible sources used to analyze the short-run and long-run effects of this tax:

Beef	
Elasticity of demand (ground beef)	-1.82 ¹⁸
Elasticity of supply	.24 ¹⁹
Average pre-tax price	\$5/lb ²⁰
Average annual pre-tax quantity per capita	84lb ²¹

¹⁵ Liz Specht, "Why Plant-Based Meat Will Ultimately Be Less Expensive Than Conventional Meat," *The Good Food Institute*, June 18, 2019, www.gfi.org/plant-based-meat-will-be-less-expensive

¹⁶ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

¹⁷ Jonathan Gruber, *Public Finance and Public Policy* (New York: Worth Publishers, 2016), 137.

¹⁸ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

¹⁹ McKendree, Melissa G.S., et al. August 26, 2019, "Impacts of Retail and Export Demand on United States Cattle Producers," *American Journal of Agricultural Economics*, 875. <https://doi.org/10.1093/ajae/aaz034>

²⁰ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

²¹ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

Estimated number of people in the US	.3282B ²²
Average annual pre-tax quantity total (calculated)	27.57B lb
External cost	\$3.53/lb ²³
Cross-price elasticity estimate	.382 ²⁴

Plant-Based Meat	
Total sales (2019)	\$939M ²⁵
Average pre-tax price	\$12/lb ²⁶
Average annual pre-tax quantity (calculated)	78.25M lb

Given the relatively high demand elasticity of consumers compared to a more inelastic supply, a \$.41 tax burden passed onto consumers will raise the price of beef by 8.2% as seen in Appendix A. This increase in price will likely decrease the consumption of beef by 14.92%, eliminating the \$7.26B cost to society and generating a tax revenue of \$82.81B as seen in Appendix B. However, it is likely that given the similarity in taste and texture to real beef, as well as the reduction in health and environmental impacts, individuals may shift their consumption to the plant-based meat market. Using the cross-price elasticity of meat and fish of .382 as a proxy for the cross-price elasticity between meat and plant-based substitutes, given that fish is the next closest red meat substitute, an increase in the price of beef would increase the demand for these plant-based substitutes by 3.13% as seen in Appendix C. An increase in

²² "U.S. and World Population Clock," *Population Clock*, www.census.gov/popclock/.

²³ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

²⁴ Tiffin, Richard, et al. November 23, 2011, "Estimating Food and Drink Elasticities." 49, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/137726/defra-stats-foodfarm-food-price-elasticities-120208.pdf

²⁵ "U.S. Plant-Based Market Overview - New SPINS Retail Sales Data," *The Good Food Institute*, www.gfi.org/marketresearch.

²⁶ Laura Reiley, "Impossible Burger: Here's What's Really in It," *The Washington Post*, October 23, 2019, www.washingtonpost.com/business/2019/10/23/an-impossible-burger-dissected/.

demand for these products could generate at least \$29.4M in extra revenue as seen in Appendix D, although likely more if prices are increased to match rising demand in the short-run. In the long-run, however, prices will likely fall as the increased demand and extra revenue can be used to drive down the unit cost of production. Given that “price point will play a big role in converting people that are currently eating meat to meat alternatives,” offering these products more cheaply is likely to cause even more people to switch to this more sustainable source of protein.²⁷

Other Impacts:

Although a Pigouvian tax on beef will eliminate the inefficiency of the negative externalities and positively affect the plant-based meat industry, there are some concerns about its effect on other industries, as well as its distribution and overall feasibility. One of these concerns is that a meat tax would adversely affect those whose livelihoods depend on high consumer demand for traditional meat by causing them to lose their jobs.²⁸ However, for the 262,900 workers directly employed in meat packing and processing, working conditions are less than ideal.²⁹ Severe, and oftentimes fatal, injuries are predictable and all too common in the industry.³⁰ However, if a beef tax is implemented and shifts demand from beef to plant-based meat, the need for workers in the plant-based meat industry will likely rise. The plant-based market will not only provide significantly better working conditions compared to meat

²⁷ Carmen Reinicke, “Beyond Meat Costs More than Traditional Meat, but Data Show Consumers Are Willing to Pay the Premium Price - for Now (BYND) | Markets Insider,” *Business Insider*, July 11, 2019, markets.businessinsider.com/news/stocks/beyond-meat-sales-are-high-but-so-is-price-2019-7-1028346898.

²⁸ Brian Kateman, “Is A Meat Tax A Good Idea?” *Forbes*, August 27, 2019, <https://www.forbes.com/sites/briankateman/2019/08/27/is-a-meat-tax-a-good-idea/?sh=567448842d3a>

²⁹ Sarah Little, “The Market Works Highlighting Progress in the Meat Industry,” *Basic Industry Stats | The Market Works*, 2020, www.themarketworks.org/stats.

³⁰ “Blood, Sweat, and Fear,” *Human Rights Watch*, July 1, 2019, <https://www.hrw.org/report/2005/01/24/blood-sweat-and-fear/workers-rights-us-meat-and-poultry-plants>.

production, but will offer significantly higher wages as well.^{31 32} Therefore, individuals currently employed in the meat industry may actually benefit from a decreased demand for beef.

As for farmers who raise cattle, the predicted revenues generated from the tax can go back to them, with the condition that a portion of the funds must be used towards making current production processes more environmentally sustainable.³³ Investments in animal feed, as well as vaccines and supplements that improve the health of livestock can reduce GHG emissions.³⁴ Therefore, this tax not only gives farmers an incentive to permanently improve their operations, reducing the overall environmental impact and improving the quality of life for the animals used in production, but also lessens the need for the prolonged use of the tax as these external costs begin to decrease as a result of changes implemented.

Another concern about a tax on meat is that it will negatively impact those with lower incomes more heavily compared to individuals with higher incomes. This argument stems from the idea that ground beef is the cheapest and most easily accessible form of protein for those without a lot of money.³⁵ However, as the meat tax stimulates demand for substitutes like plant-based alternatives that taste and feel similar to real meat, their prices will likely decrease in the long-run. This could make them more affordable and more widely available, increasing the ability for poorer individuals to purchase them. However, given that the price change for these plant-based alternatives will not be immediate, it may be possible for the tax on beef to be levied

³¹ “Economics Report: Plant Based Foods Industry Creating High Wage Jobs,” *Plant Based Foods Association*, October 13, 2020, plantbasedfoods.org/plant-based-foods-industry-creating-high-wage-jobs/.

³² “Slaughterers and Meat Packers.” *U.S. Bureau of Labor Statistics*, March 29, 2019, www.bls.gov/oes/2018/may/oes513023.htm.

³³ Brian Kateman, “Is A Meat Tax A Good Idea?” *Forbes*, August 27, 2019, <https://www.forbes.com/sites/briankateman/2019/08/27/is-a-meat-tax-a-good-idea/?sh=567448842d3a>

³⁴ “Three Ways Livestock Farming Is Becoming More Sustainable,” *HealthforAnimals*, healthforanimals.org/resources-and-events/newsletter-repository/14-world-environment-day.html?q=44.

³⁵ Brian Kateman, “Is A Meat Tax A Good Idea?” *Forbes*, August 27, 2019, <https://www.forbes.com/sites/briankateman/2019/08/27/is-a-meat-tax-a-good-idea/?sh=567448842d3a>

in multiple phases so that a majority of poorer individuals will still be able to afford traditional meat while the market approaches long-run equilibrium.

There are also worries that a high tax on meat may lead to the possibility of tax evasion and increase in purchases on the black market, especially among those without a lot of extra disposable income to pay for their protein staple.³⁶ One study found that individuals with a 50% difference in taxes levied resulted in tax evasion that was 20% higher among those with the higher tax rate.³⁷ Therefore, it is likely the proposed tax of \$3.53/lb may result in some evasion efforts which would result in economic losses. However, a widely available cheaper plant-based substitute might help mitigate this issue if increased demand is able to drive down the price in the long-run as mentioned in the analysis above.

Conclusion:

The consumption and production of beef imposes significant costs to society as a result of negative externalities related primarily to health and environmental concerns. Individuals that consume red meat are at an increased risk for chronic illnesses that inadvertently increase costs for insurance companies and healthcare providers. The environment is also negatively affected without compensation in the form of greenhouse gas emissions, water contamination, and soil degradation, among others. A Pigouvian tax levied in the exact amount of costs imposed upon society, \$3.53/lb, could not only decrease beef consumption by 14.92% but also generate revenues of \$82.81B per year that can be put back into efforts to reduce externalities at the source by increasing the price of beef by 8.2%. Individuals who do not want to sacrifice the flavor of ground beef may then look to substitute plant-based meats that are similar in taste and

³⁶ Katare, Bhagyashree, et al. 670, January 10, 2020, <https://doi.org/10.1002/ajae.12016>

³⁷ Bruno S. Frey and Benno Torgler, February 28, 2007. "Tax Morale and Conditional Cooperation." *Journal of Comparative Economics* 35: 137. <https://doi.org/10.1016/j.jce.2006.10.006>

texture, stimulating demand for these products. An analysis of the estimated cross-price elasticity found that the increased price of beef as a result of the tax could increase the demand of these plant-based meat products by 3.13%. This increase in demand will likely generate at least \$29.4M in extra revenue in the short-run, although possibly more if prices are increased to match rising demand. However, this increased demand and extra revenue could allow companies to lower their costs of production, therefore reducing the price of these products in the long-run and making them more affordable.

Given that cost was a major hindrance to plant-based meat gaining widespread popularity, a long-run price reduction resulting from improvements in the supply chain could cause more people to switch to these more sustainable products even if the tax were to be repealed. As for the concerns, more individuals, even those from low-income households, will eventually be able to afford to incorporate these plant-based meats into their diet. Additionally, this change in behavior could improve the livelihoods of those involved in the meat packing and processing industry by increasing the number of jobs available in the plant-based meat industry which has better working conditions and higher pay. Therefore, it appears that this tax could not only push the population towards adopting a more sustainable food source, but one that has tremendous long-term positive impacts on society given its benefits for health and the environment.

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Appendix:

Appendix A:

Predicted incidence of beef tax:

With a beef tax levied on producers, the change in price is an increase of \$.41/lb.

$$\Delta P = \frac{\eta_s}{(\eta_s - \eta_d)} * \tau_p$$

$$\frac{.24}{(.24 - (-1.82))} * \$3.53 = \$.41/lb$$

$$\Delta P = \frac{$.41}{\$5} = 8.2\%$$

This results in a consumer burden of \$.41/lb and a producer burden of \$3.12/lb.

$$\Delta P + \tau_c = .41 + 0 = \$.41/lb \text{ for consumers.}$$

$$-\Delta P + \tau_p = -.41 + 3.53 = \$3.12/lb \text{ for producers.}$$

Appendix B:

Cost to society eliminated as a result of the beef tax:

As a result of the tax, the consumption of beef will be reduced by 4.11B lb, a decrease in demand of 14.92%. This will reduce the \$7.26B cost to society caused by the negative externalities.

$$\frac{\Delta Q}{Q} = \eta_d * \frac{\Delta P}{P} \text{ which can be rearranged to } \Delta Q = \eta_d * \frac{\Delta P}{P} * Q$$

$$\Delta Q = -1.82 * \frac{.41}{5.00} * 27.57B \text{ which simplifies to } \Delta Q = -.1492 * 27.57 = -4.11B \text{ lb.}$$

$$\text{Cost to Society} = \frac{1}{2} \tau (-\Delta Q) = \frac{1}{2} (3.53)(4.11B) = \$7.26B$$

Predicted revenue of beef tax:

The predicted revenue to be generated from the tax is \$82.81B when taking into account the after-tax quantity.

$$MR = \frac{dR}{d\tau} = \frac{d\tau Q}{d\tau} = Q_2 \text{ and } Q_2 = Q_1 + \Delta Q \text{ so } Q_2 = 27.57B - 4.11B = 23.46B \text{ lb}$$

$$\text{Predicted Revenue} = 23.46B \text{ lb} * \$3.53 = \$82.81B$$

Appendix C:

Cross-price elasticity:

While the exact cross-price elasticity of meat and plant-based meat could not be found, the most common red meat alternative is likely to be fish as mentioned in the paper above. Therefore, the cross-price elasticity between meat and fish of .382 was used as a proxy for the cross-price elasticity between meat and plant-based meat. It is found that a tax on beef will increase the price of beef by 8.2%, which will lead to an increase in the quantity demanded of plant-based meat by 3.13%.

$$\text{Cross Price Elasticity} = \frac{\% \Delta \text{ in Quantity Demanded of Plant - Based Meat}}{\% \Delta \text{ in Price of Beef}}$$

$$.382 = \frac{x}{8.2\%}$$

$$x = 3.13\%$$

Appendix D:

Impact on plant-based meat industry:

The plant-based meat industry generated \$939M in sales in 2019. Since the average price is \$12/lb, about 78.25M lb were sold. A 3.13% increase in demand will raise the quantity sold to 80.7M lb. Therefore, the predicted increase in revenue to be generated from the increase in

quantity demanded of plant-based meat is \$29.4M. (However, it will likely be more if these companies increase their prices to accommodate the increase in demand in the short-run.)

$$\frac{\$939M}{\$12} = 78.25M \text{ lb}$$

$$\text{Increase in quantity: } 78.25M * 1.0313 = 80.7M \text{ lb}$$

$$\text{Predicted increase in revenue: } (80.7M - 78.25M) * \$12 = \$29.4M$$