FISCAL IMPACT CHANNELS OF A RED AND PROCESSED MEAT TAX IN THE NETHERLANDS

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Abstract

In recent years, concerns over the health and environmental consequences of the consumption of red and processed meat have increased. Scientific studies have linked the consumption of red and processed meat to an increased probability of cardiovascular diseases, diabetes, obesity, and cancers. At the same time, livestock production is one of the key contributors to greenhouse gas emissions, mainly methane and nitrous oxide emissions. Evidence from academic studies and real-world examples suggest that fiscal policies can be efficient in promoting both healthy and environmentally sustainable diets. This thesis aims to estimate the effect of a tax on red and processed meat in the Netherlands on consumption, budget revenues, and environmental footprint. The analysis is based on the Dutch National Consumption Survey and price elasticities of demand reported by other studies. I calculate the change in consumption of red and processed meat in the three tax scenarios: 12%, 18%, and 30% tax rates. Based on the estimated consumption after the price increase, I calculate the expected budget revenues and reduction of the environmental footprint. Tax policy design and other policy implementation questions are considered. It is concluded that a 30% sales tax would result in an average decrease of consumption of red and processed meat by 13.7%. revenues are estimated to equal 975.7 million euros, as well as 631.8 million euros of benefits due to decreased social cost are expected.

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1. Introduction

Different countries around the world have introduced taxes on food and beverages that are considered to be harmful to human health. Examples include taxes on sugar-sweetened beverages (SSB), salty snacks, sweets, fast foods, coffee in Hungary, Finland, the U.S., Mexico, Belgium, France, and many others (World Health Organization, 2014). These decisions are motivated by the evidence that taxing less healthy food can have a positive impact on changing the behavior of the consumers towards healthier options and preventing non-communicable diseases (NCDs) such as obesity, cardiovascular diseases, diabetes, and cancers. The World Health Organization acknowledges the role of fiscal policy to discourage consumption and production of foods that represent a risk factor for the development of NCDs (Thow, Downs, Mayes, Trevena, Waqanivalu, & Cawley, 2018).

In recent years, concerns over the health and environmental consequences of red and processed meat consumption have increased, drawing the attention of governments, dietitians, policy makers, and environmentalists across the world. A growing number of studies have linked high consumption of red and processed meat to an increased probability of developing heart problems, diabetes, and overweight (Harvard Chan School of Public Health, 2018). Moreover, in 2014, the International Agency for Research on Cancer concluded that there is sufficient evidence to claim that the consumption of processed meat can cause cancer. Red meat was classified as Group 2, which means that there is an association between two events, but there is limited evidence (World Health Organization, 2015). Despite the existing evidence red and processed meat are taxed at the same VAT rates as other goods and services.

At the same time, fiscal policies are widely used as a response to climate change and its consequences. Currently, environmental taxes are primarily levied on energy products, transport, pollution, and resources (Eurostat, 2021). Agriculture emissions from livestock production are generally excluded from the environmental taxation dispute their contribution to the total greenhouse gas (GHG) emissions. In 2006, Henning Steinfeld, the head of the livestock sector analysis and policy branch at the Food and Agriculture Organization of the UN in Rome, warned that livestock production causes significant damage to the environment and is responsible for 18% of the total GHG emissions, which is more than produced by the automobile industry, and an "urgent action" is needed (Food and Agriculture Organization of the United Nations, 2006). Since the publication of the report, the GHG emissions caused by livestock production have further increased up to 26% (Ritchie, 2019). Methane is produced during the digestion process of the livestock animals, as well as the growing consumption of meat and dairy products requires increasing production of the crops for feeding animals using fertilizers and machinery and additional land at the expense of forests and natural landscapes. All of the above-mentioned contributes to the GHG emissions caused by the agricultural sector. In response, recent studies showed that consumption taxes on meat and dairy products could reduce the GHG from the agriculture sector by 8.6%-19.4% (Wirsenius, Hedenus, & Mohlin, 2011; Säll & Gren, 2015; Edjabou & Smed, 2013). Thus, taxes can both positively impact health outcomes and reduce the environmental footprint from food consumption.

In this paper, using the Netherlands as a case study, I attempt to justify that introducing a tax on red and processed meat may lead to improved health and environmental outcomes, as well as increase the budget revenues. I use the cross-sectional data from the Dutch National Food Consumption Survey 2012–2016. The data is a representative sample of the Dutch population aged between 1 and 79 years. It provides insights into the quantity and frequency of consumption of red and processed meat, and the socio-demographic characteristics of the respondents. Additionally, I use the data on the budget share of different types of red meat and processed meat from the Netherlands Statistics. Own-price elasticities of demand and income elasticities for each meat category are obtained from the systematic literature review. I estimate the uncompensated price elasticities for beef, pork, lamb, and processed meat using the Slutsky equation. Based on the uncompensated price elasticities that include income and substitution effects, I calculate the change in consumption, budget revenues, and environmental impact in the three tax scenarios.

I find that 15%, 18%, and 30% tax rates on red and processed meat could result in a total annual reduction in consumption, on average, by 5.5%, 8.25%, and 13.78%, respectively. It is equivalent to around 8.0, 12.1, and 20.2 tons annually. The estimated policy revenues amount to between 395.7 and 945.7 million euros. Moreover, the total GHG emissions are expected to decrease by 0.07%, 0.11%, and 0.18%, respectively, in the three tax scenarios. The reduction in the social cost from the GHG emissions is estimated to equal between 132.9 and 332.8 million euros.

This study contributes to the existing literature on the taxation of food products that might negatively affect health and environmental outcomes. While taxes on sugar-sweetened beverages take the central place in the research, there is a limited number of studies that investigated the fiscal impact channels of taxes on red and processed meat. Moreover, the relevant studies aim to quantify different effects of food taxes and do not discuss tax implementation. This thesis seeks to fill this gap and address policy design and implementation questions. Thus, the thesis has the following research questions: what are the fiscal effects of the tax on red and processed meat, and how the tax should be designed and implemented.

The paper is structured as follows. Chapter 2 provides a critical overview of the existing literature on the effects of taxes on the consumption of targeted foods, health, and environmental outcomes. Chapter 3 presents a theoretical framework of the impact of a price increase on consumption using the Slutsky equation. The direct and indirect impact channels of the tax on red and processed meat are discussed in this Chapter. The following Chapter provides the arguments for introducing a tax in the Netherlands. Chapter 5 presents the data overview and calculations of the consumption change, policy revenues and environmental impact. Chapter 6 discusses tax policy design and implementation questions and Chapter 7 draws conclusions.

2. Literature Review

A growing number of studies attempted to investigate how taxes on different food items would impact consumption. The critical literature review suggests that these studies vary significantly in terms of methodology, type and level of a tax or subsidy, target food or nutrients, and the objective of the tax policy. Mainly, the existing research aims to estimate the potential effect of the tax on health outcomes as a tool to promote healthier diets and the environment as a tool to promote climate-friendly diets. Moreover, the main targeted foods are sugar-sweetened beverages, followed by meat and dairy products and specific nutrients such as saturated fat. Currently, there are three types of evidence available: results of the experimental studies and randomized control trials, modeling studies, and implemented policies in the real world.

Overall, the results of the randomized control trials suggest that there is a significant effect of taxes on consumption decisions. Epstein, Finkelstein, Raynor, Nederkoorn, Fletcher, Jankowiak & Paluch (2015) recruited 199 women to do weekly groceries shopping in a virtual supermarket created by the researchers. Across the weeks, fruit, vegetables, and bottled water without sugar were subsidized, while sugar-sweetened water, candies, and salty snacks were taxed. The study found that subsidies positively impacted the consumption of subsidized foods by 13.74%, while taxes resulted in a decrease of consumption of taxed foods by 6.61%. Another supermarket experiment with 306 participants identified a similar pattern: a 50% price increase on high energy-dense foods with a fixed budget decreased the consumption of high energy-dense foods and carbohydrates by 16% (Nederkoorn, Havermans, Giesen & Jansen 2011). Moreover, Epstein, Jankowiak, Nederkoorn, Raynor, French & Finkelstein (2012) reviewed 24 experimental studies that provide evidence of the effects of the price increase on consumption behavior. The experimental studies included a wide range of designs such as laboratory, restaurants, cafeteria, vending machine, and supermarket experiments. All of the studies concluded that there is a significant effect of the price change on consumption decisions. Mainly, the targeted price intervention decreases the demand for less healthy foods and increases consumption of healthier foods such as fruit and vegetables. At the same time, the external validity of the experimental studies is usually low since it depends on the setting of the studies, as well as the treated groups. Moreover, it provides insights into the effects at a certain point in time rather than the long-term impact.

In line with the results of experimental studies, modeling studies identified a decline in demand for taxed foods and an increase in consumption of subsidized foods. A systematic review of 35 modeling studies found a strong effect of the taxes on sugar-sweetened beverages and subsidies on fruit and vegetables on desirable changes in consumption patterns (Thow, Downs & Jan, 2014). Furthermore, subsidies for fruits, vegetables, and fiber-rich foods lead to higher demand at the expense of dairy products and high-fat foods (Jensen & Smed, 2007). At the same time, targeted taxes on the specific nutrients seem to be less effective with only a small impact on the choices of consumers (Thow, et al., 2014). The tax on fats reduces the consumption of animal-based foods, but it also leads to an undesirable increase in intake of sugar and carbohydrates such as bread (Jensen, et al., 2007). Overall, a combination of subsidies for healthy foods and taxes on less healthy foods leads to more positive health outcomes rather than the tax alone (Jensen, et al., 2007; Nnoaham, Sacks, Rayner, Mytton & Gray, 2009; Smed, Jensen & Denver, 2007; Thow, Jan, Leeder & Swinburn, 2010).

The tax on SSB draws the attention of most researchers as an increasing amount of evidence points out a link to obesity. A relatively small level of tax of one cent per every 28.35 grams of sugar content on SSB would result in a 24% reduction in consumption with the policy revenue of 79 billion dollars over five years (Andreyeva, Chaloupka & Brownell, 2011). A 40% tax on SSB could generate even higher revenues of 77.5 million dollars per year (Finkelstein, Zhen, Nonnemaker & Todd, 2010). Effects on the obesity reduction were estimated by Finkelstein, Zhen, Bilger, Nonnemaker, Farooqui & Todd (2013). A 20% increase in the price of SSB resulted in a decrease in the intake of calories and a subsequent weight loss of around 7.25 kilograms during the first year. At the same time, no evidence of substitution to other foods containing sugar was found.

These studies focused mainly on the effects of fiscal policies on consumption as a tool to prevent obesity and other non-communicable diseases. Other researchers aimed to quantify the impact of taxes on the mitigation of consequences of climate change. It is argued by Schmutzler & Goulder (1997) that under certain circumstances, imposing taxes on the outputs is more efficient than on the emissions. This is the case when it is costly to monitor emissions and there are available options for substitution of the outputs. Taxing animal-based products can be a clear example of such a case when there is a wide range of available plant-based substitutes advocated by the doctors and dietitians (Schösler, De Boer & Boersema, 2012). For instance, Nordgren, A. (2012) claims that technological advances in the agricultural sector might not be enough to mitigate the climate change consequences. Thus, decreasing the consumption of meat through a tax yields a more desirable outcome.

Wirsenius, Hedenus & Mohlin (2011) estimated that a 60 euros tax on animal-based products per ton of CO2 equivalents emitted could reduce the emissions from agriculture by 32 million tons in the EU-27. Moreover, evidence from the Swedish data suggests that taxing meat and dairy products could result in a 12% reduction in the GHG emissions from the agricultural sector, with beef being a key factor in the decrease (Säll & Gren, 2015). Similarly, the consumption taxes on the 23 types of foods in Denmark, including meat and dairy products, were estimated to result in a decrease of up to 19.4% of the average carbon footprint of the households (Edjabou & Smed, 2013). A more recent study by Broeks, Biesbroek, Over, van Gils, Toxopeus, Beukers, & Temme (2020) estimated the environmental impact of the tax on meat in the Netherlands. A 15% and 30% meat tax scenarios were found to result in an 8.6% and 16% decrease in the GHG emissions respectively over a horizon of 30 years. At the same time, the results of modeling studies highly depend on the availability and quality of the data.

The growing evidence of the positive effects of consumption taxes on health and environmental outcomes prompted governments to introduce such taxes in their countries. Real-world examples can provide further insight into the impact and efficiency of the fiscal policies to promote healthier and more environmentally friendly diets. In 2011, Denmark introduced a tax on saturated fat that amounted to 2.15 euros per kg of fat. The tax applied to all foods containing more than 2.3 grams of saturated fat per 100 grams of the products produced for the domestic market, including meat and dairy products. Due to a high number of opponents of the tax, it was abandoned at the end of 2012 (Vallgårda, Holm, & Jensen, 2015). At the same time, it was reported to have high costs of collection and monitoring (European Competitiveness and Sustainable Industrial Policy Consortium, 2014). However, one year of its force can provide information regarding the effects on consumption and government revenues. According to the Ministry of Taxation of Denmark (2012), the revenue raised from the tax on saturated fat amounted to around 138 million euros. Later econometric research concluded that even though the long-term effects of the tax cannot be precisely estimated, the short-run consumption of saturated fats decreased by 10-20% (Jensen & Smed, 2012).

Another example is a tax on sweets, ice-cream, and sugar-sweetened beverages in Finland that was in force between 1926 and 1999 and then reintroduced in 2010 (World Health Organization, 2015). While the primary goal of the tax was to generate additional government revenues, it was also a tool to promote a healthy diet. In 2012-2012, 331 million euros were collected as tax revenues (World Health Organization, 2015). At the same time, the effects on consumption are not fully obvious. A decline in the demand for sweets and soft drinks was observed. However, the substitution effect for other products that contain sugar but are not liable to the tax could not reveal the whole picture of the impact of the policy (European Competitiveness and Sustainable Industrial Policy Consortium, 2014).

In contrast to the previous two cases, a public health product tax in Hungary has more positive estimates of its impact. The tax was introduced in 2011 on products that contain certain nutrients like salt and sugar higher than the set threshold. Generally, the main categories of the foods taxed are salty snacks, sugar-sweetened and energy beverages, sweets, and jams (World Health Organization, 2015). An extensive assessment of the effects of the tax was conducted by the World Health Organization (2015). First, it was found that the government revenues amounted to 200 million euros throughout 2011-2014. Second, many consumers decreased the consumption of targeted foods and sustained the declined level of consumption. The reason for that was that people became more aware of the potentially harmful health consequences. Moreover, those people that substituted the target products with other foods chose mineral water, fruit and vegetables, and natural herbs as alternatives. It is worth noting that obese and overweight people were more likely to change their consumption patterns. Thus, the preliminary conclusion was that the tax policy was successful in achieving its short- and long-term goals.

At the same time, despite the positive effects of the consumption taxes on health outcomes and government revenues, researchers and policymakers are concerned about the regressivity of the tax, meaning that the tax disproportionally affects the lowest-income households. It was found that even though in the short-term, the tax might seem regressive and affect the lowest-income groups to a greater extent than those from the higher-income groups, in the long-term, the poorest households will experience the highest positive impact on their health (Sassi, Belloni, Mirelman, Suhrcke, Thomas, Salti, Vellakkal, Visaruthvong, Popkin & Nugent, 2018; Nnoaham, K. E., et al., 2009). It is related to the fact that this income group is more sensitive to the price change and is more likely to decrease consumption of less healthy foods. Moreover, the possible regressive effects could be mitigated through targeted subsidies on poor households financed from the tax revenues. Thus, the regressivity of the tax can be justified by the higher benefits for health for the income groups that initially tend to have a worse health condition. At the same time, a simultaneous increase in the intake of fiber and other nutrients as fat and sugar for the lowest-income households was found as a secondary undesirable effect (Nordström & Thunström, 2011). However, similar results were mentioned in other studies for all income groups and could be mitigated through a subsidy for healthier foods.

Overall, the critical analysis of the existing literature suggests that there is strong evidence that consumption taxes on less healthy foods result in the decreased consumption, better health outcomes, and additional budget revenues. The results could be maximized if the tax is accompanied by a subsidy for other healthier foods. Concerns over the regressivity of the tax do not seem to be an obstacle for the policy implementation since, in the long-term, the poorest households will benefit the most from the improved health conditions. At the same time, the studies do not address tax policy design and implementation questions. Since the tax on saturated fat in Denmark was quickly abolished, despite quantifying the impact of the tax on consumption, health, and environmental outcomes, other policy considerations should be taken into account.

3. Effect of Taxes on Consumption – Theoretical Background

3.1 Income and Substitution Effects

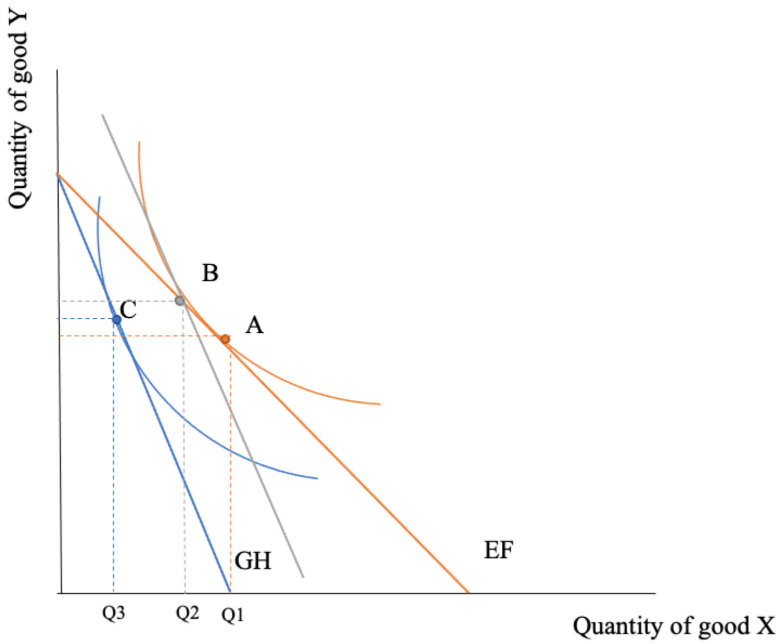
According to the microeconomic theory, the total effect of the price increase for a good is composed of income and substitution effects. The income effect describes how a change in price affects the real disposable income of an individual and the demand for this good. For instance, if the price increased, the purchasing power of the previous amount of the good within the budget constraint decreased. Consequently, the consumer has to alter its consumption behavior for the good that became relatively more expensive. The income elasticity of demand shows the sensitivity of demand to a change in disposable income. There are three types of income elasticity of demand: negative, positive, and zero. Negative elasticity of demand means that demand decreases following an increase in income. Such goods are called inferior goods. Income elasticity of demand of zero means that there is no change in demand after a change in disposable income. Positive income elasticity of demand between zero and one is associated with normal goods when demand is less sensitive to changes in income. Positive income elasticity of greater than one means that demand increases more than the income and is associated with luxury goods. Income elasticity is used to predict how demand will change following a change in disposable income due to economic growth and wage increase or change in prices that impact the total disposable income.

On the other hand, there is a substitution effect that describes how a price increase for a good impacts the demand for other goods. Substitution effect describes only the impact of relative price changes without change in disposable income. The substitution effect depends on the cross elasticity of demand that measures the change in demand for one good relatively to a price change of another good. A positive cross-elasticity of demand between zero and one means that goods are substitutes, and demand for the good increases when the price for the other good rises. A positive cross-elasticity of demand bigger than one means that goods are perfect substitutes, and the demand will change more than the price changes. A negative cross-elasticity of demand between zero and minus one means that goods are complements, and demand for the good decreases when the price for the other good increases. A negative cross-elasticity of demand greater than minus one means that goods are perfect complements, and demand will drop more than the price increases.

If cross-elasticity of demand equals zero, the goods are unrelated, and price change does not affect the demand for the other good.

The substitution and income effects are graphically presented in the Figure1 below.

Figure 1. *Substitution and Income Effects.*



Note. The figure was adapted from *Microeconomic analysis* (Vol. 3), by Varian, H. R. (1992). New York: Norton. (p.122).

Assuming goods X and Y are normal goods and EF is the initial budget line, point A is the point where the budget line is tangent to the higher indifference curve. After the price for good X increases, the consumer moves to point B, which lies on the same indifferent curve. This is the substitution effect. In the case of the income effect, the consumer moves to point C to a lower indifference curve and the budget line. At this point, he consumes less of good Y and more of good X. This is the income effect. The total effect of the price change is the combination of substitution and income effects and move from point A to point C. Moving from Q1 to Q2 is the substitution effect and from Q2 to Q3 is the income effect. The total price effect is moving from Q1 to Q3 or, in other words, the combination of change in disposable income and substitution with other goods.

3.2 The Slutsky Equation

The combination of substitution and income effect can be formally written in the form of Slutsky equation. The utility maximization of a consumer can be viewed from two sides that is called duality problem. On the one hand, the optimization problem can be solved by maximizing utility of consuming two goods subject to the budget constraint.

$$\text{Max U } (x; y) \text{ subject to } m = p_x q_y + p_y q_y,$$

where U is utility, x and y are consumption goods, M is disposable income or budget constraint, q_x and q_y quantities consumed of goods x and y, and p_x and p_y are prices of goods x and y.
On the other hand, the consumer can minimize costs while achieving the target level of utility.

$$\text{Min } p_x q_y + p_x q_y \text{ subject to U } (x; y) = \overline{U},$$

where $\overline{U}$ is a set level of utility.

Keeping the budget constraint while maximizing utility leads us to the Marshallian demand curve, which corresponds to the quantity demanded of a good with respect to its price. At the same time, the Hicksian demand curve corresponds to the quantity demanded of a good with respect to its price keeping prices of other goods and utility level constant. The intersection point of the Marshallian and Hicksian demand curves is the equilibrium of the dual consumer choice problem.

At the initial utility maximization point, it is assumed that the following condition holds to solve the duality problem:

Hicksian demand for good X=Marshallian demand for good X

$$X^h(p_x, p_y, \overline{U}) = X^m(p_x, p_y, M), \quad (1)$$

where $\overline{U}$ is a set level of utility, M is disposable income or budget constraint, p_x and p_y are prices of goods x and y.

Income M can be written in form of the minimum expenditure E to achieve the set utility level of $\overline{U}$:

$$M = E(p_x, p_y, \overline{U}) \quad (2)$$

I substitute (2) into the Marshallian demand or the right-hand side of the equation (1)

$$X^h(p_x, p_y, \overline{U}) = X^m(p_x, p_y, E(p_x, p_y, \overline{U})), \quad (3)$$

Then, I take the partial derivative of both sides of the equation (3) with respect to p_x.

$$\frac{\partial X^h}{\partial p_x} = \frac{\partial X^m}{\partial p_x} + \frac{\partial X^m}{\partial E}\frac{\partial E}{\partial p_x} \quad (4)$$

I solve the equation (4) for $\frac{\partial X^m}{\partial p_x}$

$$\frac{\partial X^m}{\partial p_x} = \frac{\partial X^h}{\partial p_x} - \frac{\partial X^m}{\partial E}\frac{\partial E}{\partial p_x} \quad (5)$$

I can rewrite $\frac{\partial E}{\partial p_x}$ as X^m because according to envelope theorem, the derivative of the objection function with respect to one of the shift parameters is simply the partial derivative. Using method of Lagrange, it can be written as:

$$L = p_x q_x + p_y q_y - \lambda(\bar{U} - U(x, y) \quad (6)$$

$$\frac{\partial E}{\partial p_x} = \frac{\partial L}{\partial p_x} = x \quad (7)$$

I substitute (7) into (5):

$$\frac{\partial X^m}{\partial p_x} = \frac{\partial X^h}{\partial p_x} - \frac{\partial X^m}{\partial E}x \quad (8)$$

Because changes in income M and expenditures E for function $X^m(p_x, p_y, M)$, I can rewrite (7) as:

$$\frac{\partial X^m}{\partial p_x} = \frac{\partial X^h}{\partial p_x} - \frac{\partial X^m}{\partial M}x \quad (9)$$

Equation (9) is known as Slutsky equation, which can be also expressed in terms of elasticities. I multiply both sides of (8) by $\frac{p_x}{X}$ and he last term on the right-hand side by $\frac{M}{M}$:

$$\frac{\partial X^m}{\partial p_x} * \frac{p_x}{X} = \frac{\partial X^h}{\partial p_x} * \frac{p_x}{X} - \frac{\partial X^m}{\partial M}x * \frac{p_x}{X} * \frac{M}{M} \quad (10)$$

From (9), I get:

$$\varepsilon_{p,x} = \varepsilon^h_{p,x} - \varepsilon_{w,x} * b_x, \quad (11)$$

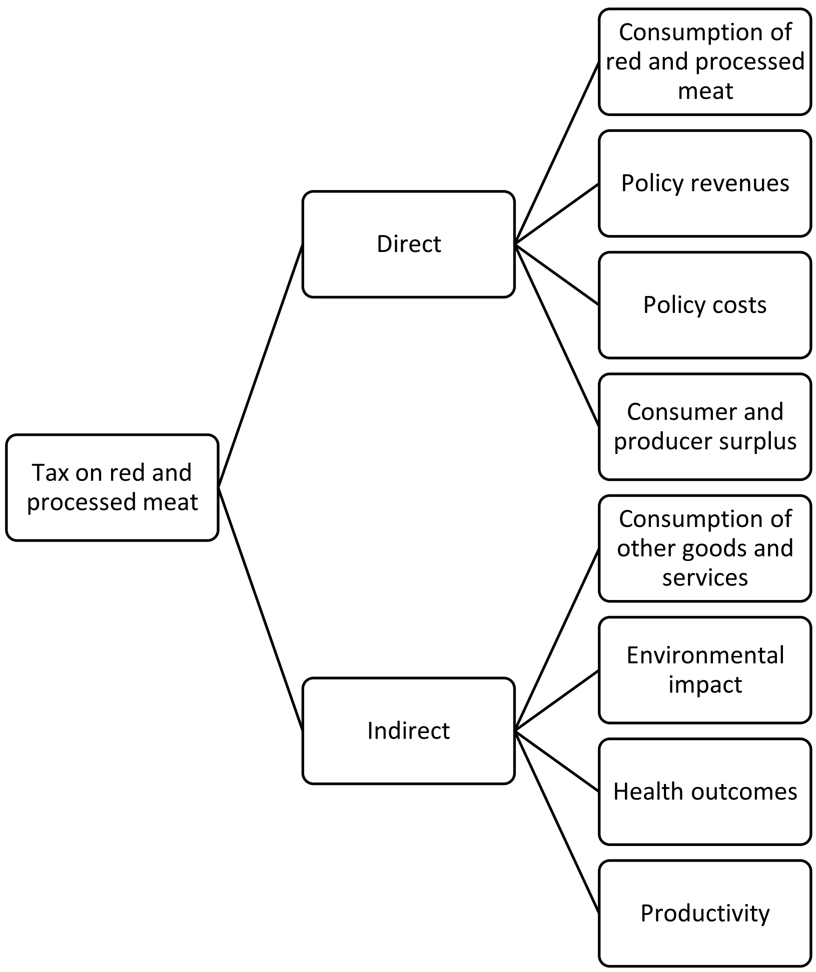
where $\varepsilon_{p,x}$ is uncompensated price elasticity for good *x* (or the total elasticity that is the result of substitution and income effects), $\varepsilon^h_{p,x}$ is the compensated price elasticity for good *x* (Hicksian elasticity), $\varepsilon_{w,x}$ is income elasticity of demand for good *x*, and b_x is the budget share of the good *x*.

Thus, using equation (11) I can calculate the total effect of the price change on consumption of a good. It is the sum of the own-price elasticity of demand and income elasticity of demand multiplied by the budget share of the good in the consumption basket.

3.3 The Short- and Long-term Fiscal Impact Channels of the Tax on Red and Processed Meat

The introduction of the tax on red and processed meat would impact different areas in the short- and long-run perspective in direct and indirect ways. The tax directly impacts the consumption of red and processed meat, policy revenues and costs, as well as consumer and producer surplus. The effect of the tax is even larger through indirect channels. A decreased consumption of red and processed meat further impacts environmental and health outcomes, consumption of other goods and services, and productivity. Direct and indirect channels of the tax on red and processed meat are discussed in this chapter.

Figure 2. *Fiscal Impact Channels of the Tax on Red and Processed Meat.*



3.3.1 Impact on Consumption of Red and Processed Meat

The tax on the consumption of red and processed meat has a direct effect on consumption. If a negative elasticity of demand for red and processed meat is assumed, then the introduction of a tax would lead to a decrease in consumption. An impact on consumption is a short-term effect of the tax introduction since households have to adjust their spending to the current disposable income. However, in the long-term, if the income grows following an economic upturn in the country, the consumption can either stabilize to the pre-tax level or, if the consumers realize the health consequences of consumption, it can further decrease.

3.3.2 Policy Revenue and Costs

Government revenue is an important aspect of the tax policy. The purpose of the introduction of the tax is to collect more money that could be used for redistribution and public goods such as education, healthcare, and infrastructure. Moreover, in the case of the tax on red and processed meat, the tax revenue could be used for subsidies for fruits and vegetables to further contribute to the health outcomes. The government can collect revenues already in the short-term, and it would consist of tax income minus the loss of income due to a decreased consumption.

A tax introduction generates not only revenues but also the associated tax collection costs. There are two types of tax collection costs: administrative costs and compliance costs. Administrative costs imply costs borne by the public sector related to tax introduction and tax collection.

Generally, administrative costs include expenses of the tax administration such as salaries, purchase of IT systems, building maintenance costs, etc. (Dziemianowicz, 2017). Tax compliance costs are incurred by the population since they must pay taxes. It is also referred to as a gap between the number of tax revenues collected and the total amount of expected tax revenues that should have been collected (Jrbashyan & Harutyunyan, 2006).

Costs of taxation are difficult to quantify. For a new tax, it is complicated to distinguish between administrative costs related only to the new tax and the total administrative costs. In terms of compliance costs, the behavior of the taxpayers is determined by different socio-economic and psychological aspects, as well as by interaction with the government.

At the same time, the difference between policy revenues and costs is important to consider since the goal of the proposed tax is to both impact the consumption and increase budget revenues.

3.3.3 Consumer and Producer Surplus

Consumer surplus measures the benefits of the consumers that are received as a result of the difference between the actual price that is paid for a good or service and the price they are willing to pay. The introduction of a tax on red and processed meat and associated price increase leads to a decrease in consumer surplus. However, in this case, as discussed above, the decrease in the consumer surplus is outweighed by the benefits gained from the long-term positive impact on health outcomes, environment, and productivity.

Producer surplus is the benefit of producers that are received as a result of the difference between the market price that they sell their goods for and the lowest price they would agree to sell for. After the introduction of a tax, the producer surplus would also decrease. If a tax would be imposed on producers, then the producers would have higher costs of production and thus, will have to sell for a higher price. In turn, consumers would buy fewer goods for a higher price, and the demand curve would shift to the left, decreasing producer surplus. If a tax would be passed through on to consumers, the producer surplus would also drop as a result of decreased demand.

The burden of the tax on consumers and producers depends on the elasticities of demand and supply. For instance, if demand is inelastic or supply is perfectly elastic, then the tax burden would be fully placed on the consumers. If demand is perfectly elastic or supply is inelastic, then the tax burden would be placed on the producers. Thus, the total effect of the tax on red and processed meat would depend on the tax incidence. Overall, despite the decrease in the consumer and producer surplus, both sellers and buyers can benefit from other positive indirect effects of the tax on red and processed meat.

3.3.4 Impact on Consumption of Other Goods and Services

The tax on red and processed meat can indirectly impact the consumption of other goods and services. Depending on the cross-price elasticities, the demand for other goods and services will either decrease or increase following the price increase for red and processed meat. For instance, fish, fruit, nuts, and vegetables are substitutes to meat since they have a positive cross-price elasticity (Tiffin, Balcombe, Salois & Kehlbacher, 2011). Consequently, a price increase for red and processed meat would lead to an increase in the consumption of fish, fruit, nuts, and vegetables. On the other hand, dairy and eggs, fats, starches, and alcohol have a negative cross-price elasticity with meat (Tiffin, et al., 2011). It is expected that their consumption would decrease following a price increase for red and processed meat. Furthermore, when the whole food basket is adjusted for the tax on red and processed meat, the effect on other goods and services can be estimated using cross-price elasticities. The overall effect is also reflected in the supply of different goods and services following the adjustment of demand. Consequently, it also impacts labor supply and demand across sectors.

3.3.5 Environmental Impact

Climate change became of concern for governments around the world. In particular, it was proven that an increased amount of greenhouse emissions caused by intensive production and land use contributes to the heating of the atmosphere. In turn, it leads to such negative consequences as extreme weather conditions, melting glaciers, wildfires, air pollution, and associated diseases (Lacis, Schmidt, Rind & Ruedy, 2010). The introduction of a red and processed meat tax can affect the environment in several ways from a long-term perspective. On the one hand, a drop in demand will force producers to decrease their supply and thus, reduce their environmental footprint. On the other hand, higher costs associated with the production will incentivize producers to innovate and run environmentally sustainable businesses. Moreover, the additional revenue generated from taxes can be used for different subsidies and investments for sustainable land use, decreasing CO2 emissions, and using new technologies that do not impact the environment. Thus, the tax on red and processed meat could result in reducing the environmental footprint of livestock production.

3.3.6 Impact on Health Outcomes

The tax on red and processed meat creates an indirect effect on the short- and long-term health outcomes. The price increase for red and processed meat leads to a decline in the purchases of these products. These impacts not only the intake of red and processed meat but also the intake of other products. In combination, these two processes lead to an overall nutrient and energy intake, which, in turn, impacts our nutritional status. Nutritional status is defined as a person's health condition depending on the intake of nutrients (Todhunter, 1970). The types of nutritional status include body weight, height, skin, functioning of our organs. Consequently, any nutrient intake directly impacts the short- and long-term health condition. The effect of food consumption on our health is not immediate and can have a cumulative effect. For instance, in the short-term, a decrease in consumption of red and processed meat could result in a weight loss, while long-term consumption of foods with high cholesterol eventually may increase the risk of heart diseases (World Health Organization, n.d.).

3.3.7 Impact on Productivity

Productivity is an important factor that impacts economic growth. It consists of capital and labor productivity. With increased productivity, the same amount of goods can be produced with fewer inputs (labor and capital), contributing to higher revenues and GDP growth. Health condition of the population impacts labor participation, absenteeism, and effectiveness of work (presenteeism). If a big proportion of the population has poor health, it would impact the overall economic growth because the country would lack an important input in goods and services production.

The tax on red and processed meat indirectly impacts human capital productivity. If as a result of the tax people reduce consumption and it has long-term beneficial effects on their health, it would also have a long-term effect on productivity. For instance, absenteeism is defined as a proportion of the total working time that was not used efficiently due to the sick leave of the worker. This phenomenon implies additional costs for the employer and thus, negatively contributes to revenues and economic growth. Another aspect of productivity, presenteeism, implies that a worker while being present at the workplace, cannot effectively use the working time and produce the necessary amount of output. Presenteeism is caused by the mental and physical health conditions of the workers. Poor health conditions can prevent the worker from utilizing the maximum of his human capital. Last but not least, low labor force participation, which is also partially impacted by the health condition of the population, negatively impacts the social and economic welfare of the country.

Additionally, the poor health condition of the population in the country also adds a burden on the national healthcare system and government budget. For example, it is estimated that approximately 1.7% of the GDP across EU countries is spent on expenditures related to disabilities and sick leaves (OECD, 2016). Consequently, the tax on red and processed meat and reduced consumption of these foods indirectly impacts many aspects of economic growth through the channel of productivity growth.

4. Rationale for Introducing a Tax on Red and Processed Meat

The introduction of the tax on red and processed meat in the Netherlands is motivated by the impact of the production of these foods on the environment, as well as the health outcomes associated with increased consumption. The arguments for the necessity of the tax are presented in this chapter.

4.1 Environmental Footprint

The increasing number of GHG emissions caused by different human activities such as the use of transport (automobile, air, and railway transport), electricity production, industrial production, construction, and agriculture are concerning (the United States Environmental Protection Agency, 2021). Worldwide, annual GHG emissions have increased almost one and a half times from 34.7 billion tons in 1990 to 49.36 billion tons in 2016 (Ritchie & Rosie, n.d.). GHG emissions are the main reason for global warming, which, in turn, leads to irreversible consequences for the planet. Extreme weather conditions of a higher frequency such as floods or droughts, wildfires, the rise of sea levels, extinction of plants and animals, diseases associated with air pollution are all caused by the increased average temperature of the atmosphere (Lacis, et al., 2010). CO2 emissions remain the major part of the total GHG emissions and account for 74.4% (Ritchie, et al., n.d.). However, it is worth noting that other gases such as methane and nitrous dioxide, which are primarily emitted by the agricultural sector, also contribute to global warming (the United States Environmental Protection Agency, n.d.).

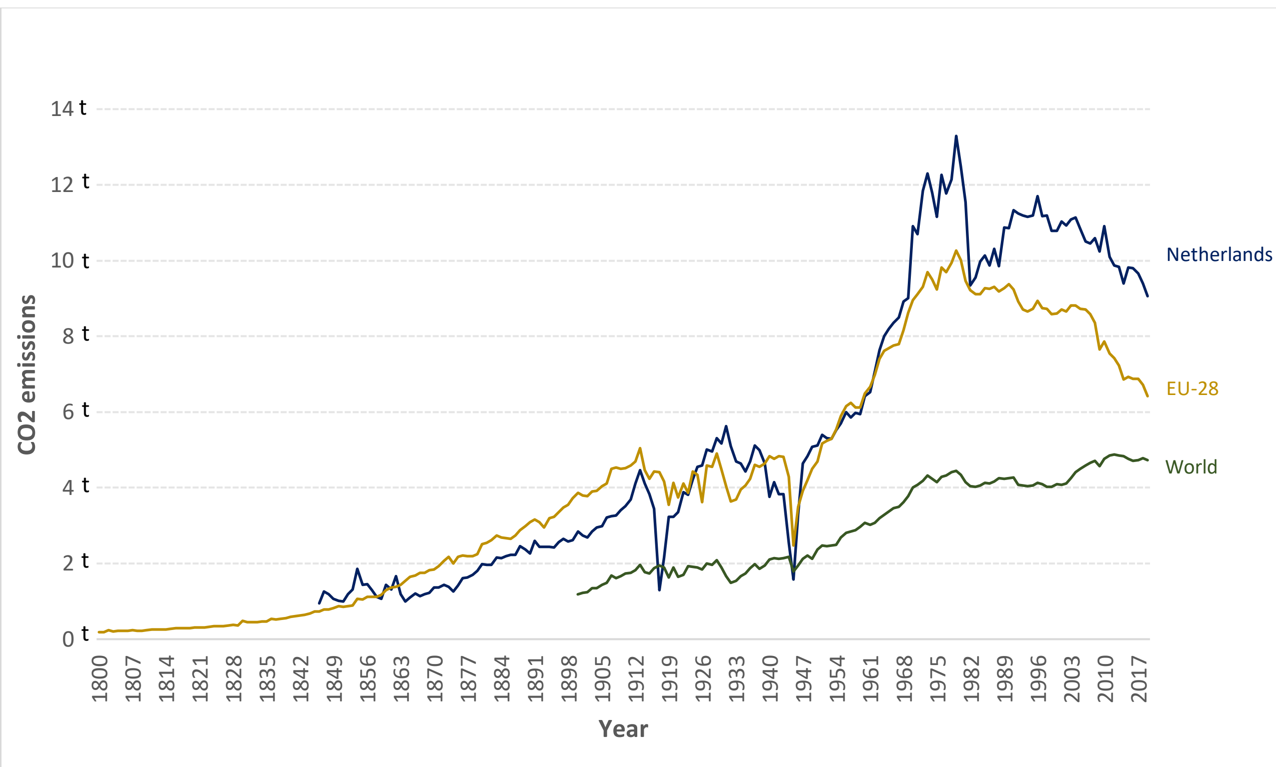
Food production produces 25% of the total GHG emissions with animal-based foods such as beef, lamb, cheese, and other dairy products producing a disproportionally higher amount of GHG per kg of the food product. For instance, beef meat production emits 60 kg of GHG per one kg, while peas – only 0.9 kg (Ritchie, 2020). At the same time, meat and dairy account for almost one-quarter of the daily energy intake worldwide (Ritchie & Roser, n.d.).

There are different channels through which the environment is affected. First, livestock, mainly cattle, produces emissions during the digestion process known as “enteric fermentation.”

The specific feature of this process is that methane is produced in the stomach of animals when fermentation occurs. Second, during the production of crops used for feeding cattle emissions are caused as a result of the use of fertilizers and agricultural machines. Third, as demand for meat and dairy products is rising, producers have to expand their agricultural lands by the means of converting natural landscapes, which results in further deterioration of the environment. Moreover, livestock uses around 10% of the annual global water flows (Ritchie, et al., n.d.). Lastly, food processing, transportation, and packaging also contribute to the emissions.

In the case of the Netherlands, CO2 emissions have become of a larger concern since its industrial activity heavily relies on mineral fuels and fuels-intensive industries (International Energy Agency, 2020). In the Netherlands, in 2017, per capita CO2 emissions amounted to 9.66 tons, which is higher than the EU and world average (6.88 and 4.73 tones, respectively) (Ritchie, et al., n.d.).

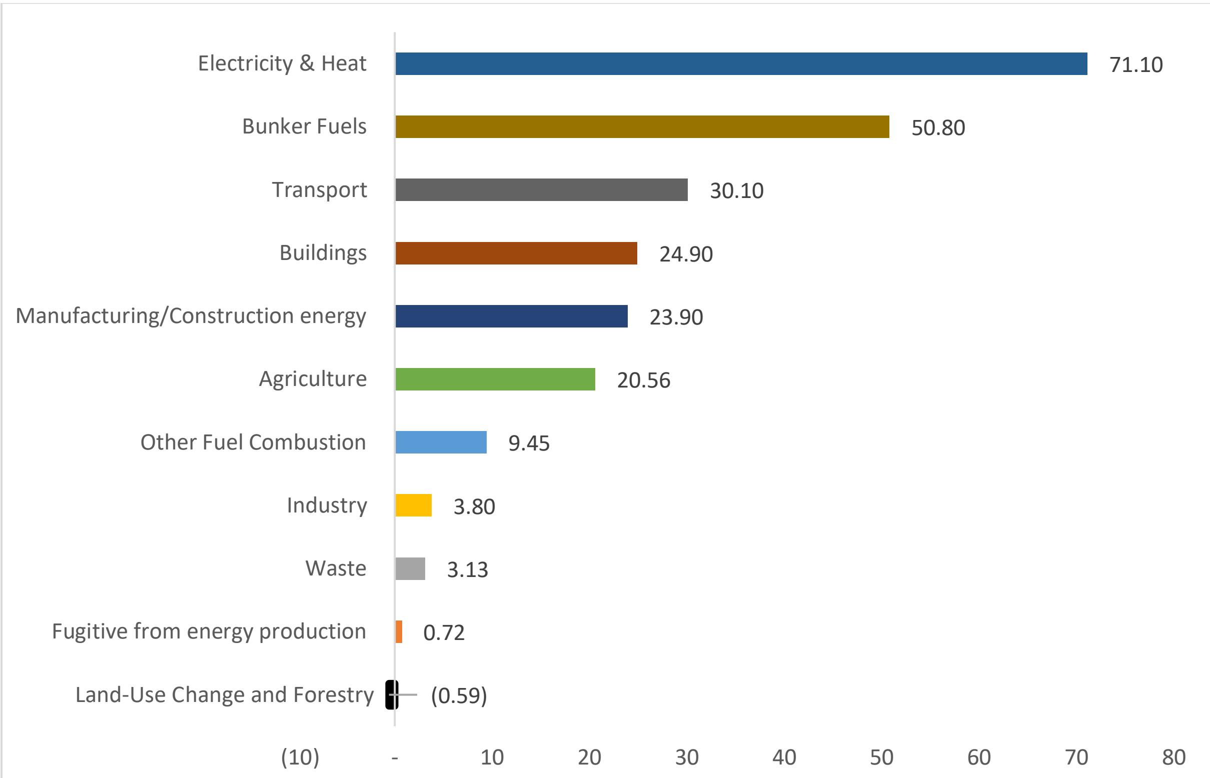
Figure 3. *Per capita CO2 emissions, 1800-2019 (in million tons).*



Note. The figure describes the development of the CO2 emission between 1800 and 2019 in the Netherlands, EU-28 and the world average. Adapted from Ritchie, et al. (n.d.).

Currently, agriculture and heat remain the largest contributors to the GHG emissions in the Netherlands with 71.10 million tons of CO2 equivalents emitted in 2016. Agriculture is the 6th largest sector by GHG emissions and is responsible for 8.6% of the total GHG emissions.

Figure 4. *Contribution of Sectors to the GHG Emissions in the Netherlands, 2016 (in million tons of CO2 equivalents).*



Note. The data was adapted from Ritchie (2020).

However, as mentioned above, GHG emissions include not only CO2 emissions but also methane and nitrous oxide emissions. Agriculture disproportionally contributes to methane and nitrous oxide emissions compared to other sectors. In 2016, 13.15 million tons of CO2 equivalents, or 68.5% of the total methane emissions, were produced by the agricultural sector (Ritchie, 2020). The impact is even more disproportionate on nitrous oxide emissions. The agricultural sector amounted to 86.9% of the total nitrous oxide emissions or 7.41 million tons of CO2 equivalents (Ritchie, 2020).

Currently, the Netherlands participates in the European Emission Trading System and does not have a separate carbon tax. The system implies a carbon cap that is set on several industrial sectors across the European Union. At the same time, while the companies cannot jointly exceed the cap, they can buy or sell their emission allowances if needed (Dutch Emissions Authority, n.d.). In 2019, the Dutch government proposed introducing a separate CO2 tax to further combat the negative impact on the environment. The tax was planned to equal 30 euros per ton of CO2 emissions in 2021 and around 125-150 euros per ton in 2030. The aim of the project is to reduce GHG emissions by 49% compared to 1990. It covers the transport and industrial sectors, as well as the construction sector (Government of the Netherlands, 2019). At the same time, the proposal mentions several measures regarding agriculture and land use. It included investments in innovations and support to farmers to reduce methane emissions from livestock productions, sustainable use of soils and land, and “create incentives for climate-friendly food consumption and reducing food waste” (Government of the Netherlands, 2019). However, it does not mention what specifically would be implemented to incentivize sustainable consumption. In December 2019, the policy proposal was submitted to the European Commission and the system should have entered into force on January 1st, 2021. However, it is still under review (Government of the Netherlands, n.d.).

Overall, taking into account the significant contribution of the agricultural sector to the total GHG emissions in the Netherlands, especially to the methane and nitrous oxide emissions, additional measures in climate policy are needed. The government of the Netherlands acknowledges the necessity of a policy to respond to climate change and developed an ambitious plan. However, the plan does not specify the measures that would be taken for incentivizing an environmentally friendly diet. Thus, the current situation in the Netherlands creates a potential for implementing a tax on red and processed meat.

4.2 Health Impact

Red and processed meat consumption impacts not only the environment through contribution to the GHG emissions but can also have a negative long-term effect on the health outcomes. In recent years, an increasing number of cohort studies have linked long-term red and processed meat consumption in increasing amounts with a higher probability of cardiovascular diseases, obesity, and diabetes (Richi, Baumer, Conrad, Darioli, Schmid & Keller, 2015). Moreover, the World Health Organization (2015) officially classified processed meat as cancerogenic to humans and red meat as cancerogenic with limited evidence.

A cohort study of 500 000 people over 10 years in the U.S. concluded that there is a statistically significant link between red and processed meat consumption and mortality rate. Men and women from the highest quantile of red meat consumption were 31% more likely to die prematurely than those from the lowest quantile. As per processed meat consumption, the highest quantile was 16% more likely to die prematurely. Moreover, the development of cardiovascular diseases was 27% and 50% more likely for men and women from the highest quantile of red meat consumption and 9% and 38% from processed meat consumption. Increased risks of mortality from cancer were found significant for the highest quantiles of red and processed meat consumption (21% and 12%, respectively) (Sinha, Cross, Graubard, Leitzmann & Schatzkin, 2009). Another study of almost 122 000 participants over 20 years and repeated surveys every four years concluded that there is a 13% and 20% higher chance of death due to increased consumption of unprocessed and processed meat, respectively. In other words, there is almost a linear relationship between an increase in servings-per-day of meat and the probability of death (Pan, Sun, Bernstein, Schulze, Manson, Stampfer, Willett, & Hu, 2012). Following the U.S. studies, European Prospective Investigation into Cancer and Nutrition analyzed almost 450 000 participants and revealed that high red and processed meat consumption leads to a higher risk of death with a hazard ratio of 1.14 and 1.44, respectively. Furthermore, a significant link was found between red and processed meat intake and cardiovascular diseases and cancer (72% and 11%, respectively) (Rohrmann, Overvad, Bueno-de-Mesquita, Jakobsen, Egeberg, Tjønneland, Nailler, Boutron-Ruault, Clavel-Chapelon, Krogh, Palli & Linseisen, 2013). Another study of almost 205 000 participants across different periods (from 1986 to 2008) found a 12% and 32% increase in the risk of type 2 diabetes and an increase of red and processed meat consumption by 50 grams per day (Pan, Sun, Bernstein, Schulze, Manson, Willett & Hu, 2011).

Following a growing concern over the health impacts of red and processed meat consumption, the WHO, as well as national healthcare systems published dietary guidelines with the recommended amount of nutrients per day. The WHO recommends that the total fat intake should not exceed 30% of the total calories consumed. Saturated fats intake should not be higher than 10% of the total calorie intake to prevent obesity and the risk of non-communicable diseases (World Health Organization, 2018). The Department of Health of the UK recommends consuming no more than 70 grams per day of red and processed meat (National Health Service, 2018). The Dutch dietary guidelines even though do not mention specific amounts of red and processed meat, recommend lowering their intake (Health Council of the Netherlands, 2015). It is assumed that pork chops contain 7.0 g of saturated fat per 100 grams and rump steak contains 4.9 g of saturated fat per 100 grams (Nidirect, n.d.).

In the Netherlands, according to the Dutch Dietary Guidelines, the average man eats around 105 and 55 grams of red and processed meat, respectively, and the average woman eats 65 and 35 grams of red and processed meat, respectively (Health Council of the Netherlands, 2015). These amounts exceed the above-mentioned recommendations. Thus, I can conclude that the current Dutch diet is neither healthy nor environmentally sustainable.

Moreover, according to the WHO estimates (2016), the prevalence of obesity, diabetes, and other non-communicable diseases is alarming. In the Netherlands, in 2016, non-communicable diseases accounted for almost 90% of the total deaths. Cancers (32%) and cardiovascular diseases (26%) are the main causes of premature deaths. Table 2 below summarizes the main risk factors related to lifestyles that lead to an increased risk of premature death.

Table 1. *Health Risk Factors Prevalence in the Netherlands, 2016.*

Risk factor	Males	Females	Total
Raised blood pressure, adults aged 18+	28%	22%	25%
Obesity, adults aged 18+	23%	23%	23%
Obesity, adolescents aged 10-19	7%	5%	6%
Diabetes, adults aged 18+	7%	5%	6%
Harmful use of alcohol	14%	4%	9%
Physical inactivity	27%	31%	29%
Salt/sodium intake	9%	8%	8%
Tobacco use	27%	23%	25%

*Note.*The table describes the percentage of the Dutch population, grouped by gender, exposed to the different non-communicable health risk factors. The data was adopted form World Health Organization (2016).

In the Netherlands, 25% of the total adult population suffers from the raised blood pressure, 23% are obese, 6% have diabetes, and 8% have a high salt and sodium intake. Various factors impact the development of non-communicable diseases. However, the role of the poor diet composition cannot be denied in the case of obesity, diabetes, and cardiovascular diseases.

The evidence of unbalanced diets that do not correspond to the Dutch Dietary Guidelines, as well as the prevalence of cardiovascular diseases, cancers, diabetes, and obesity imply that government intervention is needed to incentivize the Dutch citizens to consume healthier food. Thus, introducing a tax on red and processed meat could result in a decreased consumption of the targeted foods and, thus, in a decline in risk factors for the development of associated diseases.

5. Data and Methodology

5.1 Data Structure, Source and Limitations

To model a tax on red meat and processed meat consumption in the Netherlands, the data from the Dutch National Food Consumption Survey 2012–2016 was obtained. The data consists of several datasets, however, those that represent an interest for the thesis are the following: Participant and Consumption Food Nut. The data is a representative sample of the Dutch population aged between 1 and 79 years and consists of 4,313 households. The data was collected between 2012 and 2016 on two non-consecutive 24-hour recalls. The participant dataset contains detailed information about the socio-economic and health status of the participants: age, sex, education level, family size, income, employment, region, urbanization level, dietary and lifestyle habits, BMI, etc. These details are important for this study since I can create a general picture of the population that is consuming red and processed meat by age, gender, education, and income level. Consumption Food Nut represents information on consumption of different foods and beverages by the participants by quantity, consumption time, and place. For the study, I am only interested in the consumption of red and processed meat. It includes the following: beef, veal, pork, mutton/lamb, horse, goat, unclassified processed meat, hot processed meat, and cold-processed meat.

To extrapolate the dataset on the total Dutch population, I have applied a weighting factor to the consumption quantity that was available in the dataset. The weighting factor is used to correct for the sex, age, education, region, and urbanization level distribution compared to the Dutch population within the same age group. As a comparison point, 2014 Dutch census data was used. Moreover, the weighting factor is adjusting for combined distribution by season and consumption day.

The strength of the data is that it is a representative sample of the population of the Netherlands and different weighting factors were available. It covers both genders, different ages, sizes of the household and income categories, migration background, education, and urbanization levels. Consumption data was precisely recorded by time and place of consumption, food category, and the amount consumed. Moreover, the survey was conducted under the supervision of the Netherlands Ministry of Health, Welfare, and Sport. To assure the quality of the survey different techniques were applied. For instance, the interviewers participated in the special training, received feedbacks from the authorized dietitians, as well as quality checks on the interview process and missing values were performed.

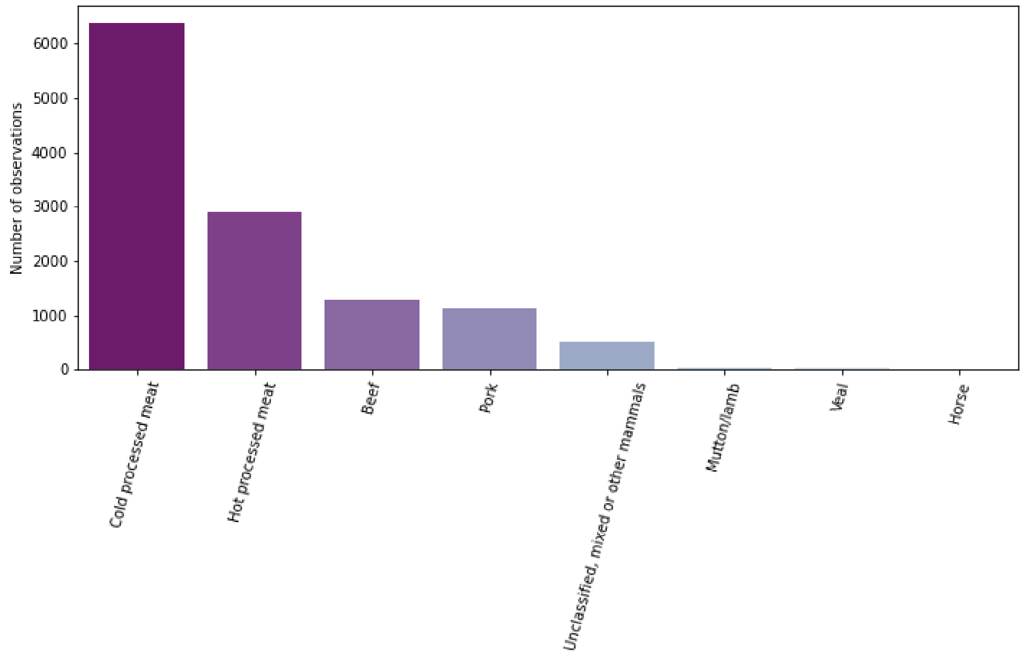
However, several issues with the data were identified. First, certain variables such as household income have more than 85% of missing values, which makes it difficult to assess how the introduction of the tax would affect inequality. Secondly, the data was collected on two non-consecutive days within the same year, and thus, it is not time-series data. Consequently, I cannot analyze the change in consumption over years for the same participants. Thirdly, the dataset does not contain information on prices and expenditures.

5.2 Data Trends

5.2.1 Consumption by Type of Meat

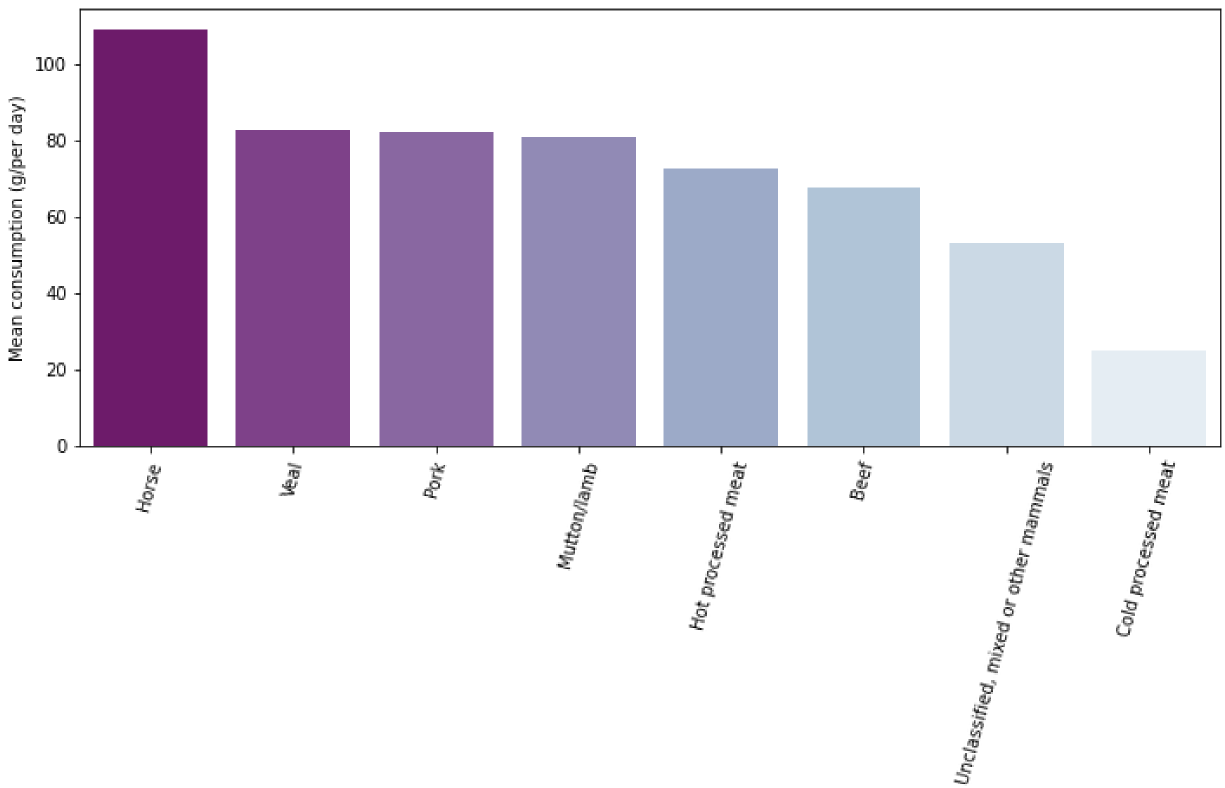
After filtering observations with red and processed meat consumption, it can be observed that cold processed meat is consumed the most frequently. 51.9% of the Dutch consume cold processed meat, followed by hot processed meat (23.5%), beef (10.4%) and pork (9.1%) (Figure 5).

Figure 5. *Frequency of Red and Processed Meat Consumption among the Dutch Population*



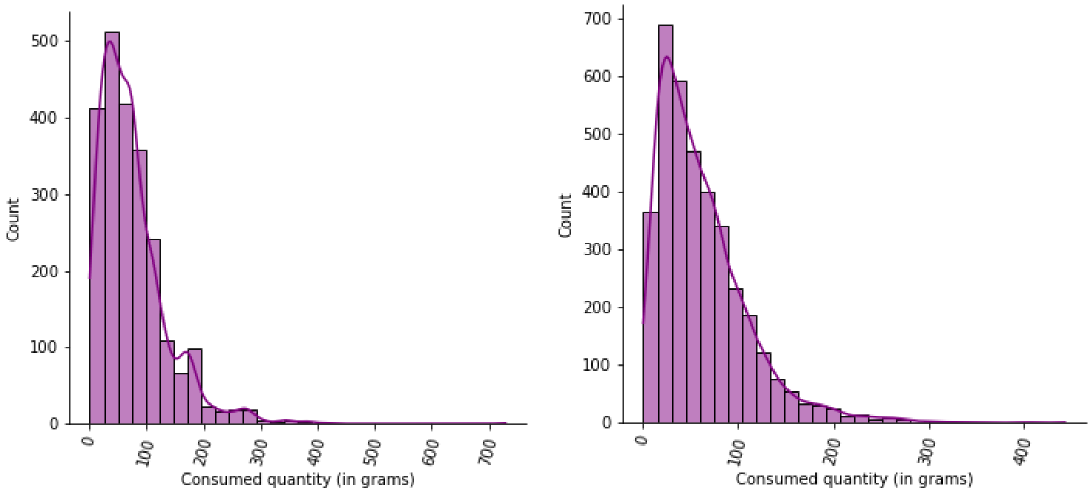
At the same time, a mean comparison shows that the highest average consumption is of horse meat with 109.2 grams per day while being the least frequently observed in the population. The average mean consumption of veal constitutes 82.7 grams per day while being the second least frequently consumed red meat type. The Dutch consume 25.19 grams per day of cold processed meat, 72.94 grams per day of hot processed meat, 67.76 grams per day of beef, 80.75 grams per day of lamb and 82.41 grams per day of pork (Figure 6). Thus, while cold processed meat is consumed by more than half of the Dutch population, the amount consumed is much smaller than the amount of beef or pork.

Figure 6. *Daily Mean Consumption of Different Types of Red and Processed Meat..*



The distributions of red and processed meat represent a long right tail with an average consumption per day of 75.1 grams and 61.8 grams, respectively (Figure 7). The standard deviation for red meat consumption is 60.05 grams, while for processed meat it equals 47.7 grams. At the same time, there is a clear presence of outliers. The maximum amount of red and processed meat consumed in the dataset amounts to 729 grams and 444 grams, respectively. An outlier is defined as three standard deviations from the mean of the population. In the dataset, 57 outliers out of 2,307 observations for red meat and 88 observations out of 3678 observations for processed meat were identified. The calculated kurtosis of the distribution is 17.9 and 18.3 for red and processed meat respectively. After removing the outliers from the dataset and recalculating them on a trimmed dataset, I obtain a similar number of outliers, which means that the distribution has indeed a fat right-tail.

Figure 7. *Distribution of Consumption of Red and Processed meat over the Dutch Population.*

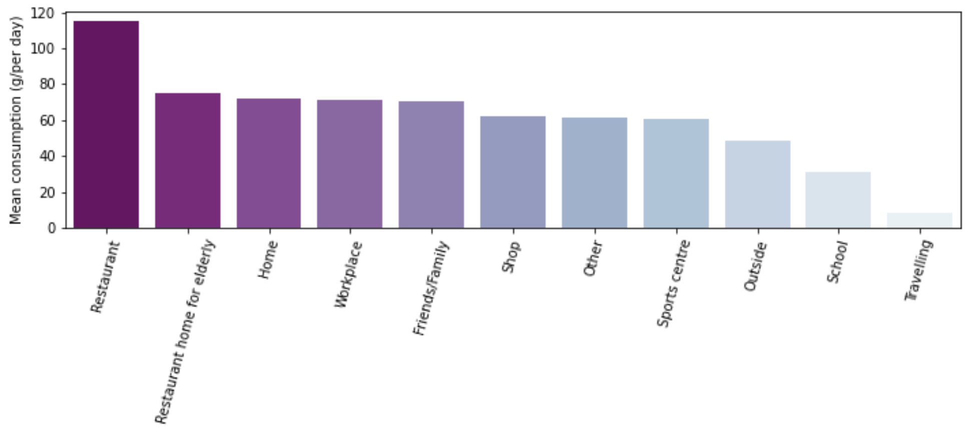


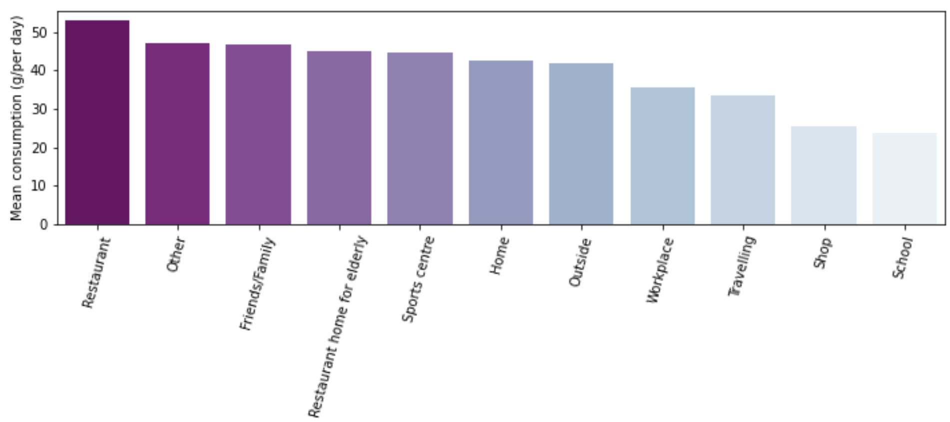
Note. Graph on the left represents red meat. Graph on the right represents processed meat.

5.2.2 Consumption by Place

For simplification, in the next sections, different types of red and processed meat are grouped into red and processed meat. Generally, the Dutch consume red and processed meat mostly at home. 85% and 71.6% of the population consumes red and processed meat at home. The second and third the most frequent place of consumption of red meat is at friends or family (7.1%) and restaurants (4.7%). At the same time, processed meat is mostly consumed at school (8.2%) and the workplace (7.0%) . In terms of consumption amount, an average of 114.85 grams per day of red meat is consumed at restaurants, followed by restaurant home for elderly (75 grams per day), and home (71.86 grams per day). Similarly, the biggest amount of processed meat is also consumed at the restaurants (52.82 grams per day), followed by other places (47.12 grams per day) and friends or family (46.78 grams per day) (Figure 8).

Figure 8. *Red and Processed Meat Consumption by Place.*



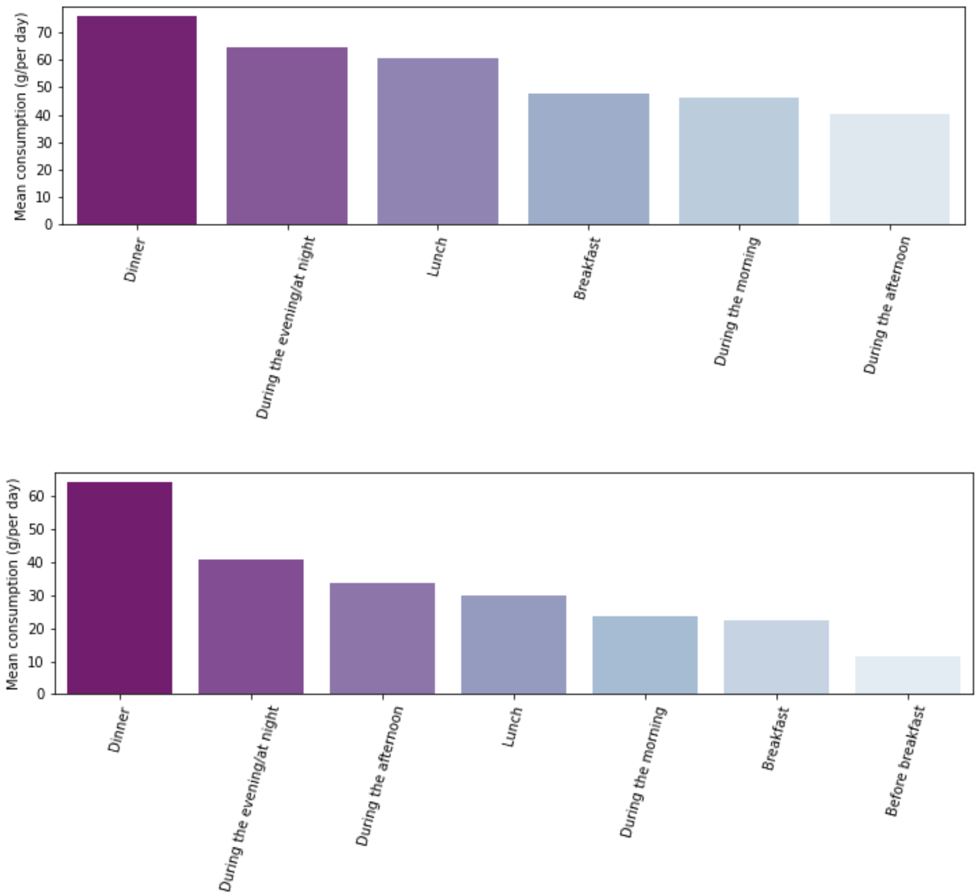


Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.2.3 Consumption by Occasion Time

Red meat is observed to be consumed the most frequently during dinner (87.1%), followed by lunch (8.7%) and during the evening or at night (1.7%). At the same time, processed meat is consumed mainly during lunch (36.8%), dinner (35.0%) and breakfast (16.3%) (see Figure 5). These numbers are consistent with the place of consumption. Since processed meat is usually used for snacks, it is often consumed during lunch at school or the workplace. In terms of consumption amount, 75.76 and 64.74 grams per day of red meat is consumed during dinner and the evening, respectively, followed by 60.65 grams per day during lunch. Processed meat is similarly consumed in the biggest amount during dinner and evening (64.17 and 40.73 grams per day respectively) (Figure 9).

Figure 9. *Red and Processed Meat Consumption by Occasion Time.*



Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.2.4 Consumption by Gender and Age Groups

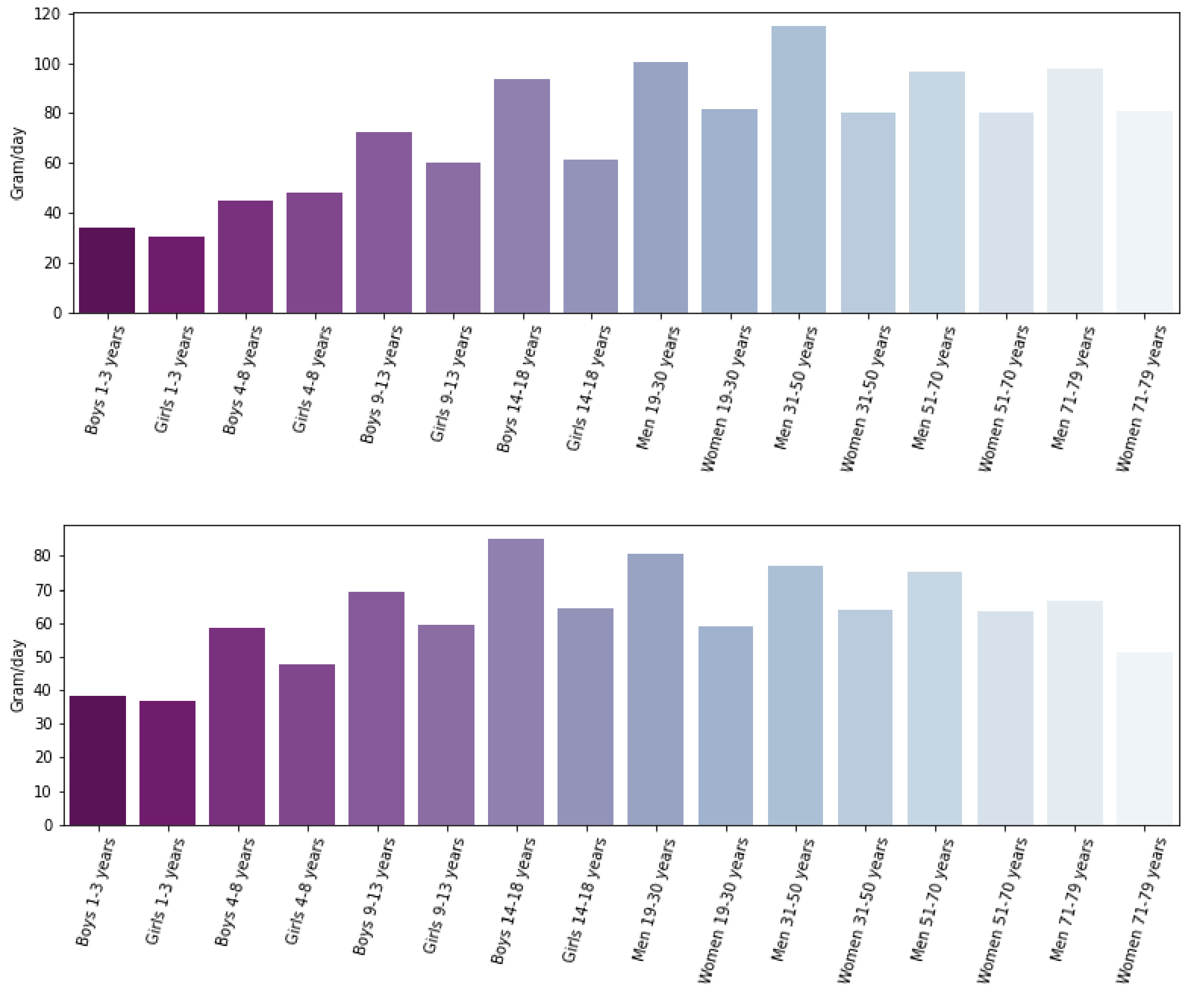
Both red and processed meat are consumed on average in a higher amount by males than females. Females consume red and processed meat by 18.67 grams and 13.24 grams per day less than males with an average of 65.4 and 55.1 grams per day. At the same time, the standard deviation of the distributions of consumption is higher for males.

The pattern of distribution of consumption by gender and age groups is similar for both red meat and processed meat, the difference constitutes only in the mean amount consumed, which is on average lower for processed meat. Men between 31 and 50 years old consume red meat in the biggest amount with an average of 114.8 gram per day. The second largest consumption group is men between 19 and 30 years old, who consume 100.59 grams per day. The third and fourth largest categories are men between 71 and 79 years old and 51 and 70 years old. The youngest groups of both genders consume the least of both red and processed meat.

Interestingly, processed meat is consumed much more among age groups between 4 and 18 years old of both genders compared to red meat. Males of 14-18 years old consume processed meat the most with an average amount of 85 grams per day. It can be related to the fact that processed meat could be used as a snack at school or workplace and is more consumed by younger males and females. In contrast, red meat is consumed more among older population. The second and the third largest categories are men 19-30 years and men 31-50 years with an average amount of 80.5 and 77 grams per day, respectively (see Figure 10).

Overall, there is a quite significant positive correlation between red and processed meat consumption and age (0.27), and negative correlation with gender (-0.16).

Figure 10. *Consumption of Red and Processed Meat by Age and Gender.*

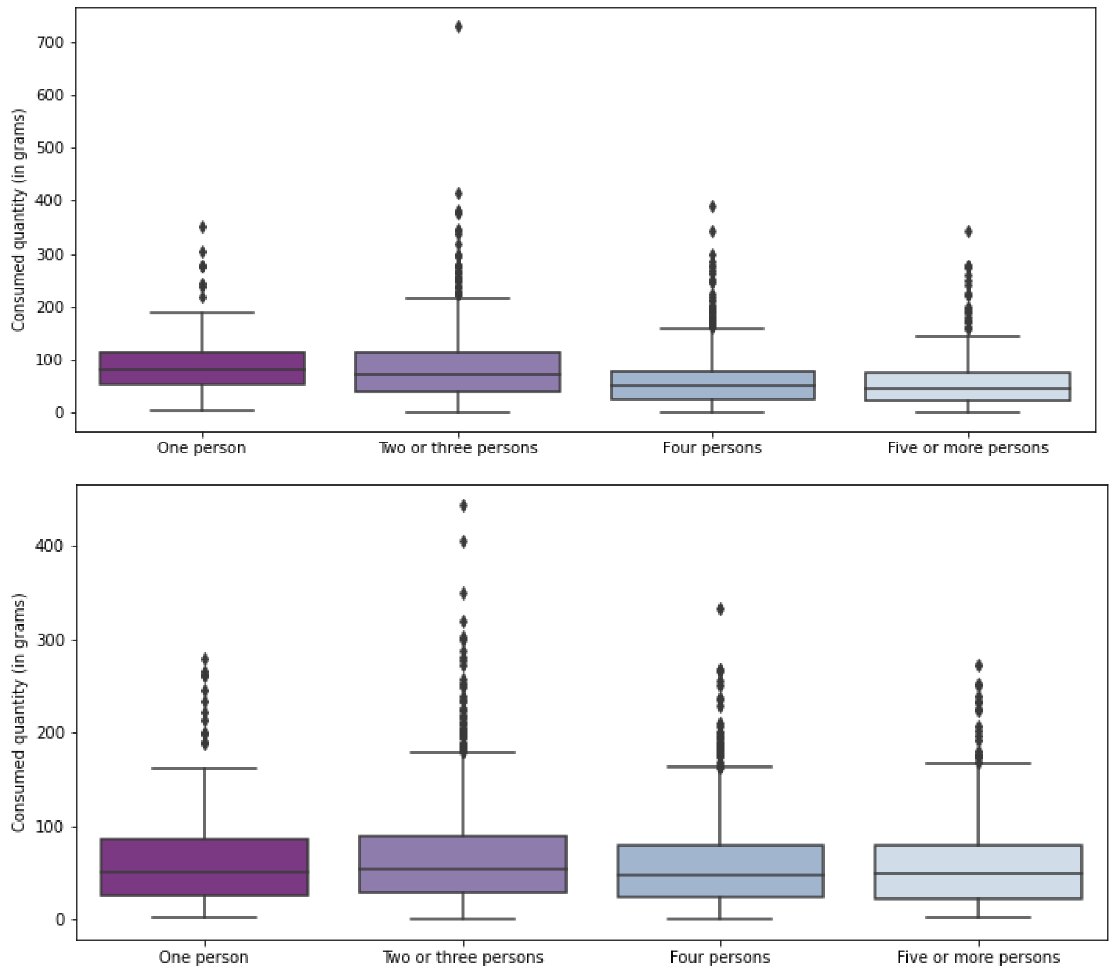


Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.2.5 Consumption by Household Size

On average, one person-households tend to consume more red meat than households of other sizes with an average amount of 90.56 grams per day. It is followed by households with two or three persons with an average of 83.9 grams per day of red meat Processed meat is consumed the most by households of two-three persons (65.6 grams per day). It is followed by one-personhouseholds with an average of 62.9 grams per day of processed meat. There seems to be a negative association between red and household size: the bigger the family, the less red meat they consume. However, it is not observed for the processed meat consumption (see Figure 11). The calculated correlation equals -0.18.

Figure 11. *Red and Processed Meat Consumption by Household Size.*



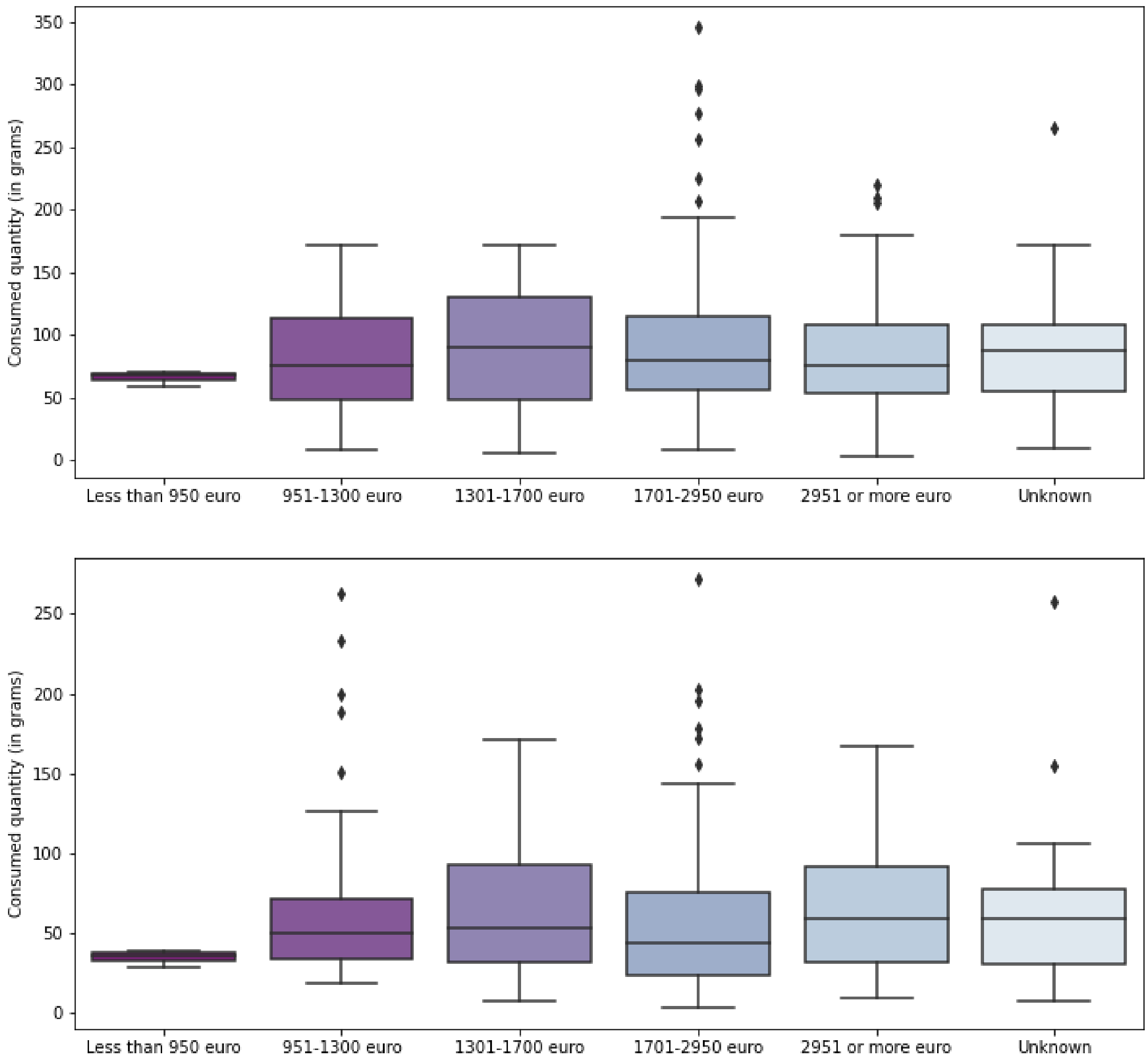
Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.2.6 Consumption by Household Income

Households with an income between 1,701 and 2,950 euros consume red meat the most with an average amount of 92.7 grams. This category of household income also has the highest standard deviation and the maximum amount consumed. The most vulnerable households with an income less than 950 euros consume red meat less than other income categories (65.6 grams per day). Interestingly, the wealthiest households with an income greater than 2,951 euros consume red meat slightly less that the middle-income households with an average of 85.8 grams. For processed meat consumption, the highest average amount of 67.8 grams per day is consumed by households with an income between 951 and 1,300 euros. Households with an income less than 950 euros consume processed meat the least with an average amount of 34.8 grams per day. Overall, there is no linear association between income and consumption of red and processed meat (see Figure 12). Household income is very weakly correlated with the consumption of red and processed meat (-0.012).

It is worth noting that for household income we have more than 85% of missing values for red and more than 87% for processed meat consumption. Moreover, we have also a quite large category of people who do not know or does not want to tell their income. These might negatively affect the validity of the results. Consequently, I cannot conclude based on the given data for household income and the identified relationship between red and processed meat consumption and household income. At the same time, the preliminary results based on the data available suggest that the highest burden of the tax might be placed on middle-income households rather than the poorest households based on the quantities consumed reported in the survey.

Figure 12. *Consumption of Red and Processed Meat by Household Income.*

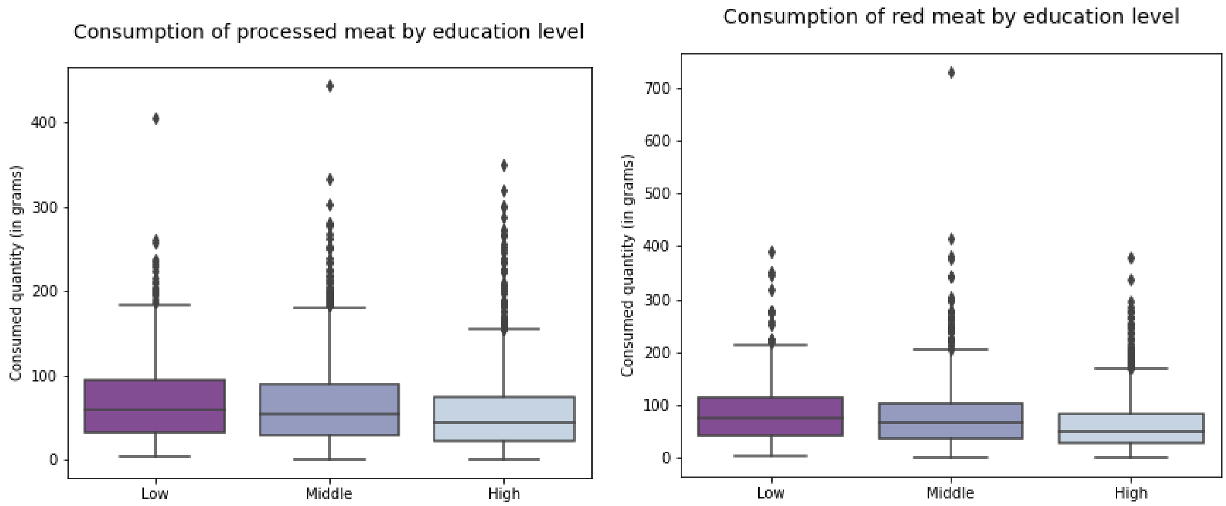


Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.2.7 Consumption by Education Level

Red and processed meat is consumed the most by households with low education level with an average amount of 85.7 and 68.8 grams per day respectively. Generally, there seems to be a negative association between education level and red and processed meat consumption: households with a higher level of education, on average, consume less red and processed meat (see Figure 13). The correlation between consumption and education level is calculated to be -0.14.

Figure 13. *Red and Processed Meat Consumption by Education level.*

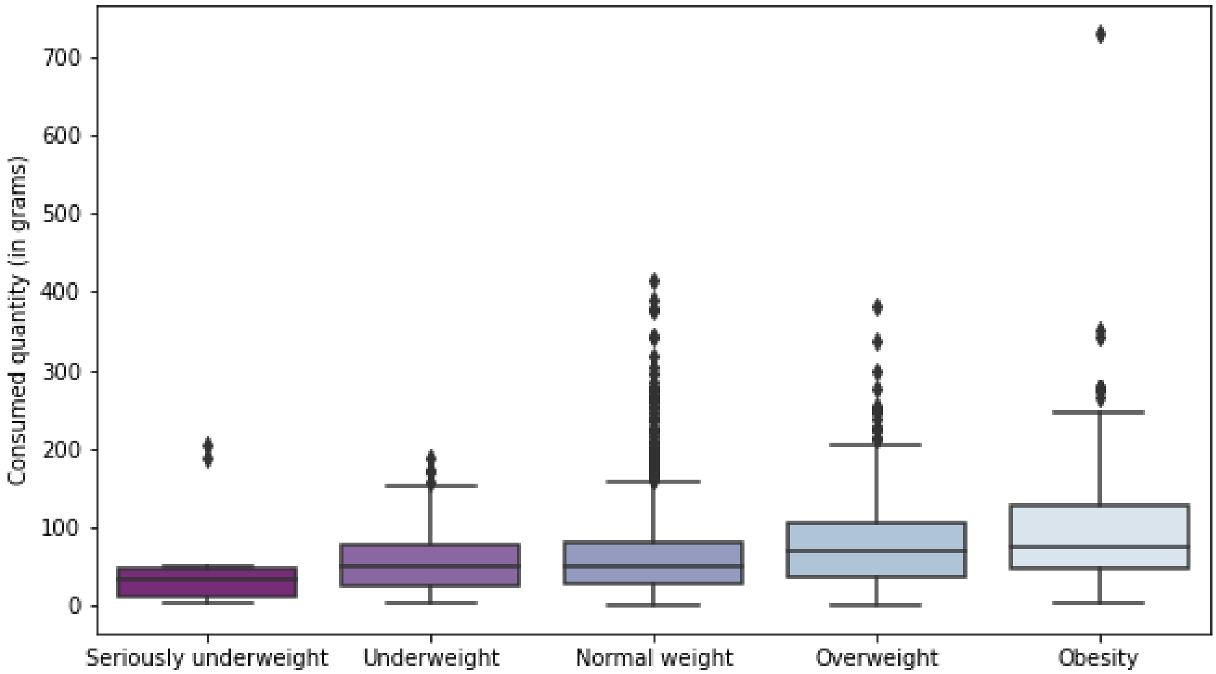


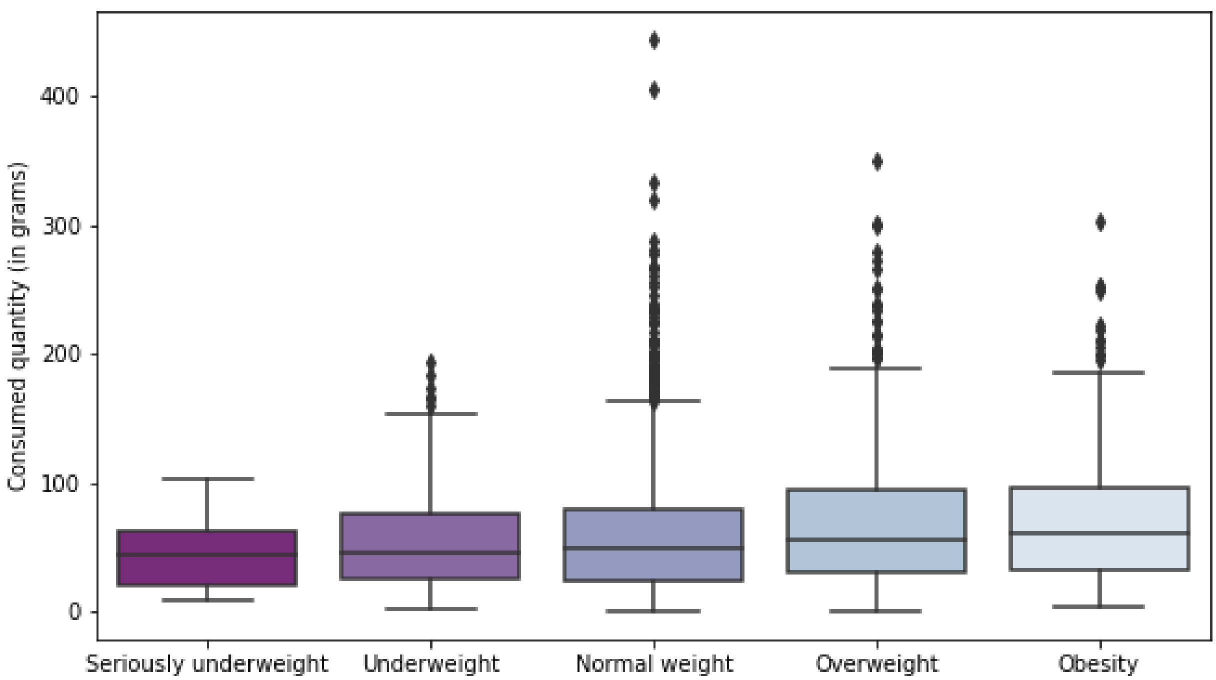
Note. Graph on the left represents red meat. Graph on the right represents processed meat.

5.2.8 Consumption by BMI Category

Both red and processed meat are consumed the most by people with obesity with an average amount of 100.3 and 70.6 grams per day, respectively. At the same time, seriously underweight people consume red and processed meat the least (51.5 and 43.4 grams per day, respectively). There seems to be a positive association between BMI category and red and processed meat consumption: people with a higher weight, on average, consume more red and processed meat (see Figure 14). However, the calculated correlation is quite low and equals -0.017.

Figure 14. *Consumption of Red and Processed Meat by BMI Category.*





Note. The upper graph represents red meat. The bottom graph represents processed meat.

5.3. Price Elasticities

A literature review of studies that explored attitudes of the Dutch population towards meat and meat substitutes was performed. Generally, the Dutch perceive meat as a part of a healthy diet and tend to underestimate the environmental impact of meat and dairy production (Geurts, van Bakel, van Rossum, de Boer & Ocké, 2016). Even though meat consumption has declined over the last years, people who consume meat substitutes constitute a very small proportion of the total population. Moreover, through a focus group, it was found that the majority of people follow traditional eating habits and are not willing to change them (Weinrich, 2018). Overall, meat remains an important part of a daily diet for the majority of people and is perceived as an important source of protein. Thus, based on the available information, I can assume that the price elasticity of demand in the Netherlands should be between zero and minus one and thus, be inelastic. This means that the demand for meat will decrease by less than the price would increase.

The compensated own-price elasticities for different types of red meat and processed meat and mean values are presented in Table 2. Table 3 presents income elasticities of demand for red and processed meat. The values from tables 2 and 3 will be used for estimating the uncompensated elasticities with the Slutsky equation.

The studies that provide information on own-price and income elasticities mainly used meta-analysis and Almost Ideal Demand System (AIDS) models to estimate the values. However, the most common meat types in the literature are beef, pork, lamb and processed meat. Thus, the further calculations would be restricted only to these types of meat.

Gallet (2010) selected 419 studies and performed a meta-regression. The studies included different types of data (time-series, cross-sectional, panel, etc.), models (AIDS, double-log, semi-log, etc.), and world regions (with North America being the dominant region, followed by Europe). Gallet (2010) reports a median price elasticity for beef of -0.869, pork of -0.78, lamb of -0.94, and meat of -0.71. Säll and Gren (2015) used a non-linear AIDS model to estimate demand for meat and dairy products in Sweden based on the data provided by the Swedish Board of Agriculture between 1980 and 2012. The price elasticity of beef and pork was found to be -0.661 and -0.562, respectively. Thiele (2008) also used the AIDS model with cross-sectional data of 12,000 German households. The study reports both compensated and uncompensated price elasticities for beef, pork, and processed meat. The values of compensated elasticities are -0.53, -0.83, and -0.92 respectively. The study finds that processed meat is the most sensitive to price change across all groups of meat. Rahbauer, Staudigel & Roosen (2018), similarly to Thiele (2008), estimated price elasticities of demand for meats for Germany using the AIDS model. However, in this case, they used panel data of 21,656 households provided by the GfK, a market research institute, that receives scans of all purchases by the participating households and performs surveys on the socio-demographic characteristics of these households. A compensated price elasticity of -1.2 and -0.71 was estimated for beef and pork, respectively. Gallet (2012) performed another meta-analysis of 362 studies to reveal regional differences in price elasticities for meat. Similar to Gallet (2010), different models, types of data, and regions were used. The price elasticities for beef, pork, and lamb in Europe were estimated to be -0.150, -0.104, and -0.116 respectively. Muhammad, D'Souza, Meade, Micha & Mozaffarian (2017) estimated price and income elasticities for different food categories and regions using the Global Dietary Database for 2010. Differently from the above-mentioned studies, Muhammad, et.al (2017) chose a semi-log quadratic functional form to calculate the values. In Western countries, processed meat has a price elasticity of -0.2 and income elasticity of -0.003. Finally, the income elasticity of demand for meat was estimated by Gallet (2012) using a meta-analysis of 393 studies. Beef, pork, and lamb were found to have income elasticities of 0.008, -0.175, and -0.146 respectively.

Data from Tables 2 and 3 can provide useful information. First, the reported values of the elasticities vary significantly across studies. This can be explained by the differences related to the types of data used, estimation errors, and periods of the data. Second, all reported own- and cross-price elasticities for different types of red meat and processed meat are below one, which means that demand for these goods is inelastic. The exception is the own-price elasticity of -1.20 reported by Rahbauer, et al. (2018). However, when the average elasticities across the studies are calculated, the absolute value does not exceed one. Third, the cross-price elasticities can be either higher or lower than the own-price elasticities. The average sign of the cross-price elasticities is positive, showing that these types of meats are substitutes and the consumers tend to switch within these groups when the price of one of the types of meat increases. Fourth, on average, the highest own-price elasticity is for beef, meaning that this type of red meat is the most sensitive to price changes. The second most sensitive type of red meat is pork, followed by lamb and processed meat. Fifth, the income elasticity of demand for pork, lamb, and processed meat is negative, meaning that the demand for these goods decreases when the disposable income of consumers rises. Even though the values are quite close to zero, these goods seem to be inferior goods. In contrast, beef has a positive sign of income elasticity, which means that it is a normal good and demand for it grows when income increases. However, the value of the elasticity is very small.

Table 2. *Own- and Cross-Price Elasticities of Demand Reported by Academic Studies*.

	Beef	**Pork**	**Lamb**	**Processed meat**
Beef	-0,869 -0,661 -0,42 -1,2 -0,15 **Mean: -0.66**	-0,368 0,03 0,7 **Mean: -0.66**		
Pork	-0,197 0,12 0,24	-0,78 -0,562 -0,59 -0,71		
Lamb	**Mean: -0.66**	**Mean: -0.66**	-0,94 -0,116 **Mean: -0.66**	
Processed meat	0,92	0,87		-0,16 -0,2 **Mean: -0.66**

Note. Legend: black (Gallet, 2010), red (Säll, et al., 2015), green (Thiele, 2008), blue (Rahbauer, et al., 2018), brown (Gallet, 2012), yellow (Muhammad, et al., 2017). Mean values are calculated where more than one price elasticities was reported across different studies.

Table 3. *Income Elasticities of Demand Reported by Academic Studies.*

	Beef	**Pork**	**Lamb**	**Processed meat**
Beef	0,008			
Pork		-0,175		
Lamb			-0,146	
Processed meat				-0,003

Note. Legend: black (Gallet, 2010), red (Muhammad, et al., 2017).

Finally, I used the data on average annual spending share of the Dutch households on beef, pork, lamb and processed meat published by the Statistics Netherlands. In 2015, beef consumption accounted for 0.4% of the total household expenditures, pork – 0.3%, lamb - 0.1%, and processed meat – 0.5% (CBS Statline, 2019).

I calculate uncompensated price elasticities as follows:

(1) Beef

$$\varepsilon = -0{,}66 - 0{,}008 * 0{,}4 = -0{,}6632$$

(2) Pork

$$\varepsilon = -0{,}54 - (-0{,}1755) * 0{,}3 = -0{,}487$$

(3) Lamb

$$\varepsilon = -0{,}52 - (-0{,}146) * 0{,}1 = -0{,}5054$$

(4) Processed meat

$$\varepsilon = -0{,}18 - (-0{,}003) * 0{,}5 = -0{,}1785$$

5.4 Results

5.4.1 Effects of the Tax on the Consumption

Three tax scenarios were modeled to estimate the effect of the price increase on the consumption of red and processed meat in the Netherlands. First, I apply the 12% rate, which, in sum, is equivalent to the highest VAT rate of 21% in the Netherlands. Second, I apply a tax rate of 18%, which, in sum, is equivalent to the highest VAT tax rate of 27% among OECD countries (OECD, 2020). Third, I apply a 30% tax rate as it is frequently used in other modeling studies of a tax on red meat (Broeks, et al., 2020). It is worth noting that in the third tax scenario, a 30% tax is not considered as a VAT tax increase but as a sales tax. Thus, the tax rate is applied to the producer's price, and then the reduced VAT rate is applied to the increased price. The tax policy design considerations will be discussed in the next chapter.

To calculate the total annual change in consumption of red and processed meat after the price increase, I use the average quantity consumed per person per day in grams obtained from the Dutch National Consumption Survey. To calculate the total annual red and processed meat consumption, I estimate the total number of people in the Netherlands that consume meat. The Dutch National Consumption Survey reports that around 2.75% of the total population of the Netherlands are either vegetarians or vegans and, thus, approximately 16.4 million people consume meat in the Netherlands (Worldometer, n.d.). The average number of days per week of red and processed meat consumption is estimated using the reported consumption days in the dataset. The target food items are consumed either zero, one, or two days out of the two recall days. I estimate the average value of the reported consumption days as a percentage and convert them into the number of days per week. The total annual consumption for each item is multiplied by the average number of days per week, four weeks, and twelve months. To calculate the percentage change in consumption after the price increase, I multiply the percentage change in price by the elasticities.

$$\Delta q = \Delta p * \varepsilon$$

The results are presented in Table 4.

Table 4. *Change in Consumption of Red and Processed Meat in the Three Tax Scenarios.*

	Daily average consumption per person (grams)	**Total annual consumption (kg)**	**% change in q-ty (12% tax)**	**Change in q-ty (kg) (12% tax)**	**% change in q-ty (18% tax)**	**Change in q-ty (kg) (18% tax)**	**% change in q-ty (30% tax)**	**Change in q-ty (kg) (30% tax)**
Beef	69,72	16.666.681	-7,96%	(1.326.334)	-11,94%	(1.989.502)	-19,99%	(3.331.003)
Pork	83,07	42.025.497	-5,84%	(2.455.970)	-8,77%	(3.683.955)	-14,61%	(6.139.925)
Lamb	80,40	57.927	-6,06%	(3.513)	-9,10%	(5.270)	-15,16%	(8.783)
Processed meat	61,80	200.313.483	-2,14%	(4.290.715)	-3,21%	(6.436.072)	-5,36%	(10.726.787)
Total	**294,99**	**259.063.588**		**(8.076.532)**		**(12.114.799)**		**(20.206.498)**

Note. The table presents the results of the calculations based on the uncompensated elasticities and average daily consumption per person in the three tax scenarios.

I find that with a 12% tax rate, beef consumption will decrease by 7.9%, pork – by 5.8%, lamb – by 6.1%, and processed meat – by 2.1%. It is equivalent to a reduction of 0.28 kg in per capita annual beef consumption, 0.58 kg in pork consumption, 0.016 kg in lamb consumption, and 0,3 kg in processed meat consumption. An annual decrease in red and processed meat consumption is expected to be 8,076 tons. In an 18% tax rate scenario, beef consumption is expected to decline by 11.9%, pork consumption – by 8.7%, lamb consumption – by 9.1%, and processed meat – by 3.2%. The change in quantities consumed is equivalent to 0.42 kg, 0.87 kg, 0.024 kg, and 0.45 kg per person, respectively. The total annual drop in red and processed meat consumption was calculated to equal 12,114 tons. As expected, a 30% tax rate resulted in the highest decline in consumption. The 30% tax rate affected beef consumption by 19.9%, pork consumption – by 14.6%, lamb consumption – by 15.1%, and processed meat consumption – by 5.3%. It is expected that annual beef consumption per person would decrease by 0.7 kg, pork – by 1.4, lamb – by 0.04 kg, and processed meat – by 0.76 kg. A total reduction in red and processed meat consumption after introducing a 30% tax rate amounts to 20,206 tons.

5.4.2 Effects of the Tax on Budget Revenues

An increased tax is expected to result in higher budget revenues. The total effect of the three tax scenarios is calculated as the new tax income minus the loss of income due to reduced consumption.

$$\text{Budget revenue} = q_1 * (p_1 - p_0),$$

Where p_0 is the initial price, p_1 is the increased price, q_1 is the quantity consumed after the price increase.

Since the prices for red and processed meat were not included in the data from the Dutch National Consumption Survey, I extracted average prices from the Albert Heijn website, which is the biggest supermarket chain in the Netherlands. Albert Heijn had a market share of 34.9% in 2019, and online prices could be representative for the whole country (Coppola, 2020). To estimate the average prices for 2015, I used Consumer Price Index from the Statistics Netherlands (CBS Statline, 2021). The results are reported in Table 5.

Table 5. *Budget Revenues in the Three Tax Scenarios.*

	Average price (euros)	Total revenues (12% tax) (euros)	Total revenues (18% tax) (euros)	Total revenues (30% tax) (euros)
Beef	11,85	21.813.973	26.088.686	47.408.336
Pork	8,08	38.366.613	46.469.949	86.986.626
Lamb	20,44	133.468	161.448	301.353
Processed meat	14,26	335.434.161	414.703.781	811.051.885
Total		**395.748.215**	**487.423.865**	**945.748.200**

Note. The table presents the results of the calculations based on the average price of different types of red and processed meat and change in consumption after the tax introduction.

It is estimated that a price increase of 12% for red and processed meat would result in annual flow of budget revenues of 395.7 million euros. A higher tax rate is associated with a higher tax revenue. The total budget revenues in 18% tax rate scenario are calculated to amount to 487.4 million euros, while in 30% tax rate scenario – 945.7 million euros. Thus, I would propose introducing a 30% tax rate on red and processed meat that would result in an annual drop in consumption of 20,206 tons and 945.7 million euros of budget revenues.

5.4.3 Effects of the Tax on the Environment

First, to estimate the reduction in the GHG emissions as a result of the decreased consumption after the price increase, I multiply the amount of CO2 equivalents per kg of the targeted food item by the difference between consumption before and after price decrease in the three tax scenarios. In addition, several assumptions are made. Following CE Delft (2018), I assume that processed meat consists of 65% of pork, 20% of beef, and 15% of poultry meat. I calculate the CO2 equivalents per kg of processed meat according to the above-mentioned proportions. Moreover, it is considered that beef consumption consists of 75% of veal (dairy bread) and 25% of beef (mature bread) (Bruyn, Warringa & Odegard, 2018).

The baseline value of the total GHG emissions in the Netherlands is taken from the Statistics Netherlands for 2018, and it amounts to 189.3 billion of CO2 equivalents (CBS Statline, 2019). Second, I calculate the decrease in the social cost caused by GHG emissions. Monetization of the social costs of climate change is very complex and difficult to estimate. Consequently, estimates vary significantly across studies (Wang, Deng, Zhou & Yu, 2019). For these reasons, I use the value of the social cost per kg of the CO2 equivalents estimated by Bruyn, et al. (2018) for the Netherlands of 0.094 euros. The results are presented in Table 6 below.

Table 6. *Effects on the GHG in the Three Tax Scenarios.*

	CO2 equivalents per kg	**Social cost per kg (euros)**	**Total CO2 equivalents reduction (12% tax)**	**Total social cost reduction (euros) (12% tax)**	**Total CO2 equivalents reduction (18% tax)**	**Total social cost reduction (euros) (18% tax)**	**Total CO2 equivalents reduction (30% tax)**	**Total social cost reduction (euros) (18% tax)**
Beef	30,75	2,89	(40.784.785)	(117.888.422)	(61.177.178)	(176.832.632)	(102.428.338)	(296.069.112)
Pork	7,00	0,66	(17.191.790)	(11.312.198)	(25.787.685)	(16.968.297)	(42.979.476)	(28.280.495)
Lamb	24,00	2,26	(84.305)	(190.192)	(126.472)	(285.320)	(210.791)	(475.544)
Processed meat	17,45	1,64	(74.872.973)	(122.814.138)	(112.309.460)	(184.221.207)	(187.182.433)	(307.035.345)
Total	**79,20**	**7,44**	**(132.933.854)**	**(252.204.950)**	**(199.400.795)**	**(378.307.456)**	**(332.801.038)**	**(631.860.496)**
% of total GHG emissions			**-0,07%**		**-0,11%**		**-0,18%**	

Note. The table presents the results of the calculations of the effect of the three tax scenarios on the reduction of the GHG emissions and social cost of GHG emissions.

A shown in Table 7, beef production is responsible for the highest amount of CO2 equivalents per kg of the product (30.75), followed by lamb (24), and processed meat (17.45). As expected, the largest reduction in the CO2 equivalents per kg of the food item comes from processed meat since it has biggest share in the total red meat consumption. Overall, a 12% tax on red and processed meat could result in a total reduction of 132.9 million of CO2 equivalents, which would contribute to 0.07% decrease in the total GHG emissions in the Netherlands. In case of a 18% and 30% tax scenarios, the total GHG emissions could be reduced by 199.4 and 332.8 millions CO2 equivalents or by 0.11% and 0.18% respectively. It is estimated that the reduction in the GHG emissions after the price increase in the three tax scenarios would be equivalent to 252.2 – 631.8 million euros decrease in the social costs caused by the climate change. The 30% tax rate scenario results both in the highest GHG emissions and social costs from the climate change decrease.

6 Tax Policy Design

The effects of the introduction of the tax on red and processed meat would be also determined by the way the policy was designed and implemented. Thus, it is important to consider different types of taxes that can be levied on the red and processed meat, as well as analyze their strengths and weaknesses. Taxes do not only increase budget revenues and can have a positive impact on social welfare but also can distort the economy. Consequently, all the possible consequences have to be carefully analyzed from the perspective of all parties involved, including consumers, producers, and the government.

The aim of the tax on red and processed meat stated in this thesis was to mitigate negative health and environmental consequences, as well as increase budget revenues that can be used for further promoting environmentally friendly production and healthy diets. These can be achieved through a carbon tax, VAT tax, sales tax, and excise tax. The advantages and disadvantages of each type of tax and its current implementation in the Netherlands will be discussed in this section. As per WHO guidelines, if taxation aims to decrease consumption, then the price increase should happen at the selling point (World Health Organization, 2015). For instance, depending on the business interest, the producers might choose not to increase the final price by the total amount of the new tax. It mainly happens if the market is highly competitive, and the producer wants to keep its market share while decreasing its revenue because of additional costs. This situation may lead to higher government revenues; however, it will not impact the demand since the final consumer price will not change. Moreover, it depends on the elasticity of demand and elasticity of supply of the particular product. However, compared to price elasticities of demand, supply elasticities are rarely estimated in the academic literature. Thus, it is difficult to predict who will bear the burden of the tax on red and processed meat. This imposes a limitation on this study.

It is worth noting that different types of taxes are not mutually exclusive. For instance, there are certain goods on which both excise and VAT taxes or CO2 and VAT taxes are paid. Thus, a combination of two types of taxes can be applied to achieve the stated aims. Furthermore, a new innovative approach to consumption taxes may be needed.

6.1 Comparison of Different Types of Taxes

6.1.1 Carbon Tax

The main goal of a carbon tax is to reduce greenhouse gas emissions. It is imposed on producers by increasing their production costs that translate into higher consumer prices and, thus, lower demand, and is a type of indirect tax. A carbon tax is a type of Pigouvian tax since it aims to outweigh the effect of negative externalities, namely pollution. Typically, the tax is imposed on companies that burn fossil fuels such as coal, oil, gasoline, and natural gas. In turn, the process of burning fuels is causing CO2 emissions that are heating the atmosphere.

Taking into consideration the plan to introduce a CO2 tax and a comprehensive set of measures to reduce negative externalities of agricultural production, it is not a feasible way to discourage consumption through a carbon tax. First, the carbon would be paid by producers, and it is not known if the full amount of the taxes would be passed through on to final consumers of red and processed meat. Consequently, such type of tax is not likely to impact the consumption of red and processed meat and, thus, would not achieve one of the aims of the tax policy. Secondly, because of an additional tax, the burden put on farmers and meat producers might be significant enough to cause negative economic consequences. The costs of production directly impact the revenues and, in turn, the economic and social welfare. While the tax can incentivize the producers to innovate and improve their efficiency, it can also introduce unfavorable economic consequences for the whole population.

To conclude, the solutions proposed by the government of the Netherlands that imply support for farmers to decrease CO2 emissions by introducing innovations seem to be a more rational solution than just simply taxing them.

6.1.2 VAT Tax

VAT tax, another type of indirect tax, is imposed at every stage of production when value is added until the final consumer. The tax is applied to all goods and services produced in the country. Currently, there are three VAT rates in the Netherlands: 0%, 9%, and 21%. A 0% rate is mainly applied to services, such as international passenger transport, cross-border transactions, and exports of Dutch goods to the other EU countries. A 9%-VAT is considered to be a reduced rate, and it applies to books and medicines, food and beverages, including livestock. At the same time, a 21% rate applies to everything that is not covered by reduced rates (Tax Authorities of the Netherlands, n.d.).

The main disadvantage of the VAT tax is that it applies to all goods, and thus, it cannot generate a large differential between prices for different goods and impact consumption (World Health Organization, 2015). On the other hand, the main advantage of the tax is that it is applied on every stage of the supply chain only on the value-added and does not generate a cascade effect when on the next stage a tax is levied on a good with already a tax included. In the case of a VAT tax, to achieve the goal of lowering consumption of red and processed meat and promoting healthy eating, the tax should be reduced for fruit and vegetables and increased for red and processed meat. For instance, such a practice was already implemented in other EU countries and can be followed by the Netherlands (European Commission, 2020). At the same time, VAT is a type of tax that is subject to the EU regulations, and each country cannot freely change the rate, which makes the implementation of the policy more difficult. According to this regulation, the standard and reduced rate cannot be lower than 15% and 5%, respectively (Your Europe, 2021). Thus, the VAT rate for fruits and vegetables can be maximum reduced by 4%. Consequently, changing the VAT rates is a much more complex process that does not necessarily will change consumption patterns.

6.1.3 Excise Tax

In contrast to VAT, an excise tax is imposed immediately at the time of production and is incorporated in the final price of the goods and is paid by producers. There are two types of excise tax: specific and ad valorem.

Specific excise tax is applied to the quantity of the goods produced. For instance, a certain amount of tax per ton or liters produced of the good. In the Netherlands, an excise tax is paid on alcohol, tobacco products, and mineral oils (Dutch government information for entrepreneurs, 2020). Generally, specific excise taxes generate quite predictable government revenue but it is not adjusted for inflation since it is paid only per amount produced. At the same time, the tax is applied with no difference in the quality of the product and thus, the producers might have an incentive to create a competitive advantage. Moreover, producers might choose to alter the content of the good to pay less of excise tax.

Ad valorem excise tax, on the opposite, is paid as a percentage of the price of the consumers and is automatically adjusted for inflation. However, it more significantly impacts the profit margin of the producers and might lead to higher damage for businesses, as well as might not generate a stable revenue flow (World Health Organization, 2015).

Overall, an excise tax is more complex than a VAT tax. For instance, in case of the specific excise tax, the certain amount of the nutrients should be determined as a base for the tax. This might be similar to a tax on saturated fat in Denmark. Ad valorem tax, as in case of a carbon tax, would not be applied at the selling point and thus, would probably not impact the consumption significantly.

6.1.4 Sales Tax

A sales tax, different from VAT and excise taxes, is imposed during the final sale and is paid by the end consumers, not at each stage of the supply chain. The following goods in the Netherlands have a sales tax: fruit and vegetable juices, soft drinks, and mineral water (Customs Administration of the Netherlands, n.d.).

The sales tax seems to be the most feasible way to implement the tax policy. First, the tax would be paid by the final consumer, and there can be a large price differential between the targeted product and other healthier options, while the environmental impact would be outweighed by the CO2 tax paid by the producers as per the new legislation introduced by the government of the Netherlands. Secondly, taking into account that red and processed meat is consumed mostly at home (85% and 71.6%, respectively), the main selling points are supermarkets and butchers where the sales tax is charged. The fiscal obligation can be also extended to the restaurants, cafes, canteens, and other outdoor eating places to cover the remaining percentage of consumption that does not occur at home. Thus, the tax can directly impact the consumption of red and processed meat by households.

Table 7 summarizes the strengths and weakness of the above discussed taxes with respect to red and processed meat consumption.

Table 7. *Strengths and Weaknesses of Different Types of Taxes on Red and Processed Meat.*

Type of the tax	Advantages	Disadvantages	Implementation in the Netherlands
CO2 tax	Incentivize the producers to be more environmentally responsible and innovative through increase of the costs and competition	1.The tax might not be passed fully on to the consumers 2. The consumers might not alter the consumption 3. The tax can distort economic equilibrium and affect economic welfare	Should have been implemented in 2021 on the top of the European Emission Trading System
Excise tax: specific	1. Generates stable flow of government revenues 2. Incentivizes the producers to be more environmentally responsible and innovative through increase of the costs and competition	1. The tax is not adjusted for inflation; 2. The amount that falls under the tax can be manipulated by the producers 3. May not be fully passed on to consumers and thus, not impact the consumption	Applied to alcohol, tobacco products and mineral oils
Excise tax: ad valorem	1. The tax is adjusted for inflation 2. Incentivizes the producers to be more environmentally responsible and innovative through increase of the costs and competition	1.Generates a more unpredictable flow of revenues 2. The tax can be more distorting for businesses 3. The tax does not create incentives for producing higher quality goods	
VAT tax	Does not generate cascade effect	Does not affect consumption behavior since is applied to all goods	0%, 9% and 21% for all goods
Sales tax	The tax is paid by the final consumer and thus, the consumption is likely to decrease	1. The tax may affect revenues of selling points 2. The tax may be regressive	Applied to fruit and vegetable juices, soft drinks and mineral water

Note. The table summarizes the strengths and weaknesses of different types of taxes discussed in this chapter.

Moreover, based on the calculations from the previous chapter, it can be seen that a 30% sales tax generates a higher revenue and impacts red and processed meat consumption more significantly. Through the channel of the decreased consumption, it also affects the environmental footprint. Thus, based on the quantitative evidence and theoretical considerations of strengths and weaknesses of different types of taxes, I suggest that a 30% sales tax on red and processed meat should be introduced.

6.2. Other Policy Considerations

As mentioned in Chapter 2, multiple studies found that the biggest impact on overall diet quality could be achieved through a combination of a tax on red and processed meat and subsidies for other healthier options such as fruit and vegetables. Thus, the policy revenues from the tax on red and processed meat could be used to subsidize other categories of food that would lead to better health outcomes (World Health Organization, 2015).

This thesis does not address the distributional effects of the proposed tax policy. However, they are worth mentioning. Lack of accessibility to the data about expenditure share on food by different income groups represents a serious challenge. To approximate the possible effects of the tax, I consider the statistics for Denmark. Both countries have a very similar spending share on food (12% for the Netherlands and 11% for Denmark), as well as comparable household disposable income (Economic Research Service, 2021). According to the data from the Household Budget Survey from Denmark, expenditure on food for the lowest-income households amounts to between 6.8% and 10.9% of the total disposable income, whereas the expenditure for the highest-income groups equals around 5.5% (Statistics Denmark, 2019). Thus, the price impact for the poorest households can be as much as twice higher than for the richest households. At the same time, as the consumption data from the Netherlands suggests, the lowest-income households tend to consume the smallest amount of red meat, followed by the highest-income group among the five income categories. Thus, the main burden falls on middle-income households. At the same time, a tax on processed meat might disproportionally affect the second-lowest income group that was found to consume the highest amount of processed meat. Overall, no clear linear association was found between the income and red and processed meat consumption due to lack of data. However, as mentioned in the literature review, several studies found that the long-term positive impacts on the health outcomes for the lowest-income groups can outweigh the financial burden. Moreover, the undesirable regressive effects of the tax can be mitigated through additional subsidies targeted at the most vulnerable citizens. Overall, additional research is required that would focus on the distributional effects of the tax on red and processed meat before the policy could be implemented.

Policy costs and implementation issues might represent another challenge for the proposed policy. The final costs of the policy will depend on the type of tax that was chosen and the overall policy design that might also include subsidies for healthier foods. The thesis focused only on the strengths and weaknesses of the different types of consumption taxes and did not quantify the costs. However, another paper that focused on the effects of the tax on meat estimated that a 30% tax would result in 20 million euros of policy costs and 19.7 billion euros of policy revenues over 30 years (Broeks, et al., 2020). Thus, the policy revenues, as well as additional welfare benefits for the government, such as reduced healthcare costs and increased productivity, significantly exceeds the costs of the policy implementation.

Policy implementation issues should be carefully considered since it was one of the reasons why the tax on saturated fat was abolished in Denmark (World Health Organization, 2020). Mainly, cross-border trade and farm gate sales scenarios should be taken into account. These considerations are crucial since they may result in a zero effect of the policy, both for consumption and government revenues. The tax policy should put attention on collecting taxes on farms that directly sell to the end customers. Farm sales could remain untaxed in the new tax policy scenario. To avoid this issue, a special entity could be appointed to be in charge of monitoring the compliance of the farms to the new tax rules.

Cross-border trade represents another challenge for collecting revenues. According to a recent report, food, and beverages, online purchases account for around 30% of the total goods and services ordered online (European Commission, 2018). At the same time, cross-border purchases account for 22,8% of the total online sales (Cross-Border Commerce Europe, 2019). It is predicted that a price increase for red and processed meat could result in the intensification of online cross-border purchases. However, for cross-border e-commerce that should not be an issue since starting from the July,1, 2021 new VAT rules for e-commerce will come into force developed by the EU commission. The main benefit of the new VAT rules is that the tax will be paid at the place of the final consumer (European Commission, n.d.). Thus, the tax on red and processed meat would also be under these regulations. A higher concern is related to traditional cross-border shopping. When a tax covers a smaller jurisdiction, it is more likely that the cross-border sales will increase after the price change, while the larger area decreases the effect of the cross-border sales. Moreover, the extent of the cross-border sale would depend on the availability of efficient public and private transport, the willingness of the consumers to bear opportunity costs related to the traveling time, location of the shops outside the tax jurisdiction, etc. (World Bank, 2020). To decrease the possible cross-border trade effects, the tax policy should be accompanied by raising the awareness of the citizens about the health and environmental impact of red and processed meat consumption. If the consumers will decrease consumption not only due to the price change but also due to voluntary decisions, then cross-border sales are not likely to represent an issue. The data from Hungary suggests that people report an increased awareness about the health impact of nutrients intake (World Health Organization, 2015).

Moreover, an educational policy is also important for raising awareness of the population about the intake of different nutrients and their impact on the organism. While there is a growing number of scientific studies, as well as WHO and national healthcare systems recommendations, consumers are not always aware of the impact of certain foods on their health. The data from the Dutch National Consumption Survey suggests that people with lower level of education tend to consume more red and processed meat than people with higher level of education. Moreover, it was found that such factors as the type of food or brand lead to a judgmental bias, which in turn leads to misleading choices of food (Provencher & Jacob, 2016). Moreover, consumers interpret the healthiness and safeness of food differently. For instance, when a respondent was asked about the healthiness of beef, he immediately associated it with production methods such as beef produced on traditional farms without adding hormones rather than its nutritional components (Verbeke, Pérez-Cueto, de Barcellos, Krystallis & Grunert, 2010). Generally, participants consider that meat is an important part of a healthy diet as a source of protein. Some other people have a perception of meat as a luxury good and associate it with income and social status (Ruby, 2012). At the same time, the barriers towards the consumption of meat substitutes are psychological factors and unawareness (Hoek, Luning, Weijzen, Engels, Kok & De Graaf, 2011). First, people tend to consume relatively similar to their peers, and the need for public acceptance is reinforced (Higgs & Ruddock, 2020). People are less willing to consume meat substitutes at restaurants or family dinners rather than when eating alone (Michel, Hartmann & Siegrist, 2021). This evidence suggests that social acceptance of eating behaviors is an important factor for meat consumption. Second, meat alternatives are often associated with being vegetarian rather than with a healthy diet, and thus, it creates a negative perception of plant-based foods (Michel, Hartmann & Siegrist, 2021). To conclude, eating behavior is influenced by a range of psychological factors and can be eliminated by promoting public acceptance of healthy meat substitutes.

Overall, before the tax on red and processed meat could be introduced, several aspects should be carefully considered. First, more knowledge regarding the impact of the tax on consumers, producers, and the economy, as well as the distributional effects are needed. Second, the design of complementary policies such as subsidies for healthy foods and raising awareness about the health impacts of consumption of red and processed meat and availability of the substitutes should be considered. Third, policy cots and undesirable effects such as cross-border trade and farm gate sales should be taken into account. Finally, while this thesis sheds light on the potential of introducing of tax on red and processed meat and tax policy design, some other challenges should be met. For instance, political considerations play an important factor in policy implementation. However, this is out of the scope of this paper.

7 Conclusion

This thesis estimates the effects of a tax on red and processed meat in the Netherlands on consumption, budget revenues, and environmental footprint. Taking into account a growing concern over health and environmental consequences of increased red and processed meat consumption, imposing a tax on the consumption of these products might be a feasible way to improve the diet, decrease the risk of non-communicable diseases and reduce GHG emissions caused by the livestock production. The study finds that the tax could produce the desired outcomes in the three tax scenarios. The total annual consumption of red and processed meat could decrease by up to 20,206 kg per year, resulting in 945.7 million euros of additional budget revenues. At the same time, it is estimated that the environmental footprint could be reduced by up to 0.18% of the total GHG emissions, which is equivalent to 631.8 million euros of social cost reduction. These results support the estimates of other academic studies.

Additionally, this thesis discusses the tax policy design and other policy considerations. Based on the comparison of different types of taxes, it can be concluded that a 30% sales tax would maximize the efficiency of the policy. Compared to other types of taxes, a sales tax is expected to impact consumption more significantly and achieve the stated goals since it occurs at the selling point closer to the final consumer. Moreover, it is recommended that the tax is accompanied by a subsidy on healthy food options, as well as a policy aimed at raising awareness about the health and environmental consequences of red and processed meat consumption and the availability of meat substitutes.

However, the study has several limitations. First, the Dutch National Consumption Survey does not provide an opportunity to estimate a demand function and calculate price elasticities because of a lack of data on prices and household expenditures. Consequently, the results rely on the own price and income elasticities of red and processed meat reported by other studies. Moreover, data on prices and expenditures were used on the aggregate level. Second, this study reports only budget revenues generated by the tax. To estimate the total effect on the budget, the data on cross-price elasticities with other goods and services and supply elasticities are needed. Third, it is assumed that the tax is fully passed on to the consumers in the tax scenarios. In practice, only part of the tax could be passed on to the consumers depending on the relation between demand and supply elasticities.

At the same time, the results of the thesis contribute to the current public policy challenges in the Netherlands. While the necessity to reduce GHG emissions and promote a sustainable and healthy diet is widely discussed, no measures were yet introduced. Thus, the results could be used to further develop a comprehensive set of measures to improve health and environmental outcomes. Further research could focus on the total effects of the tax on the economy, as well as consider the distributional effects on the lowest-income households.

Appendix

Table 8. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Region.*

	Red meat								Processed meat							
Region	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
The 3 large municipalities (Amsterdam, Rotterdam, The Hague)	215	76,90	57,35	1,37	35,17	64,83	105,37	277,00	331	56,63	44,64	0,44	24,48	44,00	75,01	260,72
West (Utrecht, Noord-Holland, Zuid-Holland excl. the 3 large municipalities and suburbs)	683	70,70	57,67	1,28	30,74	57,75	95,79	416,00	1152	60,49	47,29	0,24	24,58	48,00	82,80	303,42
North (Groningen, Friesland, Drenthe)	237	75,89	59,75	2,00	33,49	60,25	102,00	285,00	398	69,58	54,31	1,00	29,22	58,40	94,67	332,90
East (Overijssel, Gelderland, Flevoland)	531	76,60	58,64	3,11	36,00	62,96	100,90	390,00	809	62,66	45,39	0,88	27,49	53,74	84,30	301,00
South (Zeeland, Noord-Brabant, Limburg)	538	77,65	66,03	1,16	33,84	66,00	101,50	729,38	837	61,90	48,77	2,55	27,00	51,50	80,00	444,00
Suburbs	103	77,73	55,96	4,97	35,17	66,00	109,54	274,00	151	59,88	43,52	1,41	24,60	49,13	86,25	217,75

Table 9. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Gender*

	Red meat								Processed meat							
Gender	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Male	1189	84,15	67,16	1,49	36,75	70,05	113,00	729,38	1885	68,36	52,30	0,24	29,75	56,28	92,17	444,00
Female	1118	65,48	49,70	1,16	30,00	55,65	83,47	346,00	1793	55,11	41,32	0,41	22,75	45,50	75,63	279,00

Table 10. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Household Size.*

	Red meat								Processed meat							
Household size	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
One person	221	90,56	56,35	2,85	54,58	80,00	113,00	352,00	326	62,90	50,78	2,00	24,79	50,25	86,44	279,00
Two or three persons	1058	83,94	64,28	1,28	38,61	72,00	112,95	729,38	1587	65,65	50,60	0,24	28,78	54,00	88,92	444,00
Four persons	656	64,35	53,60	1,49	26,33	51,04	78,83	390,00	1141	58,48	43,93	0,88	24,56	48,00	80,00	332,90
Five or more persons	372	59,76	53,71	1,16	22,63	44,33	75,03	344,00	624	58,08	44,44	1,13	22,45	48,57	80,00	272,00

Table 11. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Household Income.*

	Red meat								Processed meat							
Household income	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Less than 950 euro	3	65,61	5,58	59,34	63,42	67,50	68,75	70,00	4	34,88	4,40	29,00	32,75	36,00	38,13	38,50
951-1300 euro	28	83,60	47,07	8,48	48,03	76,00	113,00	172,00	42	67,81	57,72	18,49	33,66	50,25	71,09	262,50
1301-1700 euro	47	89,77	49,00	5,98	48,60	90,00	130,16	172,00	67	62,81	38,05	7,67	31,99	53,12	92,65	171,20
1701-2950 euro	161	92,79	58,39	7,71	56,25	80,00	115,00	346,00	202	55,51	42,00	3,32	24,00	43,94	75,05	271,75
2951 or more	61	85,80	49,70	2,85	53,91	75,27	107,77	220,00	82	63,03	38,41	9,07	32,03	59,39	91,38	167,00
Participant doesn't know or doesn't want to tell	31	88,34	51,04	8,97	54,56	87,40	107,91	265,00	46	59,69	43,06	7,52	30,88	59,10	77,92	257,30

Table 12. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Migration Background.*

	Red meat								Processed meat							
Migration background	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Dutch	2159	75,31	60,66	1,16	33,62	62,91	100,00	729,38	3425	61,89	47,45	0,24	26,30	50,63	83,13	444,00
Western immigrant	53	72,64	42,65	2,74	36,43	75,00	109,81	170,00	95	67,60	49,09	4,04	29,61	58,00	83,62	233,65
Non-Western immigrant	94	71,62	54,89	2,74	36,78	56,25	83,75	266,06	157	58,93	52,58	5,00	22,00	40,00	82,00	268,00

Table 13. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Education Level.*

	Red meat								Processed meat							
Education level	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Low	476	85,76	59,43	2,74	42,65	75,00	113,00	390,00	702	68,82	48,21	3,21	33,00	58,58	94,60	404,53
Middle	884	79,75	65,62	1,49	36,00	67,12	104,00	729,38	1400	65,79	49,05	0,44	29,29	54,09	89,97	444,00
High	947	65,42	53,19	1,16	28,00	51,26	85,00	378,00	1576	55,36	45,48	0,24	22,00	43,90	75,00	350,00

Table 14. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Age and Gender*.

	Red meat								Processed meat							
Age and gender	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Boys, 1-3 years	140	33,77	24,20	1,49	17,05	26,08	46,43	108,00	267	38,38	27,57	0,24	18,13	28,97	53,13	176,00
Girls, 1-3 years	156	30,27	22,50	1,16	13,86	22,93	40,84	79,03	281	37,07	26,51	0,41	16,00	31,86	52,00	145,00
Boys, 4-8 years	114	45,10	33,33	2,00	20,06	36,00	68,25	172,00	225	58,55	37,01	2,63	27,68	54,75	80,00	188,25
Girls, 4-8 years	123	48,02	43,09	2,68	22,19	39,32	63,00	277,00	227	47,69	30,19	2,68	23,34	41,50	69,60	134,00
Boys, 9-13 years	139	72,52	54,18	2,74	35,74	53,86	104,11	300,00	233	69,24	52,48	1,51	28,60	57,75	95,75	350,00
Girls, 9-13 years	126	60,21	36,98	3,11	34,50	56,23	78,75	187,50	226	59,57	39,95	1,41	29,18	49,08	83,21	224,00
Boys, 14-18 years	153	93,61	70,07	5,39	44,91	77,40	121,98	416,00	246	85,07	59,01	6,81	41,99	73,07	113,90	404,53
Girls, 14-18 years	132	61,21	42,41	4,44	28,15	53,00	79,92	220,50	216	64,57	44,79	3,35	26,75	56,79	91,80	251,50
Men, 19-30 years	148	100,59	72,01	5,59	48,57	78,75	129,37	390,00	224	80,55	62,85	1,00	35,24	66,49	104,13	444,00
Women, 19-30 years	131	81,43	53,36	2,74	42,41	64,61	106,63	274,00	199	59,06	44,21	2,00	25,36	51,25	82,34	279,00
Men, 31-50 years	152	114,84	87,31	5,78	60,99	90,27	158,91	729,38	220	77,04	54,74	3,22	34,27	65,02	107,61	260,72
Women, 31-50 years	144	80,26	56,97	8,48	40,82	69,46	104,21	303,63	219	64,19	49,43	5,34	29,14	54,20	82,75	272,00
Men, 51-70 years	174	96,95	64,98	7,07	51,37	80,06	126,45	352,00	240	75,07	54,43	1,00	33,00	60,72	102,13	319,20
Women, 51-70 years	144	80,53	57,20	3,85	39,21	68,99	111,01	295,00	211	63,41	49,81	3,21	22,60	52,50	87,43	265,00
Men, 71-79 years	169	98,08	57,20	2,85	60,00	90,00	129,47	299,50	230	66,80	47,45	3,32	33,18	54,46	92,57	271,75
Women, 71-79 years	162	80,81	48,14	7,91	47,31	75,00	103,79	346,00	214	51,28	34,91	4,28	24,00	43,79	67,92	188,34

Table 15. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by Urbanization Level.*

	Red meat								Processed meat							
Urbanization level	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Extremely urbanised	378	75,62	56,80	1,37	35,10	63,24	104,47	378,00	617	57,88	44,82	0,41	24,60	45,53	78,90	267,30
Strongly urbanised	658	77,19	59,35	1,16	35,84	64,46	104,52	416,00	1055	62,63	50,66	0,88	26,21	49,98	83,92	444,00
Moderately urbanised	476	70,48	65,18	2,74	30,96	56,26	88,79	729,38	749	61,72	47,75	1,00	25,58	49,40	81,50	350,00
Hardly urbanised	535	76,09	59,39	1,66	32,93	65,16	100,50	377,03	829	63,17	46,95	0,24	27,38	54,00	85,14	319,20
Not urbanised	260	75,54	58,02	2,74	36,00	62,93	100,00	390,00	428	63,75	45,60	5,94	29,15	54,50	86,68	332,90

Table 16. *Descriptive Statistics of Red and Processed Meat Consumption in the Netherlands by BMI Category.*

	Red meat								Processed meat							
BMI category	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Seriously underweight	13	51,57	66,39	2,74	11,87	33,12	47,42	204,21	32	43,38	26,33	8,00	19,87	43,99	61,89	102,38
Underweight	82	59,17	43,45	4,62	26,75	49,58	78,75	187,50	150	56,02	41,70	1,39	24,80	45,27	76,50	193,00
Normal weight	1213	65,99	56,11	1,28	27,72	51,33	80,00	416,00	2053	59,68	47,00	0,24	24,29	49,00	80,00	444,00
Overweight	458	80,89	57,83	1,16	37,95	71,40	106,25	380,87	673	68,49	51,80	1,00	30,00	55,96	93,75	350,00
Obesity	209	100,36	84,03	5,25	47,97	76,50	127,75	729,38	324	70,68	51,83	3,21	32,00	61,43	95,84	303,42

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