
Research-Thesis: European Meat Consumption and the Environment

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EUROPEAN MEAT CONSUMPTION AND THE ENVIRONMENT

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2 List of Abbreviations

FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GNI	Gross National Income
HICP	Harmonised Index of Consumer Prices
VIF	Variance Inflation Factor
FBS	Food Balance Sheets
OLS	Ordinary Least Squares
FAFH	Food away from home
SUA	Supply–Utilization Accounts
CPC	Central Product Classification
PPP\$	Purchasing Power Parity (constant 2021 international dollars)
SUR	Seemingly unrelated regressions
AIDS	Almost ideal demand system
QUAIDS	Quasi-Ideal Demand System

3 Introduction

From the deforestation of the Amazon to the rising prevalence of diet-related diseases, meat consumption stands as one of the most pressing global issues of our time and remains a highly complex matter. Despite scientific consensus on its negative environmental impact, global consumption does not appear to follow existing recommendations. Indeed, it continues to rise, reaching exceptionally high levels such as 121.72 kg per capita in the United States in 2022. In Europe, the situation is similarly concerning with consumption of approximately 78.52 kg per capita in 2022 (FAO, 2023). These levels encompass different meat types. Globally, the consumption breakdown shows that the most consumed meats are poultry, followed by pork, beef and finally sheep and goat (WHITTON et al., 2021). Unfortunately, meat consumption is not merely a personal choice that affects only the consumer. Meat production has various negative impacts on the environment. Its effects are manifold : it pollutes the air, soil, water, and contributes to deforestation. These impacts are well known to scientists, yet they do not seem to resonate with consumers. This is a clear example of negative consumption externalities.

To tackle this issue, the European Union has developed its Farm to Fork strategy to promote more sustainable production practices and consumption patterns (EUROPEAN COMMISSION, 2020). However, most of its objectives are linked to the production side, which may not be sufficient. Indeed, BONNET et al. (2020) note that many policies have been implemented to enhance the sustainability of production, yet additional measures are required to address this issue, which may share similarities with other examples of negative consumption externalities, such as smoking. Moreover, the dietary changes required to achieve a healthy diet are substantial, involving more than a 50% reduction in the consumption of unhealthy foods and over a 100% increase in the consumption of healthy foods (WILLETT et al., 2019).

To identify possible levers for initiating change in Europe, it is essential to evaluate the major factors influencing meat consumption. By understanding how consumers make their choices, policymakers can select the most effective solutions. MILFORD et al. (2019) estimated in 2019 the drivers of global meat consumption for the years 2005 and 2011. According to their findings, the five most impactful global drivers are gross national income per capita, a Western culture, the share of the population living in urban areas, the relative price of meat, and social globalisation. For the European Union, KAROUNTZOS et al. (2025) found that GDP per capita in purchasing power parity, along with the availability of livestock and methane emissions, were associated with an increase in meat consumption, whereas unemployment and inflation were linked to a decrease.

Another important economic aspect to consider at the European level is the extent to which consumers respond to meat prices, both overall and by specific meat category. Estimating own- and cross-price elasticities in Europe can provide policymakers with valuable insights for designing effective fiscal incentives. BOUYSSOU et al. (2023) conducted a meta-analysis estimating own- and cross-price elasticities for poultry, pork, beef, and mixed meat products, drawing on approximately 50,000 demand elasticities from 444 studies covering 87 countries. The authors also report own- and cross-price elasticity estimates specific to the European Union.

The study by MILFORD et al. (2019) examines global meat consumption at only two points in time (2005 and 2011) and focuses on both ruminant meat and total meat consumption. In contrast, KAROUNTZOS et al. (2025) investigates the European level using panel data analysis between 2000 and 2021. The added value of the present study lies in the decomposition by meat type, allowing for a better understanding of how different key drivers influence each category. The objective is to identify which public policies may be the most suitable for each meat type.

While these studies offer valuable insights, they either focus on specific countries or on aggregated meat categories, which may mask important differences between meat types. This master's thesis seeks to address this gap by decomposing meat consumption into distinct cate-

gories, enabling a more detailed analysis of the key drivers for each. The objective is to identify which public policies may be the most suitable for each meat type, taking into account their specific consumption patterns and determinants.

Therefore, this study examines meat consumption in Europe by type, presenting the different trends observed across the continent. Subsequently, a regression analysis will be performed for each meat type, namely beef, poultry, pork, mutton and goat, as well as the category 'other meat', which includes meats not falling into any of the categories listed above. The independent variables used are gross national income per capita, the share of the population living in urban areas, the price of beef, and the relative prices of poultry, pork, mutton and goat (all relative to poultry prices, except for the poultry regression, where the base price is beef). The database, structured as panel data, was created by combining various data sources, such as the FAO and the World Bank.

Regarding the regression, models were constructed based on the results of diagnostic tests. Fixed-effects models were ultimately employed, with Driscoll–Kraay standard errors to correct for heteroskedasticity, autocorrelation, and cross-sectional dependence. This methodology will be discussed in detail in the Empirical Strategy section.

This master's thesis is structured as follows. It begins with a review of the existing literature on meat demand and its environmental impacts. This is followed by a data and empirical section, in which the data sources and variable construction are discussed. The descriptive statistics are then presented, followed by the empirical strategy and the results by meat type. Selected theoretical properties of demand functions are also examined before turning to the limitations of the study. The thesis concludes with a concluding section.

4 Literature Review

The world population has been steadily increasing for centuries, surpassing the milestone of eight billion in 2022, according to the United Nations. They have also estimated that the world population in 2050 will reach 9.7 billion people. However, all these individuals have something in common : They need to eat (UNITED NATIONS, 2022).

Their diets encompass various goods, including meat, and meat consumption has been steadily increasing for decades.

This literature review aims to present key findings from existing research on meat consumption and its environmental impact worldwide. The discussion will first address the current literature on meat consumption, followed by an overview of the prevailing consensus on the environmental effects of meat production.

This literature review serves as the foundation for this master’s thesis entitled *"European Meat Consumption and the Environment."*

Globally, meat consumption has been increasing steadily over the years, with quantities now reaching significant levels in certain countries. To what extent, however, remains a critical question.

Examining global patterns, actual meat consumption is not directly observable. Instead, the data used represents available meat consumption, which tends to overestimate actual consumption since food waste is not accounted for. The Food and Agriculture Organization of the United Nations (FAO) is the primary source for such data. According to their methodology, meat consumption is defined as the quantity of meat effectively available for consumption, divided by the number of people consuming it (FAO, 2001).

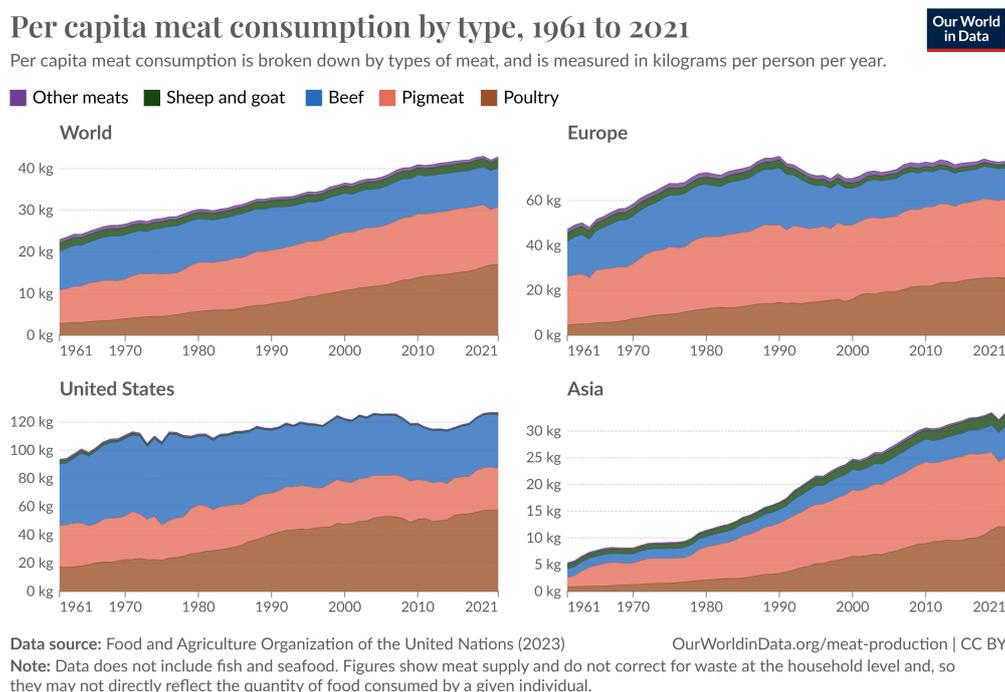


FIGURE 1 – Food and Agriculture Organization of the United Nations (2023) – with major processing by Our World in Data

Using the FAO (2023), with substantial processing by Our World in Data, the trends in meat consumption across different regions of the world can be analyzed. The data indicates that per capita meat consumption is increasing globally. However, distinctions can be observed : relative stability is noticeable in the United States and Europe, whereas meat consumption has

increased significantly in Asia (OUR WORLD IN DATA, 2023).

It is also important to note that, although meat consumption in Asia has increased significantly, the level reached in 2022 was 44,4 kilograms per capita. In comparison, the United States recorded a much higher level of 121,72 kilograms per capita, making Asia's increase less striking in relative terms (FAO, 2023).

Another notable trend observable in Figure 1 is the increasing consumption of poultry and pork meat, while beef consumption shows a declining tendency. This pattern aligns with findings from HENCHION et al. (2014) in their study, *Meat Consumption : Trends and Quality Matters*. Using the same FAO dataset from 1990 to 2009, HENCHION et al. (2014) highlighted an 8% decrease in bovine meat consumption, a 20% increase in pork meat consumption, and a substantial 75% increase in poultry consumption. They also observed an 11.8% rise in sheep and goat meat consumption.

In 2021, WHITTON et al. (2021) conducted a regression analysis using FAO data to examine meat consumption trends between 2000 and 2019 in the world. Their analysis, with meat consumption as the dependent variable and time as the independent variable, revealed a significant global upward trend in meat consumption per capita, with a coefficient of 0.34 (p-value < 0.001). Furthermore, they confirmed a decreasing share of beef and pork in total meat consumption worldwide, along with a notable increase in poultry consumption per capita. Poultry also gained a larger share of total meat consumption.

In summary, while overall meat consumption continues to increase, poultry has emerged as the most consumed meat worldwide, acting as a substitute for other types of meat.

Another significant finding in the study by WHITTON et al. (2021), titled *Are We Approaching Peak Meat Consumption? Analysis of Meat Consumption from 2000 to 2019 in 35 Countries and Its Relationship to Gross Domestic Product*, is the identification of a potential tipping point in meat consumption trends. Their analysis provided evidence that, at a certain level of GDP per capita (specifically USD 40,000) the upward trend in meat consumption tends to reverse. This finding offers some hope for a natural decline in meat consumption as economies develop, without negatively impacting the quality of life for populations.

Concerning the factors influencing meat consumption, MILFORD et al. (2019) estimated that they can stem from various sources. Economic factors, such as income per capita, may lead to an increase in meat consumption and a change in preferences. Relative prices also contribute to the nutrition transition towards higher meat consumption, particularly due to their decreasing trend. Regarding social factors, urbanisation and female labour force participation have been associated with increased meat consumption, partly because of greater reliance on convenience foods and the influence of advertising. Finally, cultural and religious factors also play a significant role in shaping meat consumption preferences. Their analysis was based on 123 countries worldwide in 2005 and 137 countries in 2011.

At the European level, few analyses on the drivers of meat consumption were available. However, in May 2025, KAROUNTZOS et al. (2025) published an article entitled *"Behavioral Economics in EU : Meat, ESG, Macroeconomics"*. This highly relevant paper found that GDP PPP (purchasing power parity) per capita, livestock availability, and methane emissions are determinant factors that may increase meat consumption. Conversely, unemployment and inflation were found to have a negative impact on meat consumption. The authors concluded that economic stability and growth are associated with increasing meat consumption, whereas an uncertain economic climate tends to reduce it. Their study was based on data from the 27 European Union countries over the period 2000 to 2021.

Analysing the current situation, understanding the drivers that shape meat consumption is both important and highly relevant. Indeed, the environmental impact of meat production is widely recognised as harmful. Numerous studies have assessed these effects, which encompass various dimensions. Globally, four main categories of impact can be identified : greenhouse

gas emissions, deforestation, water usage, and biodiversity loss. These categories entail a range of consequences, including soil degradation, chemical pollution, energy consumption, waste disposal, and acid rain (DRAGULANESCU, 2014).

Regarding greenhouse gas emissions, the Organisation for Economic Co-operation and Development (OECD) estimated in 2002 that the livestock industry accounted for 65% of global nitrogen oxide emissions. Additionally, 64% of total ammonia emissions were attributed to livestock production. Another significant contribution from the livestock industry is methane emissions, representing 37% of the global total (OECD, 2002).

Compared to plant-based foods, meat production emits considerably more greenhouse gases, primarily due to higher energy consumption (GODFRAY et al., 2018). Emissions also vary by type of meat : ruminants are the highest emitters, followed by non-ruminants and poultry (GODFRAY et al., 2018).

Deforestation associated with livestock industry expansion has severe environmental consequences. Beyond its detrimental effects on biodiversity, it also contributes significantly to carbon dioxide emissions. Additionally, deforestation is linked to desertification in arid regions, erosion, landslides, and the pollution of aquatic ecosystems(DRAGULANESCU, 2014).

The world's water resources are also significantly impacted by meat production. A substantial portion of water is used to irrigate crops grown for livestock feed (GODFRAY et al., 2018). While using water for crop irrigation may be less detrimental in regions where water is abundant, it can have a profound environmental impact in areas where water is a scarce and limited resource (GODFRAY et al., 2018).

The use of water in meat production, while representing only a small portion compared to the water footprint for crop growth, can lead to significant environmental issues. Many large factory farms manage the disposal of manure through the creation of manure lagoons, where water, manure, and other waste materials are mixed to form artificial ponds. Environmental harm arises when these lagoons spill, allowing contaminated water to seep into the ground. This process releases antibiotics, hormones, and other chemical substances into the environment, posing serious risks (AMERICA et al., 2024).

Regarding the water footprint, MEKONNEN et HOEKSTRA (2012) analyzed it in three countries : the United States, the Netherlands, and India. They found that the water footprint depends on the type of meat produced and the level of industrialization in the production process. The Netherlands produced meat with a lower water footprint, likely due to more industrialized agricultural practices. In contrast, India had the highest water footprint, attributed to a less favourable climate and less industrialized production methods. Interestingly, the study revealed that industrialized production has a smaller water footprint than grazing systems, contrary to common assumptions. Concerning meat types, the study highlighted that beef has the largest water footprint, followed by sheep, pork, goat, and chicken meat (MEKONNEN & HOEKSTRA, 2012).

Food consumption in Europe was analysed by NOTARNICOLA et al. (2016) to identify the most environmentally harmful food categories. Using a life-cycle assessment-based approach, the study found that meat and dairy products were the most impactful. Among meats, beef was identified as the most polluting ; however, it was consumed less frequently. In contrast, pork had a lower environmental impact but was more widely consumed (NOTARNICOLA et al., 2016).

Taken together, the existing literature underscores both the environmental and economic dimensions of meat consumption. The next section outlines the data and empirical strategy employed in this thesis to further investigate these dynamics in the European context.

5 Data and Empirical Strategy

5.1 Data sources and Measurement

This section presents the various data sources used to construct the database employed in this master's thesis and outlines the procedures applied to build the different variables. Table 12 in the Appendix provides a summary of all data sources alongside their corresponding descriptions.

5.1.1 FAO Food Balance Sheets (FBS)

The main explanatory variable of this analysis, namely the food supply available for human consumption by meat type, was retrieved from the FAO Food Balance Sheets (FBS). Data compiled under the old FBS methodology were used for the years prior to 2010 (FAO, 2025d), while data following the revised methodology were used for subsequent years (FAO, 2025e).

A clear understanding of the construction of these variables is crucial for an accurate interpretation of the results. According to FAO (2025c, p. 3), "FBS estimates reflect the availability of food that is intended for human consumption and available for purchase at the point of sale."

Food Balance Sheets are based on the accounting identity that food available within an economy must originate from domestic production, imports or existing stocks. This relationship is expressed in Equation 1 :

$$TS_t = P_t + M_t - \Delta S_t \quad (1)$$

where TS_t denotes total supply, P_t domestic production, M_t imports, and ΔS_t the variation in stocks.

Total supply is then allocated across different uses through the Supply Utilization Accounts (SUAs), as described in Equation 2 :

$$TS_t = X_t + F_t + FP_t + FE_t + SD_t + TC_t + IU_t + L_t + R_t \quad (2)$$

where X_t denotes exports, F_t food, FP_t food processing, FE_t livestock feed, SD_t seed use, TC_t tourist consumption, IU_t industrial use, L_t losses along the supply chain, and R_t other residual uses.

Based on the SUAs, processed products are converted into their primary commodity equivalents. For instance, pasta is expressed in flour-equivalent terms. These primary-equivalent values are then aggregated by product category in order to obtain the quantities reported in the Food Balance Sheets as food available for human consumption.

However, food available for human consumption should not be interpreted as actual consumption. As illustrated in Figure 2, this aggregate includes household consumption, collective consumption (e.g. hospitals, schools, military institutions and prisons), away-from-home consumption, and retail-level waste. In addition, it implicitly includes food losses occurring at the consumer level, with the exception of retail waste, which is reported separately.

Therefore, it is essential to keep in mind that the quantities extracted from the FBS tend to overestimate actual food consumption, as they do not fully account for food waste occurring at different stages of the supply chain (FAO, 2025c, p. 3). Measuring actual food consumption remains a complex empirical challenge : while estimates may approximate real intake, they generally remain imperfect. This feature of the FAO methodology leads to a systematic upward bias in consumption levels. However, the data remain highly suitable for cross-country comparisons, which constitutes a major advantage for the purpose of this master's thesis.

Relying exclusively on household survey data would not capture collective consumption or food consumed away from home (FAFH), and would therefore also be subject to measurement

Food Available for Human Consumption

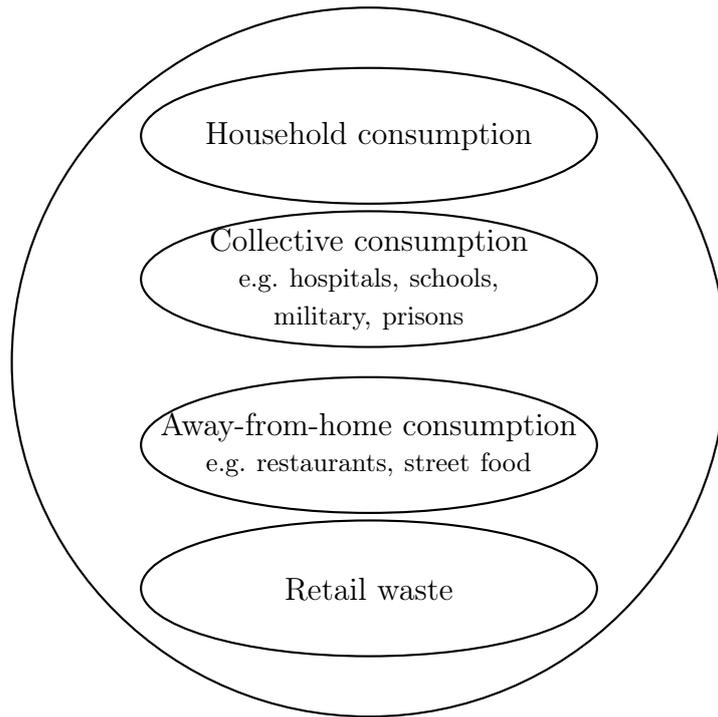


FIGURE 2 – Components of food available for human consumption

error. Moreover, such surveys are in most cases conducted at the national level only. Cross-country comparisons over long time periods may thus be adversely affected by differences in survey design, coverage, and methodology.

Looking back at the data used in this study, the dependent variables extracted from the FBS were the consumption of Beef, Poultry, Pork, Mutton and Goat and Other Meat category, expressed in kg per capita (FAO, 2025d, 2025e).

These data were mainly available for the period 1961–2023, with an overall completeness rate of 72% across the 27 European countries listed in Appendix Table 11. However, as explained in the following section, due to the availability of price data, the analysis was restricted to the period 1995–2023, which increased the completeness rate to 99%.

5.1.2 Producer Prices Data

The first independent variables used in this analysis are the producer prices for each meat type. These prices were downloaded from FAOSTAT (FAO (2025b)) and are expressed in USD per tonne. The data are available from 1991 to 2025; however, the database is only 28% complete over the full period. Due to this substantial level of missing data, the analysis period was restricted to 1995–2023, for which data completeness reaches approximately 65%.

Several price series are reported under the Central Product Classification (CPC) framework (UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, STATISTICS DIVISION (2002)). Table 1 presents the detailed list of available meat categories and their corresponding variable names used in this master’s thesis.

After matching prices with their corresponding meat categories, the mean price was calculated by country, year, and meat type to obtain a single average price for each combination. The resulting values were then divided by 1,000 to convert prices from USD per tonne to USD per kilogram.

TABLE 1 – CPC product categories and corresponding meat types used in the empirical analysis

Item	CPC Code	Meat Type (Used in Analysis)
Meat of cattle with the bone, fresh or chilled	21111.01	Beef
Meat of buffalo, fresh or chilled	21112	Beef
Meat of pig with the bone, fresh or chilled	21113.01	Pork
Meat of rabbits and hares, fresh or chilled	21114	Other meat
Meat of sheep, fresh or chilled	21115	Mutton/Goat
Meat of goat, fresh or chilled	21116	Mutton/Goat
Horse meat, fresh or chilled	21118.01	Other meat
Meat of asses, fresh or chilled	21118.02	Other meat
Meat of mules, fresh or chilled	21118.03	Other meat
Other meat of mammals, fresh or chilled	21119.9	Other meat
Meat of chickens, fresh or chilled	21121	Poultry
Meat of ducks, fresh or chilled	21122	Poultry
Meat of geese, fresh or chilled	21123	Poultry
Meat of turkeys, fresh or chilled	21124	Poultry
Meat of pigeons and other birds n.e.c., fresh, chilled or frozen	21170.01	Other meat
Game meat, fresh, chilled or frozen	21170.02	Other meat

Source : Authors' compilation based on FAOSTAT price data (FAO (2025b)).

5.1.3 Other Data Sources

The share of the population living in urban areas was calculated by dividing the total urban population by the total population of each country. These data were obtained from the FAO database, which provides annual demographic information by sex and by urban/rural residence (FAO, 2025a). Due to its construction, this variable is bounded within the $[0,1]$ interval. This variable was available for the period 1995–2023 for all European countries, with a completeness rate of 99%.

Gross national income per capita (GNI), expressed in constant 2021 international dollars and adjusted for purchasing power parity (PPP), was retrieved from the World Bank database (WORLD BANK, 2025). These data were available for the period 1995–2023 for the 27 European countries, with a completeness rate of 97%.

The producer prices presented in the previous section are expressed in nominal terms. However, nominal prices are affected by inflation and are therefore not suitable for reliable economic analysis. To approximate real prices, the Harmonised Index of Consumer Prices (HICP) for meat is used (EUROSTAT, 2024a). Although the HICP is available from Eurostat by country and by meat type, using meat-specific indices would substantially reduce data availability. For this reason, the HICP aggregated over all meat categories is used instead of meat-type-specific indices.

5.2 Descriptive Statistics

5.2.1 Meat Consumption Variables

To provide an overview of current meat consumption in Europe, it is useful to begin with descriptive statistics. The analysis of the dataset reveals that pork is the most consumed type of meat in the European Union, with an average of approximately 38.4 kg per capita per year (standard deviation : 9.828). It is followed by poultry, with 20.4 kg per capita (s.d. 6.168), and beef, with 14.98 kg per capita (s.d. 7.424). On average, a European consumes about 2.02 kg of mutton and goat meat (s.d. 2.728) and 1.64 kg (s.d. 1.478) of other meats annually. These numbers are presented in Table 2.

Regarding the number of observations, the dataset contains the same number of observations for each meat type. Further examination reveals that the database includes 10 missing observations for each meat category. These missing values correspond to Belgium and Luxembourg before the year 2000. This is due to the fact that, prior to 2000, data for Belgium and Luxembourg were reported jointly rather than separately. For the other European countries, the dataset does not contain any missing observations.

This results in a total of 773 observations for 27 countries over an average of 28.63 years, within a full time span of 29 years (1995–2023).

Looking more closely at Table 2, pork consumption appears to average 38.404 kg per capita per year, with a standard deviation of 9.828 kg. The minimum observed value in the sample is 13.05 kg per capita, corresponding to Bulgaria in 2006, while the maximum is 68.51 kg per capita for Denmark in 1998.

Regarding the between variation, Bulgaria has the lowest country-level average pork consumption, with 26.38 kg per capita per year over the period. The highest average is recorded for Spain, at 55.45 kg per capita per year.

The within variation captures how much pork consumption fluctuates within a given country over time. The smallest within value (16.15 kg per capita) corresponds to the smallest deviation from a country's mean consumption and is observed for Croatia in 1998. The largest within value (67.35 kg per capita) reflects the strongest deviation from a country's own average, observed for Denmark in 1998.

On average, pork consumption fluctuates by about 6.446 kg per capita around the country-specific mean. This suggests that, for most countries, pork consumption shows a moderate degree of temporal variability, with an average deviation of approximately 16.78% from the country's mean level. In addition, the between standard deviation is higher than the within standard deviation, which indicates that cross-country differences dominate within-country fluctuations. This pattern suggests that a random effects model may be more appropriate for the analysis.

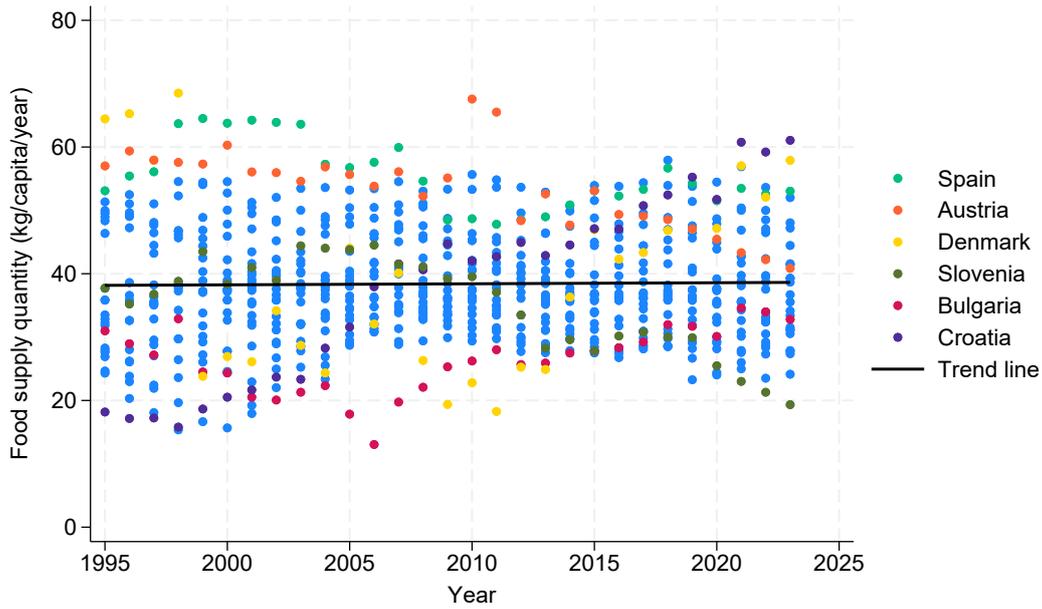
TABLE 2 – Descriptive Statistics of Meat Consumption Variables (kg per capita)

Variable	Mean	Std. Dev.	Min	Max	Observations
Pork consumption (kg per capita)					
Overall	38.404	9.828	13.05	68.51	$N = 773$
Between	–	7.517	26.38	55.45	$n = 27$
Within	–	6.446	16.15	67.25	$\bar{T} = 28.63$
Poultry consumption (kg per capita)					
Overall	20.365	6.168	4.79	37.06	$N = 773$
Between	–	4.740	10.79	28.84	$n = 27$
Within	–	4.028	6.27	34.36	$\bar{T} = 28.63$
Beef consumption (kg per capita)					
Overall	14.978	7.424	0.15	34.28	$N = 773$
Between	–	7.020	4.19	30.08	$n = 27$
Within	–	2.908	5.40	31.87	$\bar{T} = 28.63$
Mutton and goat consumption (kg per capita)					
Overall	2.019	2.728	0.02	14.67	$N = 773$
Between	–	2.537	0.04	11.63	$n = 27$
Within	–	1.076	-2.89	8.27	$\bar{T} = 28.63$
Other meat consumption (kg per capita)					
Overall	1.639	1.478	0.07	9.76	$N = 773$
Between	–	1.163	0.16	4.44	$n = 27$
Within	–	0.931	-1.72	7.93	$\bar{T} = 28.63$

Notes :

The table presents descriptive statistics for meat consumption variables across 27 European countries over the period 1995–2023. Source : Own calculations based on the FAO database (FAO, 2025d, 2025e).

FIGURE 3 – Temporal evolution of per capita pork supply in 27 European countries (1995–2023)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e).

Figure 3 displays assimilated pork consumption over the period 1995–2023. The countries discussed in the descriptive statistics are highlighted in the graph.

Two points clearly attract attention : the observations for 2010 and 2011, which are substantially higher than the highlighted countries and the general pattern. These points correspond to Austria, where pork consumption reached 67.58 kg per capita in 2010 and 65.51 kg per capita in 2011.

Moreover, Slovenia and Malta exhibit the lowest levels of pork consumption toward the end of the period.

Looking at this graph, it also appears that cross-country variation has decreased over time, suggesting a gradual harmonisation of habits in terms of assimilated pork consumption across European countries. On the other hand, the overall trend in pork consumption appears relatively stable throughout the period.

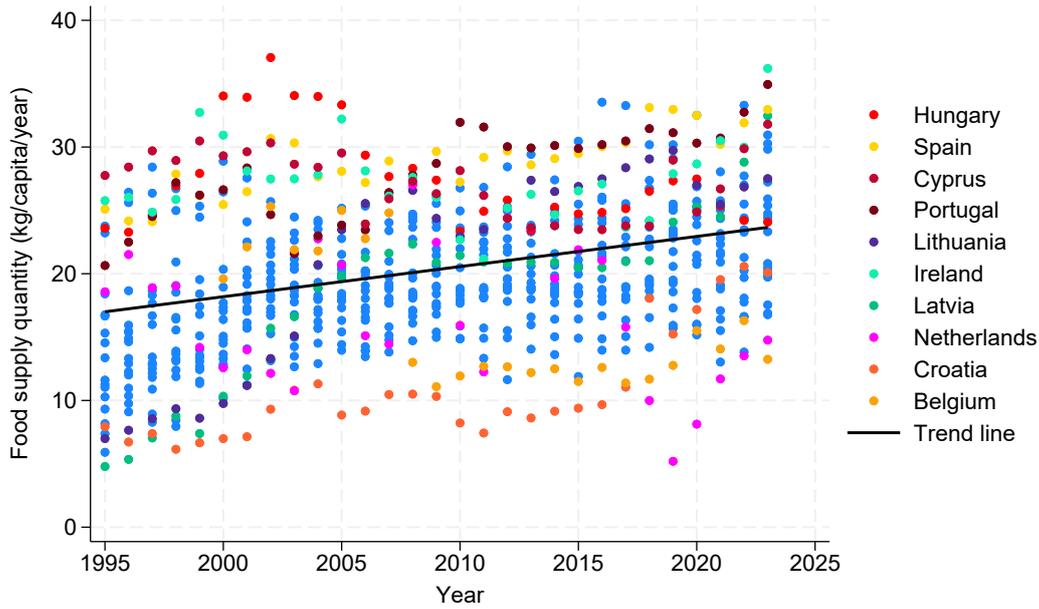
The second most consumed type of meat in Europe is poultry. The descriptive statistics presented in Table 2 show that the minimum consumption was 4.79 kg per capita in Latvia in 1995. The maximum consumption was recorded for Hungary in 2002, when each person consumed 37.06 kg of poultry per year on average.

The country with the lowest average poultry consumption is Croatia, with an average of 10.79 kg per capita. Conversely, the country with the highest average consumption during the analysed period is Spain, with 28.84 kg per capita.

When looking at changes in consumption over time for each country, it appears that Lithuania has the smallest deviation from its own average in 1995 (6.27 kg per capita), whereas Latvia shows the largest deviation from its own average in 2023 (34.36 kg per capita).

Finally, poultry assimilated consumption tends to vary from the country-specific average by 4.028 kg per capita on average. This result is lower than the variation between countries (6.168 kg per capita), which may indicate that a random effects model may be more appropriate.

FIGURE 4 – Temporal evolution of per capita poultry supply in 27 European countries (1995–2023)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e).

Figure 4 represents the approximated poultry consumption in the 27 European countries over the time period. The graph highlights the countries discussed in the descriptive statistics and shows that the Netherlands currently reports relatively low poultry consumption, following an unusual consumption pattern.

Among the countries with higher consumption levels, Portugal and Ireland stand out. At the beginning of the period, Cyprus also displayed high poultry consumption, but its per capita consumption steadily declined over time.

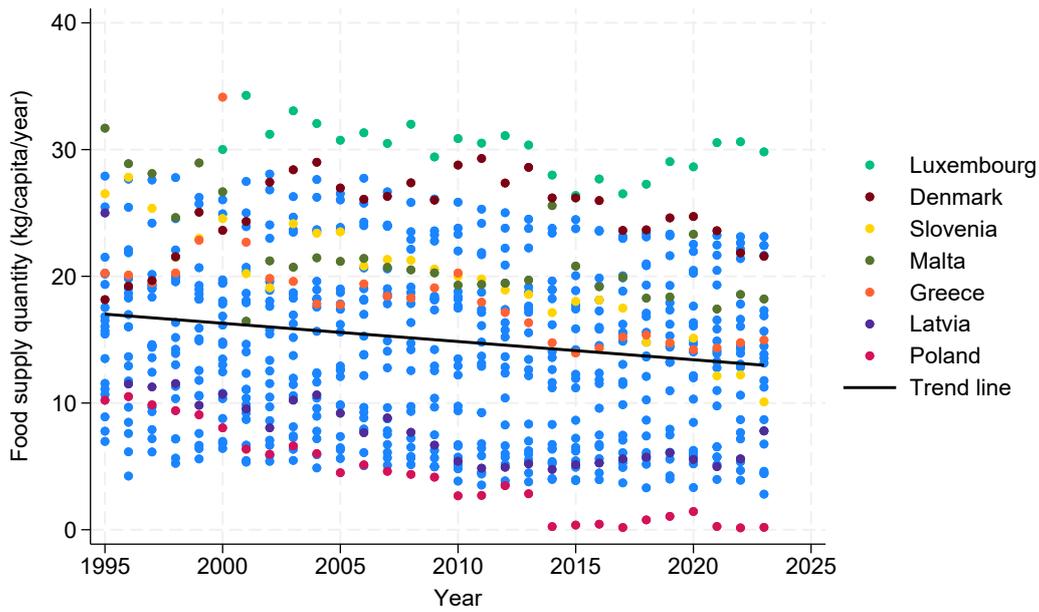
The overall trend indicates an increase in poultry consumption across European countries, which is consistent with the findings of previous studies (**add citation**).

Beef consumption appears to be the third most consumed meat category in the European Union, with an average of 14.978 kg per capita per year over the analysed period and a standard deviation of 7.424 kg per capita. The minimum recorded value is 0.15 kg per capita, observed in Poland in 2022, which reflects a long-term decline in beef consumption in that country. At the opposite end, Luxembourg reached the highest observed value with 34.28 kg per capita in 2001, after which beef consumption declined for approximately 15 years.

Regarding between-country variation, Poland exhibits the lowest average beef consumption, with a mean of 4.19 kg per capita over the time frame. Luxembourg again records the highest country-level average, with 30.08 kg per capita.

Looking at deviations from country-specific means, Slovenia shows the smallest deviation (5.40 kg per capita) in 2023. The largest deviation is observed for Latvia in 1995. However, this value appears questionable : a visual inspection of the beef consumption series for Latvia suggests that the 1995 observation is inconsistent with neighbouring years. Its reliability therefore appears doubtful. This can be seen in Figure 5.

FIGURE 5 – Temporal evolution of per capita beef supply in 27 European countries (1995–2023)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e).

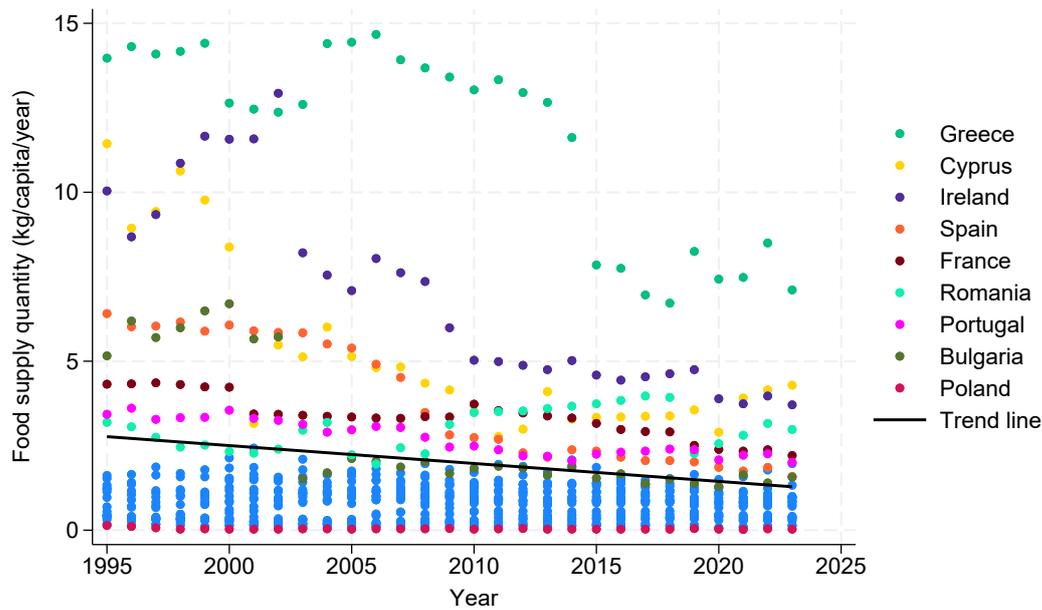
Analysing Figure 5, it appears that other data points also stand out. For instance, beef consumption in Greece in 2000 is higher than in the surrounding years, and there is notable variability in beef consumption in Malta. Regarding the overall trend, a general decline can be observed.

The penultimate variable is mutton and goat consumption. In the European Union, an individual consumed on average 2.019 kg of mutton and goat, with a standard deviation of 2.728. The minimum annual consumption, 20 grams per capita, is observed in Poland in 2021. The maximum consumption, 14.67 kg per capita, corresponds to Greece in 2006.

Looking at the between-country minimum and maximum averages, Poland shows the lowest average consumption, at 40 grams per capita, whereas Greece displays the highest average consumption, with 11.63 kg per capita.

The minimal within variation is -2.89 , indicating that in 2018 Greece recorded a level of mutton and goat consumption significantly below its country-specific average. This represents the lowest annual deviation in the dataset. Conversely, the largest within deviation is observed for Ireland in 1995. Ireland's time series displays a pronounced downward trend, yet the elevated value in 1995 remains plausible, as similarly high levels were recorded in the years preceding it.

FIGURE 6 – Temporal evolution of per capita mutton and goat supply in 27 European countries (1995–2023) (kg per capita)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e).

Figure 6 helps identify the main consumers of mutton and goat meat. Greece, Cyprus, and Ireland stand out as the largest consumers of this type of meat; although their consumption tends to decrease over time, it remains consistently above the European Union average. In most other EU countries, consumption levels are below 5 kg per capita per year, and the overall trend across the Union appears to be declining.

The last observation that can be made about the descriptive statistic of meaning that the within standard deviation (1.076 kg/capita) is slightly lower than the between standard deviation (2.537 kg/capita) cross-country differences are somewhat larger than within-country variation. However, because the overall mean is very low 2.019 kg/capita), even small absolute changes represent large relative fluctuations over time. Therefore, consumption of mutton and goat is low on average but relatively volatile in proportional terms.

All the meat that were not part of the category seen above were recorded in the other meat variable. This other meat seen to be consumed on average by 1.639 kg per capita with a standard deviation of 1.47. The minimum recorded is 70 grams per capita in Lithuania in 2001. The maximum consumption recorded is 4.44 kg per capita and account for the per capita consumption in Netherlands in 2009.

The between minimum bring that the smallest average by country is 0.16 kg per capita of other meat. It appears that, Poland had the smallest average consumption of other meat while Italy, with an average of 9.76 kg per capita, has the highest average of other meat consumed in the database.

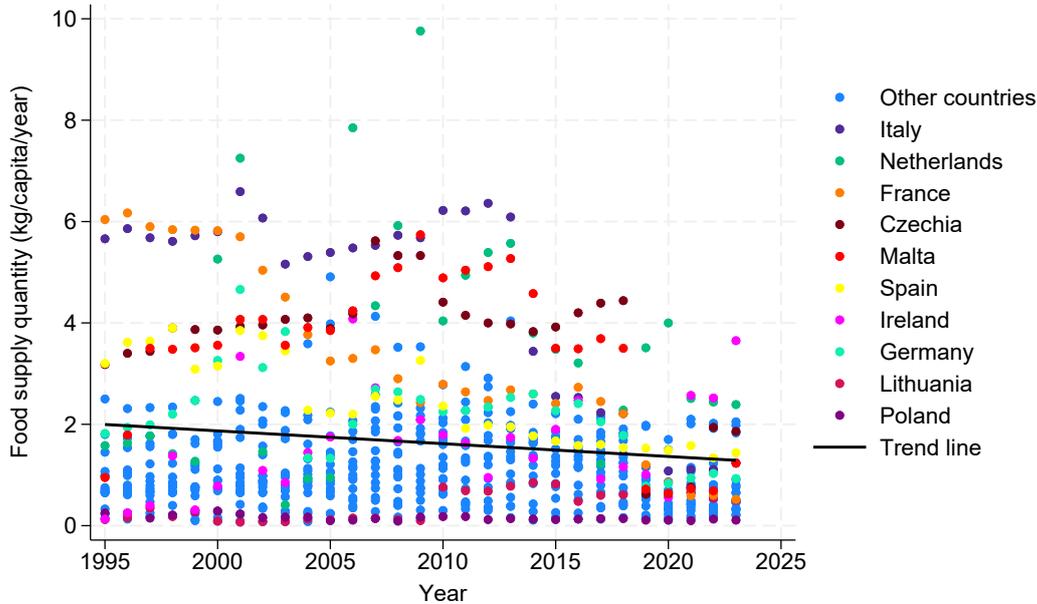
The within line highlighted that the minimal variation regarding a country's own average was -1.72 kg per capita and was resulting of the consumption of other meat in Italy in 2020. The consumption of other meat was more or less stable prior 2015 and decreased brutally after that. From around 6 kg per capita to less than 4 after 2015.

The largest within estimation was 7.93 and result from Netherlands in 2009. The data obtained from the FAO regarding the consumption of other meat in the Netherlands do not

follow any path apparently and vary a lot as it can be seen in the Figure 7 (FAO, 2025d, 2025e).

The last observation that can be made from the Table 2 is that, as for the previous meat type, the within standard deviation is lower than the between standard deviation for the other meat category. It may imply that, a random effect model may be the more suitable model for the analysis.

FIGURE 7 – Temporal evolution of per capita other meat supply in 27 European countries (1995–2023)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e).

The Figure 7, which represents the consumption levels of other meat over time, highlights several elements. First, the figure has a similar structure to Figure 6, which depicts mutton and goat consumption. As before, most countries are located in the lower part of the graph, while only a few lie above the trend line. Among these countries are the Netherlands, Italy, France, Czechia, Malta, and Spain. However, for all countries except the Netherlands, consumption of other meat remains below 8 kg per capita; the Netherlands reaches nearly 10 kg per capita. On average, the consumption of other meat tends to decrease within the European Union.

To provide a broader perspective on meat consumption in Europe, Table 3 reports the descriptive statistics for total meat consumption across the 27 European countries over the study period (1995–2023).

This variable is constructed by summing the different meat categories for each country and year. Consequently, the number of observations and the time span remain identical to those presented in Table 2.

TABLE 3 – Descriptive statistics for the total meat consumption in kg per capita for the 27 European Countries (1995-2023)

	Mean	Std. Dev.	Min	Max	Observations
<i>Overall</i>	77.4048	14.7655	28.75	119.61	$N = 773$
<i>Between</i>		12.0774	56.07	104.13	$n = 27$
<i>Within</i>		8.8133	45.42	116.38	$\bar{T} = 28.63$

Notes :

The table presents descriptive statistics for meat consumption variables across 27 European countries over the period 1995–2023. Source : Own calculations based on the FAO database (FAO, 2025d, 2025e).

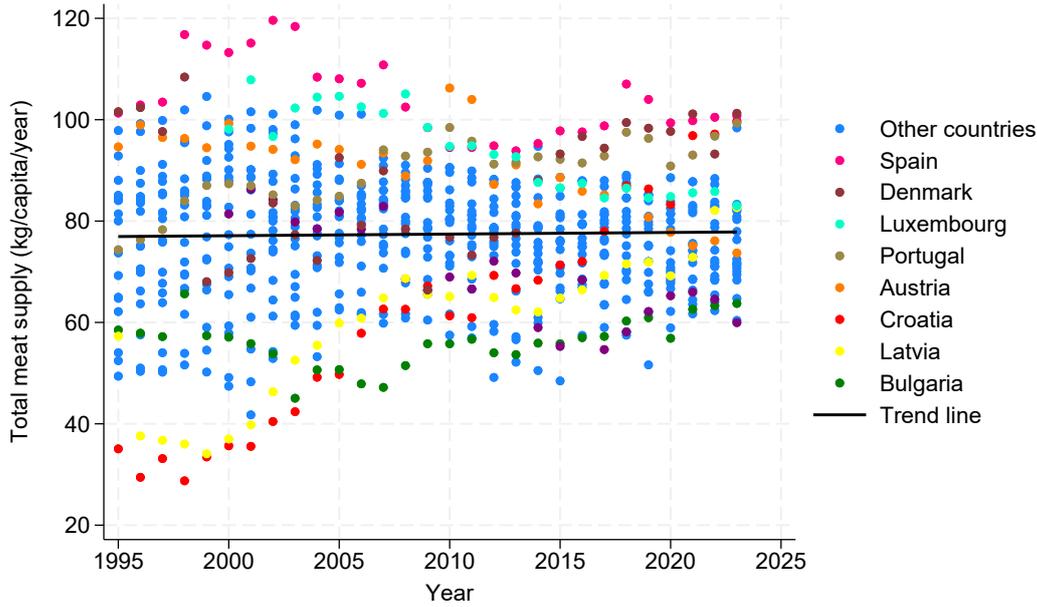
It appears that, in the European Union, an individual consumed on average 77.405 kg of meat per year between 1995 and 2023, with a standard deviation of 14.7655. The minimum value, 28.75 kg per capita, was recorded in Croatia in 1998. After this point, Croatia experienced a steady increase in meat consumption, reaching nearly 100 kg per capita in 2023. The maximum consumption level, 119.61 kg per capita, was observed in Spain in 2002. Thereafter, Spain’s meat consumption fluctuated but remained close to 100 kg per capita.

The lowest country-level average was observed in Bulgaria, with 56.07 kg per capita, making it the country with the smallest average meat consumption among the 27 Member States. In contrast, Spain had the highest average consumption, at 104.13 kg per capita.

The smallest within-country deviation (45.42 kg per capita) and the largest (116.38 kg per capita) were both observed in Croatia. This reflects the country’s sharp rise in meat consumption over the period : its 1998 level was the furthest below its own average, while its 2023 level was the furthest above it.

The within standard deviation is lower than the between standard deviation. This suggests—similarly to what was observed for the individual meat categories—that variation is greater across countries than within countries over time. This pattern indicates that a random effects model may be more appropriate for the analysis.

FIGURE 8 – Temporal evolution of per capita total meat supply in 27 European countries (1995–2023)



Source : Own computation based on FAO Food Balance Sheets (FAO, 2025d, 2025e). Data in kg per capita.

The Figure 8 represents total meat consumption per capita (in kg) for each European country over the period 1995–2023. The overall trend appears to remain relatively stable, fluctuating around 80 kg per capita. Some countries, such as Spain, Denmark, Luxembourg, and Portugal, display higher levels of meat consumption, while others, such as Bulgaria and Latvia, exhibit lower consumption levels.

5.2.2 Nominal Producer Prices

The following section discusses the descriptive statistics related to producer prices obtained from FAO (2025b) and structured according to the procedures described in Section 5.1.2. It is important to note that the prices presented in this section are expressed in nominal terms and converted into USD to allow for cross-country comparisons. However, this approach entails certain limitations. In particular, nominal prices incorporate both domestic inflation and fluctuations in exchange rates. Therefore, the trends observed in the descriptive statistics should not be interpreted as reflecting real price changes, but rather nominal developments that combine these different effects. It was decided to describe it in order to provide an overview of the prices faced and perceived by consumers.

It can be observed that the database does not contain the same number of observations for each meat type. The number of observations ranges from 591 to 658, whereas a complete dataset would include 783 observations (27 countries over 29 years, from 1995 to 2023). The other meat category contains the highest number of observations, followed by mutton and goat, poultry, beef, and finally pork. Naturally, the number of available time periods, represented by \bar{T} , follows the same pattern.

It can also be noted that the within-country standard deviation is consistently smaller than the between-country standard deviation. This suggests that, as with the consumption variables, a random effects model may be more appropriate. This will be formally assessed using statistical tests later in the analysis.

Table 4 presents these descriptive statistics for producer prices expressed in USD per kilogram. The ranking from the most to the least expensive meat type is as follows : mutton and goat, beef, other meat, poultry, and finally pork.

TABLE 4 – Descriptive Statistics of Meat Producer Prices (USD per kg)

Variable	Mean	Std. Dev.	Min	Max	Observations
Mutton and goat producer price (USD/kg)					
Overall	4.2608	1.6747	0.4965	10.4692	$N = 647$
Between	–	1.3990	1.9897	7.1106	$n = 27$
Within	–	0.9981	1.0809	8.7723	$\bar{T} = 23.96$
Beef producer price (USD/kg)					
Overall	3.5812	1.5105	0.9157	10.3659	$N = 598$
Between	–	1.3343	1.8245	8.3175	$n = 27$
Within	–	0.7507	-0.6089	5.6296	$\bar{T} = 22.15$
Other meat producer price (USD/kg)					
Overall	3.3119	2.2790	0.4163	15.1342	$N = 658$
Between	–	2.0771	1.1222	10.4964	$n = 27$
Within	–	0.8987	-1.8585	7.9497	$\bar{T} = 24.37$
Poultry producer price (USD/kg)					
Overall	2.4156	1.2043	0.7146	7.2042	$N = 613$
Between	–	1.0412	1.2396	5.4146	$n = 27$
Within	–	0.6715	0.3573	6.2245	$\bar{T} = 22.70$
Pork producer price (USD/kg)					
Overall	1.9632	0.5721	0.8033	4.7558	$N = 591$
Between	–	0.5762	1.4727	3.9583	$n = 27$
Within	–	0.3499	0.4287	3.8186	$\bar{T} = 21.89$

Notes :

The table presents descriptive statistics for producer prices of mutton & goat, beef, other meat, poultry, and pork across 27 European countries over the available period.

Source : Own calculations based on FAOSTAT producer price data.

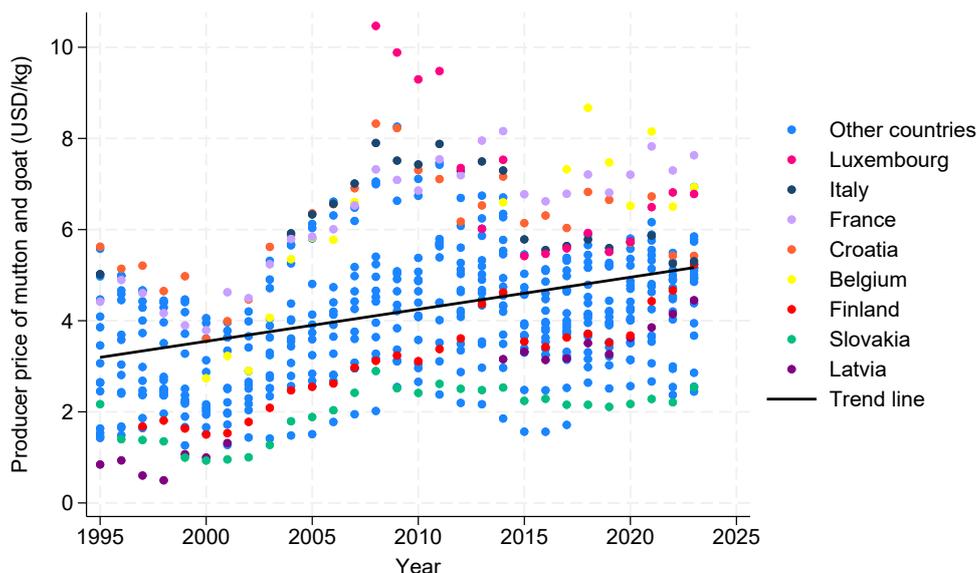
By starting by the most expensive meat, the mutton and goat category, it appears that its average price was 4.26 USD/kg (standard deviation : 1.674) during the time period and among the 27 European countries. The cheapest price observed was 0.4965 USD/kg in Latvia in 1998. In the data, the mutton price for Latvia was very low but increasing before 2001. Unfortunately, there is a gap in the data after this year and the mutton price is only available again in 2014 at 2.3785 USD/kg. The producer price continued to rise until 2023.

The highest mutton price detected in the database is 10.469 USD/kg. It was recorded in Luxembourg in 2008. The mutton producer price for Luxembourg is only available after 2008 and decreased to reach 6.7812 USD/kg in 2023.

Another information brought by the Table 4 is that, Slovakia has an average mutton price of 1.9897 USD/kg and this makes it the country with the lowest average price. In another hand, the country with the most expensive price is the Luxembourg, with an average mutton price of 7.11 USD/kg.

The minimum variation (1.08 USD/kg) regarding to the own country average comes from Belgium in 2000 and the maximum (8.773 USD/kg) from Finland in 1995. For Belgium, the producer prices were only available from 2000 and increased after that. For Finland, the data seems unreliable. Indeed, 1995 is the first price available in the database and it is very high with regard to the following years. Due to this large difference, it was decided to transform this data for Finland in 1995 into a missing value. The graph of the mutton and goat producer price before transformation could be found into the Appendix in the Figure 20.

FIGURE 9 – Producer Prices of Mutton and Goat in 27 European Countries, 1995–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for mutton and goat across 27 European countries over the period 1995–2023.

Source : Own calculations based on FAOSTAT producer price data.

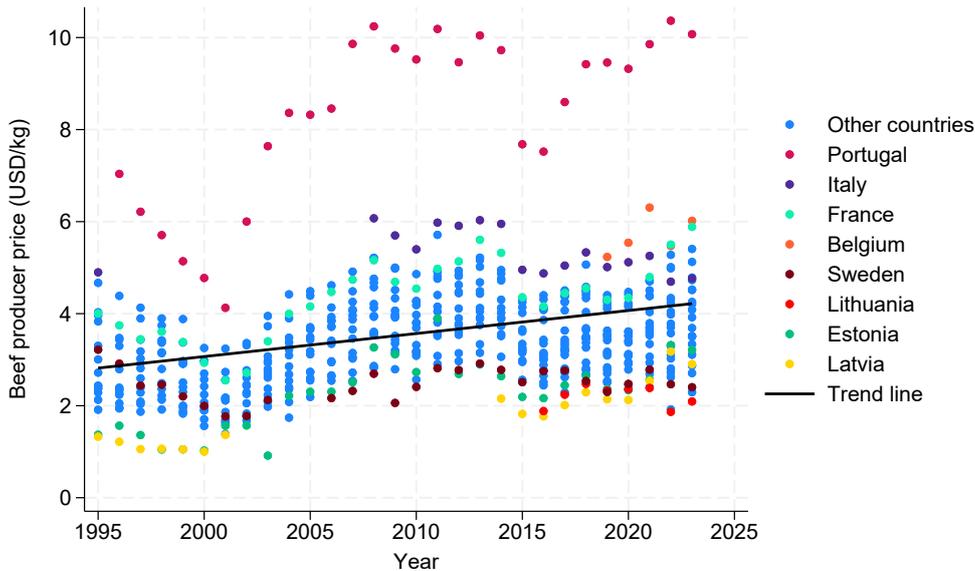
To complement these descriptive statistics, Figure 9 displays the evolution of mutton and goat producer prices for the 27 European countries. Overall, the prices show an upward trend, converging toward approximately 6 USD/kg. Some countries, such as Luxembourg, Italy, France, and Croatia, consistently exhibit higher price levels, while others, including Latvia, Slovakia, and Finland, remain below the European trend.

After reviewing the dynamics of mutton and goat prices, attention now turns to beef, the second most expensive meat category. According to Table 4, the overall average beef price is 3.5812 USD/kg, with a standard deviation of 1.5105. The lowest observed price is 0.9157 USD/kg, recorded in Estonia in 2003, while the highest value, 10.3659 USD/kg, is observed in Portugal in 2022.

Latvia displays the lowest country-level average beef price in the dataset, with a mean of 1.8245 USD/kg. In contrast, Portugal exhibits the highest average price, at 8.3175 USD/kg, consistently showing elevated producer price levels throughout the period.

Finally, the smallest deviation from a country’s own average occurs in Portugal in 2001, while the largest deviation is also found in Portugal in 2022. This pattern reflects the evolution of Portugal’s beef prices over time. Between 1996 and 2001, producer prices decreased from 7.04 to 4.13 USD/kg (with no data available for 1995). Following this decline, prices rose steadily, eventually reaching the maximum of 10.36 USD/kg in 2022.

FIGURE 10 – Producer Prices of Beef in 27 European Countries, 1995–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for mutton and goat across 27 European countries over the period 1995–2023.

Source : Own calculations based on FAOSTAT producer price data.

Figure 10, which displays beef producer prices in the European Union over the period 1995–2023, clearly shows that Portugal exhibits much higher prices than the other European countries. Other countries with comparatively high beef producer prices include Italy, France, and Belgium. In contrast, Latvia, Lithuania, Estonia, and Sweden belong to the group of countries with lower price levels.

The graph also provides information on the dispersion of the data. It appears that most European countries follow a similar upward trend over time, with the notable exception of Portugal.

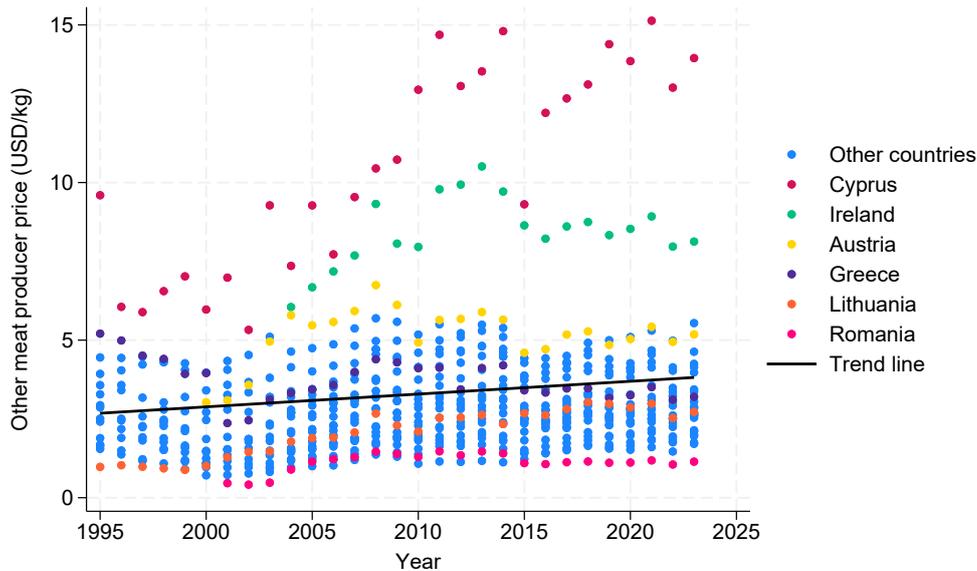
Following the examination of beef prices, the next step is to analyse the producer prices associated with the other meat category.

The overall mean producer price for the other meat category is 3.3119 USD/kg, with a standard deviation of 2.2790. The lowest recorded price is 0.4163 USD/kg, observed in Romania in 2002. As shown in the scatter plot for Romania, prices remained low but relatively stable before 2014. After this point, the producer price increased by approximately 2 USD/kg, representing a substantial change. Given the heterogeneous nature of this category, interpreting this jump is challenging.

The maximum price is recorded in Cyprus in 2021. In this case, producer prices show a sharp and sustained increase throughout the period.

Regarding the country-level means, the lowest average producer price for the other meat category is observed in Romania, with a value of 1.1222 USD/kg. Conversely, Cyprus exhibits the highest average producer price over the period, at 10.4964 USD/kg. Cyprus also displays both the minimal within-country variation in 2002 and the maximal within-country variation in 2021. This pattern reflects the substantial increase in its producer price for other meat, which rose from approximately 5 USD/kg in 1995 to about 15 USD/kg in 2023. Such a pronounced upward trend generates the widest gap between the country’s mean and its extreme yearly observations.

FIGURE 11 – Producer Prices of Other Meat in 27 European Countries, 1995–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for mutton and goat across 27 European countries over the period 1995–2023.

Source : Own calculations based on FAOSTAT producer price data.

Moreover, Figure 11 shows that Cyprus stands far above the producer prices of the other countries. The country whose producer price comes closest to that of Cyprus is Ireland ; however, aside from these two cases, the remaining countries generally remain between 1 and 5 USD/kg. Such a large gap raises questions regarding data consistency or underlying structural differences.

Another observation from the graph is that the overall trend appears to be slightly positive.

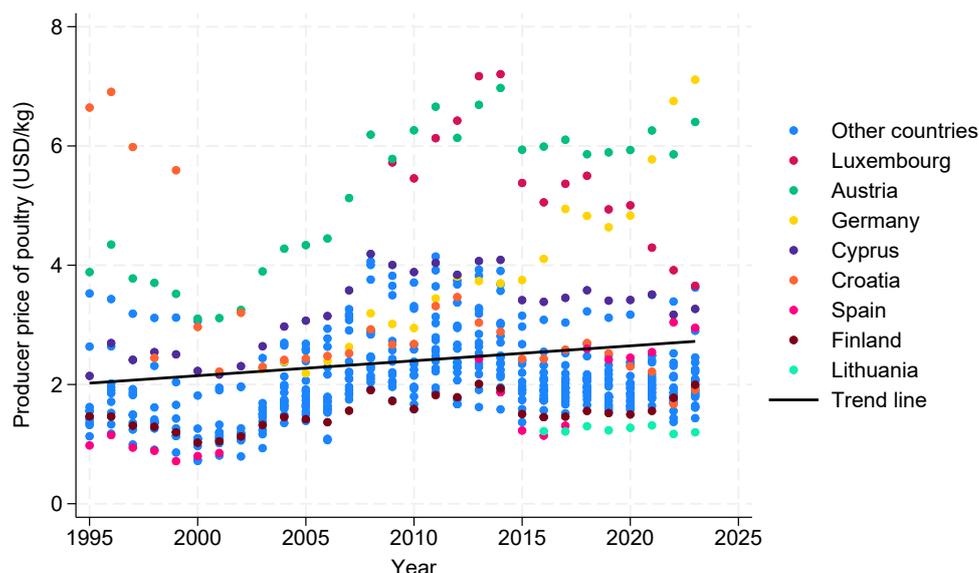
The following section focuses on poultry, a low-cost meat category that is priced above pork in the Table 4.

Regarding poultry, the lowest recorded producer price over the period was 0.7146 USD/kg in Spain in 1999, while the highest was 7.2042 USD/kg in Luxembourg in 2014. The plot for Spain shows that the price remained around 1 USD/kg between 1995 and 2001. After a gap in the data between 2002 and 2012, the series resumes at 2.40 USD/kg, decreases slightly, and then rises again. Overall, however, these fluctuations remain relatively modest.

Turning to country-level averages, the lowest mean price was 1.2396 USD/kg in Lithuania and the highest was 5.4146 USD/kg in Luxembourg. For Lithuania, only 8 observations out of 29 are available, which limits the reliability of this mean due to the large number of missing values. In Luxembourg, data are available from 2009 onward and show a continuous increase over six years, reaching the recorded maximum before declining to below 4 USD/kg.

Regarding within-country variation, the smallest deviation from its own mean price was observed for Austria in 2000. This indicates that, in that year, Austria’s poultry price was the closest to its country-specific average, representing the smallest deviation in the entire database. Table 4 also reports the largest deviation, 6.2245 USD/kg, recorded in Croatia in 1996. To better understand these cases, it is useful to refer to their graphical patterns. Figure 12 illustrates these variations clearly.

FIGURE 12 – Producer Prices of Poultry in 27 European Countries, 1995–2023 (USD/kg)



Notes : The figure presents producer prices in USD per kilogram for poultry across 27 European countries over the period 1995–2023.

Source : Own calculations based on FAOSTAT producer price data.

The Figure 12 confirms that the 2000 value for Austria lies closest to its country-specific mean and also highlights Austria’s comparatively high poultry prices relative to other countries. In the case of Croatia, the 1996 value stands out as the furthest from Croatia’s average poultry price. As shown in Figure 12, Croatia displayed unusually high prices before 2000, except for 1997, while prices in subsequent years remained around 2 to 3 USD/kg.

Among the countries with lower poultry producer prices, Lithuania and Spain stand out, as well as Finland, for which there is substantial data coverage. Among the higher-price countries, Austria and Luxembourg are strongly represented. It can also be observed that Germany, which had relatively low poultry prices in 2005, became the country with the highest poultry producer price in 2023. Finally, the overall trend for the European Union shows an upward trajectory.

Having examined the previous categories, the analysis now proceeds to the descriptive statistics for pork, identified as the lowest-priced meat type across countries and over time.

The average pork producer price in the European Union over the period was 1.9632 USD/kg, with a standard deviation of 0.5721 USD/kg. The lowest recorded value was 0.8033 USD/kg in Cyprus in 2000, while the highest was 4.7558 USD/kg in Italy in 2023. For Cyprus, the graph indicates that the pork price was around 1.30 USD/kg in 1995, declined until approximately 2000, and then displayed an upward trend thereafter. For Italy, only eight observations are available (from 2016 to 2023), yet the series shows a very sharp increase over these years.

The second row of Table 4 reports that the lowest country-level average is 1.4727 USD/kg for Belgium, while the highest average is 3.9583 USD/kg for Italy. For Belgium, data availability appears questionable : only the years 2000, 2001, and 2019–2023 are available. Nevertheless, the recorded values range from 1.2845 to 1.5863 USD/kg, indicating relatively limited variation. As explained above, the data for Italy display a sharp increase, which contributes to its relatively high average.

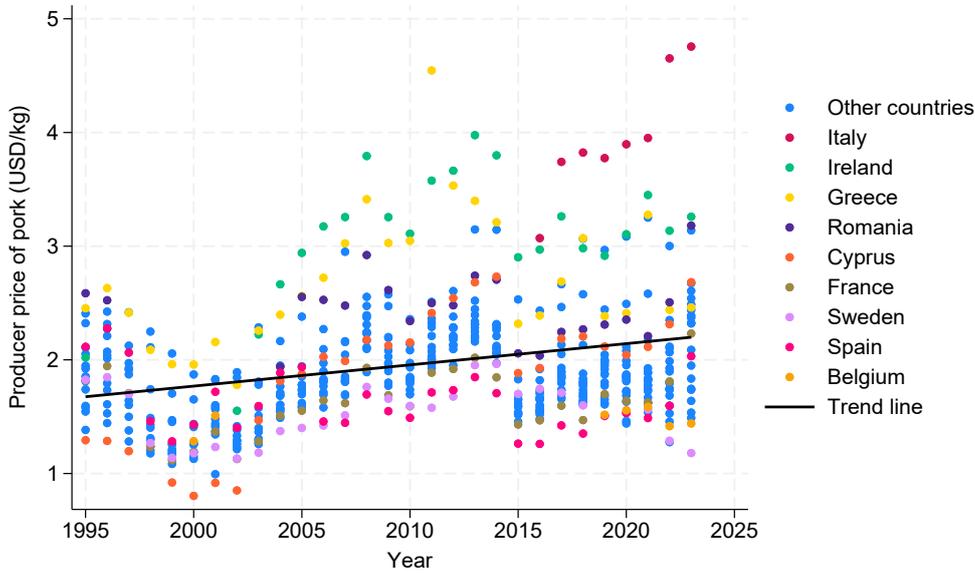
The last row of Table 4 reveals that the smallest deviation from a country’s own average occurred in Ireland in 2002 (0.4287 USD/kg), whereas the largest deviation was observed in Greece in 2011 (3.8186 USD/kg). Ireland shows an upward trend in pig prices prior to 2008,

followed by a relatively stable pattern thereafter. In Greece, the sharp deviation in 2011 corresponds to a pronounced peak in the pig producer price, reaching 4.5457 USD/kg. After this peak, the price gradually decreased, returning to its usual range. This suggests that the spike is unlikely to be a measurement error and more plausibly reflects an underlying economic activity.

The following Figure 13 display the producer prices for pig during the period 1995-2023 for each European Union. In order to have a more readable graph, only the some countries with particularities are highlighted. Specifically, the countries discussed in the descriptive statistics. This graph brought also information about the countries with higher pig producer price such as Italy, Ireland, Greece and countries with lower producer price such as France, Sweden, Spain and Belgium.

The overall trend regarding the producer price of pig seems to be increasing.

FIGURE 13 – Producer Prices of Pork in 27 European Countries, 1995–2023 (USD/kg)



Notes : The figure presents producer prices in USD per kilogram for poultry across 27 European countries over the period 1995–2023.

Source : Own calculations based on FAOSTAT producer price data.

As discussed above, these prices are intended to approximate the prices faced by consumers but are expressed in nominal terms and thus incorporate inflation. To obtain real prices, nominal producer prices are deflated using the Harmonised Index of Consumer Prices (HICP) for meat provided by EUROSTAT (2024a). In order to maximize data availability, the aggregate meat HICP is used instead of meat-specific indices. Although this approach may not perfectly capture price dynamics for each meat type, inflation trends are expected to be broadly similar across meat categories, and the improvement in data coverage is non-negligible.

The construction of real prices is identical for all meat types and can be expressed as follows :

$$p_{it}^{real,m} = \frac{p_{it}^{nominal,m}}{(HICP_{it}^{meat}/100)}, \quad \forall m \in \{\text{Beef, Pork, Poultry, Mutton, and Goat, Other Meat}\} \quad (3)$$

where $p_{it}^{nominal,m}$ and $p_{it}^{real,m}$ denote the nominal and real producer prices of meat type m in country i and year t , respectively, and $HICP_{it}^{meat}$ is the Harmonised Index of Consumer Prices

for meat (base year 2015 = 100). Unfortunately, the HICP data base for meat do not contain index for the year 1995 for .

5.2.3 Real Producer Producer Prices

The following section discusses the descriptive statistics related to producer prices obtained from FAO (2025b), which are deflated using the Harmonised Index of Consumer Prices (HICP) for meat provided by EUROSTAT (2024a), and constructed following the procedures described in Section 5.1.2. It is important to note that all prices presented in this section are expressed in real terms and converted into USD to ensure comparability across countries.

TABLE 5 – Descriptive Statistics of Real Meat Producer Prices (USD per kg)

Variable	Mean	Std. Dev.	Min	Max	Observations
Mutton and goat real producer price (USD/kg)					
Overall	4.5751	1.7604	0.8180	11.9375	$N = 605$
Between	–	1.5030	1.9977	7.0551	$n = 27$
Within	–	0.9726	1.6378	9.4575	$\bar{T} = 22.41$
Beef real producer price (USD/kg)					
Overall	3.8219	1.5098	1.2877	10.4035	$N = 563$
Between	–	1.3677	1.9287	8.4053	$n = 27$
Within	–	0.6692	-1.2951	5.8201	$\bar{T} = 20.85$
Other meat real producer price (USD/kg)					
Overall	3.5498	2.5008	0.6205	15.7402	$N = 633$
Between	–	2.3049	1.1670	12.0400	$n = 27$
Within	–	0.8140	-0.3379	7.2500	$\bar{T} = 23.44$
Poultry real producer price (USD/kg)					
Overall	2.5607	1.2527	0.7612	7.5088	$N = 587$
Between	–	1.1108	1.0825	5.7854	$n = 27$
Within	–	0.6243	-0.4092	6.8366	$\bar{T} = 21.74$
Pork real producer price (USD/kg)					
Overall	2.0763	0.5967	0.8659	4.5713	$N = 559$
Between	–	0.5426	1.3823	3.6738	$n = 27$
Within	–	0.3881	0.4569	4.1206	$\bar{T} = 20.70$

Notes : The table reports descriptive statistics for real producer prices of mutton & goat, beef, other meat, poultry, and pork across 27 European Union countries for the time period 1996-2023. Prices are expressed in constant USD per kilogram. Source : Own calculations based on FAOSTAT producer price data (FAO, 2025b) and the Harmonised Index of Consumer Prices for meat (base year 2015 = 100) from EUROSTAT (2024a)

When considering real prices, the ranking from the highest to the lowest average price remains unchanged, as expected. Indeed, the Harmonised Index of Consumer Prices (HICP) used for deflation is identical across meat types within each country and year (EUROSTAT, 2024a). However, differences arise in price levels, data availability, time coverage, and standard deviations. Missing values in the HICP database result in fewer observations and a shorter time span for real prices compared with nominal prices. The number of observations retained by

meat category is reported in Table 5. Due to missing HICP values for meat prices, the year 1995 was excluded from the analysis.

Regarding the descriptive statistics by meat type presented in Table 5, a total of 605 observations are available for 27 countries, with an average time dimension of 22.41 years was recorded for the mutton and Goat real prices. This means that the database is complete at 80% between 1996 and 2023.

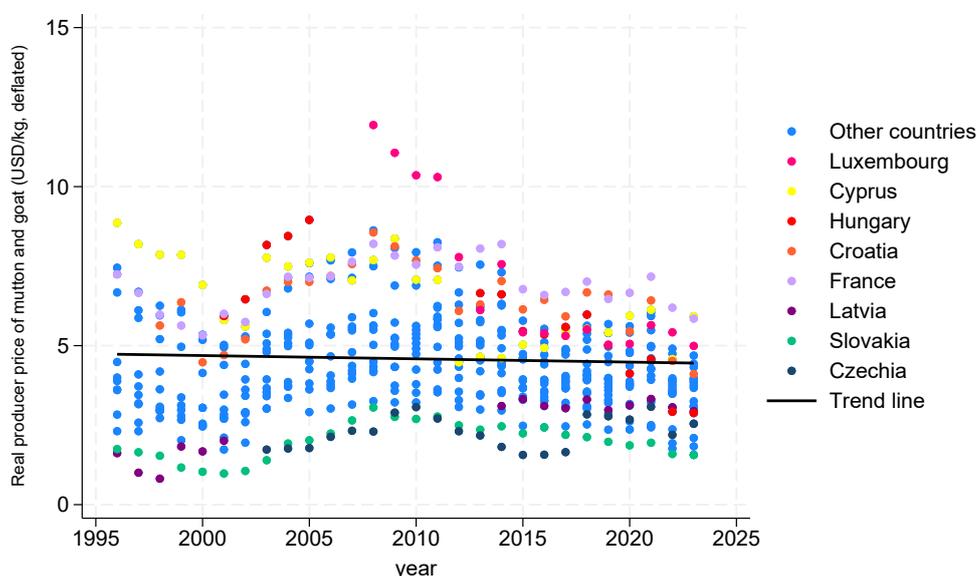
Mutton and goat meat exhibit an average real producer price of 4.5751 USD/kg, with a standard deviation of 1.7604. The lowest observed real producer price was 0.8180 USD/kg in Latvia in 1998, while the highest price was recorded in Luxembourg in 2008, reaching 11.94 USD/kg.

The between-country standard deviation amounts to 1.5030 for the full sample of real mutton and goat producer prices. Slovakia displays the lowest average real price across the period (1.9977 USD/kg), whereas Luxembourg records the highest country-level average price at 7.0551 USD/kg.

The within-country standard deviation equals 0.9726, representing approximately 21% of the average price. The smallest year-to-year deviation from a country's mean price is observed in Hungary in 2023 (1.6378 USD/kg), while the largest deviation occurs in Luxembourg in 2008, with a deviation of 9.4575 USD/kg from its own average.

Figure 14 illustrates the evolution of real mutton and goat producer prices between 1996 and 2023, highlighting both the highest and lowest country-level observations. The figure also reveals a very slight downward trend over the period.

FIGURE 14 – Producer Prices of Mutton and Goat in 27 European Countries, 1996–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for mutton and goat across 27 European countries over the period 1996–2023.

Source : Own calculations based on FAOSTAT producer price data (FAO, 2025b) and HICP meat data (EUROSTAT, 2024a).

Regarding the second most expensive meat in real terms reported in Table 5, the dataset contains 563 observations covering 27 European countries over an average of 20.85 years,

implying that approximately 75% of the potential observations are available for the period 1996–2023.

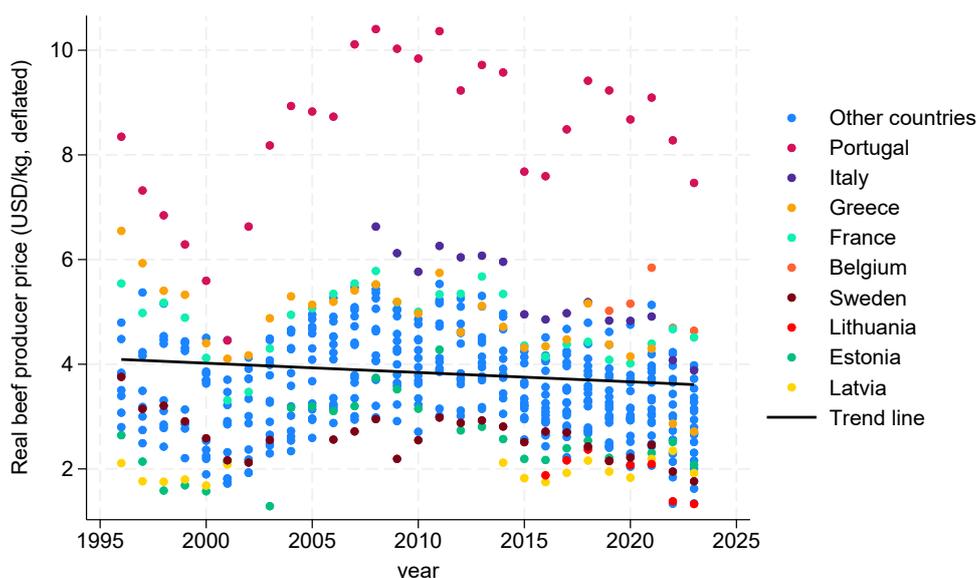
Table 5 indicates that the average real beef price is 3.82 USD/kg, with an overall standard deviation of 1.5098 USD/kg. The lowest real price recorded at the yearly level was 1.277 USD/kg in Estonia in 2003, while the highest value reached 10.40 USD/kg in Portugal in 2008.

The between standard deviation for real beef prices amounts to 1.3677 USD/kg, indicating substantial cross-country heterogeneity : on average, country-level mean prices deviate from the overall mean by approximately 1.37 USD/kg. The lowest average price over the period was observed in Lithuania (1.9287 USD/kg), whereas Portugal exhibits the highest country-level average, at 8.4053 USD/kg.

The within standard deviation equals 0.6692 USD/kg, suggesting more limited price variation over time within countries compared to cross-country differences. The smallest within deviation (−0.129 USD/kg) corresponds to Portugal in 2001, while the largest within deviation (5.9201 USD/kg) is also observed for Portugal in 2008, highlighting pronounced temporal volatility in Portuguese beef prices over the period.

Figure 15 displays the average real beef price by country and by year for 27 European countries over the period 1996–2023. The figure shows that Portugal consistently exhibits higher average prices compared to the other countries. Overall, the series displays a slightly declining trend.

FIGURE 15 – Producer Prices of Beef in 27 European Countries, 1996–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for beef across 27 European countries over the period 1996–2023.

Source : Own calculations based on FAOSTAT producer price data (FAO, 2025b) and HICP meat data (EUROSTAT, 2024a).

The analysis now turns to the descriptive statistics of the other meat category. This category comprises 633 observations for 27 European countries, with an average time coverage of 23.44 years, implying that the dataset is approximately 84% complete over the period 1996–2023.

On average, the real producer price of other meat amounts to 3.5498 USD/kg in the European Union, with an overall standard deviation of 2.5008 USD/kg. The lowest price recorded

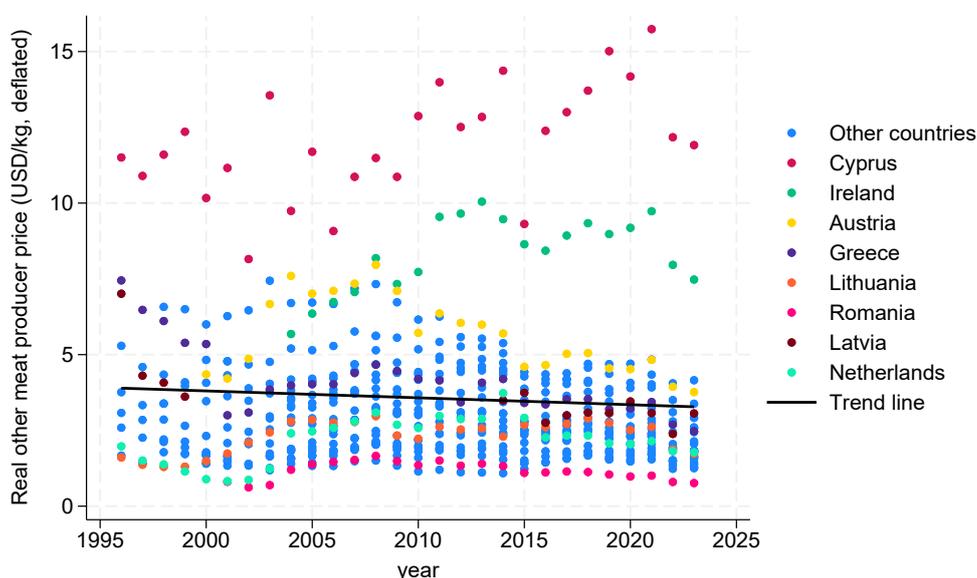
was 0.6205 USD/kg in Romania in 2002, while the highest price reached 15.7402 USD/kg in Cyprus in 2021.

The between standard deviation equals 1.1108 USD/kg, indicating substantial cross-country heterogeneity in average prices : on average, country-level mean prices deviate from the overall mean by about 1.11 USD/kg. Romania exhibits the lowest average price over the period (1.0825 USD/kg), whereas Cyprus records the highest country-level average, at 12.04 USD/kg.

The within standard deviation amounts to 0.8139 USD/kg, suggesting more limited variation over time within countries. On average, year-to-year fluctuations represent approximately 23% of the mean price of other meat. The smallest within deviation (−0.3379 USD/kg) is observed for Cyprus in 2002, while the largest within deviation (7.27 USD/kg) also occurs in Cyprus, in 2021, highlighting pronounced temporal volatility in that country.

Finally, Figure 16 illustrates that Cyprus and Ireland consistently exhibit higher real prices for other meat compared to the remaining European countries. Overall, the figure suggests a slightly declining trend in real prices over the period considered.

FIGURE 16 – Producer Prices of Other Meat in 27 European Countries, 1996–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for other meat across 27 European countries over the period 1996–2023.

Source : Own calculations based on FAOSTAT producer price data (FAO, 2025b) and HICP meat data (EUROSTAT, 2024a).

Turning now to the descriptive statistics of real poultry prices reported in Table 5, the dataset comprises 587 observations for 27 European countries, with an average time coverage of 21.74 years. This implies that approximately 78% of the potential observations are available over the period 1996–2023.

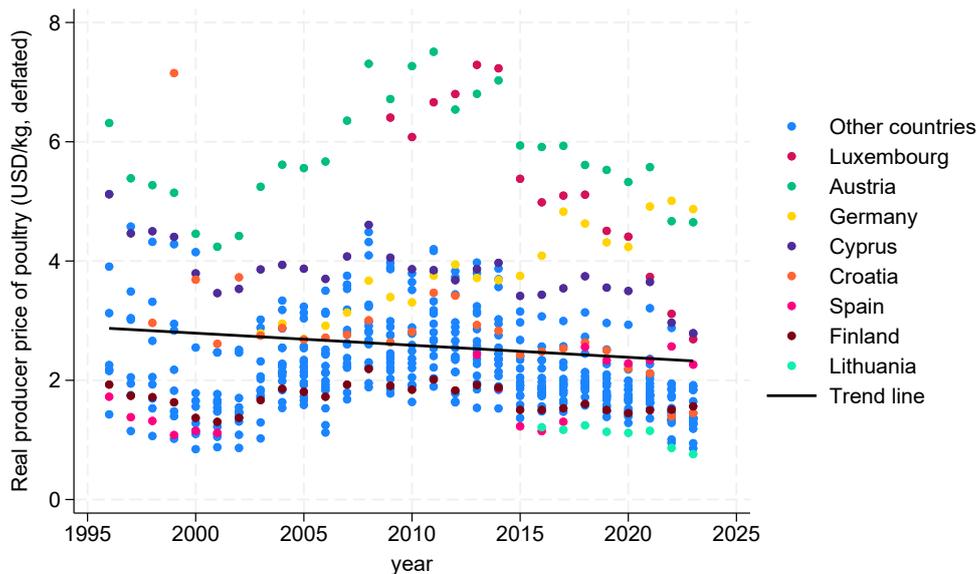
The overall average real price of poultry amounts to 2.5607 USD/kg. The lowest yearly price recorded in the dataset is 0.7612 USD/kg, observed in Lithuania in 2023, while the highest yearly price reached 7.5088 USD/kg in Austria in 2011.

The between standard deviation equals 1.1108 USD/kg, indicating notable cross-country heterogeneity in average poultry prices. Lithuania exhibits the lowest country-level average real price (1.0825 USD/kg), whereas Austria records the highest average, at 5.7854 USD/kg.

The within standard deviation amounts to 0.6243 USD/kg, reflecting more limited price variation over time within countries. The smallest deviation from a country's own mean (-0.4092 USD/kg) is observed in Luxembourg in 2023, while the largest within deviation (6.8366 USD/kg) occurs in Croatia in 1999.

Finally, Figure 17 presents the real poultry price series for the 27 European countries over the period 1996–2023. Consistent with the descriptive statistics, Austria and Luxembourg display relatively high price levels compared to other countries. The figure also illustrates the increasing availability of data over time and suggests a gradual downward trend in real poultry prices.

FIGURE 17 – Producer Prices of Poultry in 27 European Countries, 1996–2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for poultry across 27 European countries over the period 1996–2023.

Source : Own calculations based on FAOSTAT producer price data (FAO, 2025b) and HICP meat data (EUROSTAT, 2024a).

The less expensive meat of the Table 5 is Pork. Real price of pork was available for 27 countries for approximately 20.70 year. The total number of observations was 559. This correspond to a completeness of the dataset at almost 74%.

The overall mean of this database was 22.0763 USD/kg with a standard deviation of 0.5967. The smallest yearly price detected was 0.8659 USD/kg in Sweden in 2023. The highest real pork price detected was 4.5713 USD/kg in Greece in 2011.

Looking at the between standard deviation, it appears that countries' mean are on average around 0.5426 USD/kg from the overall average. The smallest average by country was 1.38 USD/kg in Hungary while the highest mean by country was 3.6738 USD/kg for Italy.

5.2.4 Gross National Income

The gross national income per capita was available in constant 2021 international dollars, adjusted for purchasing power parity. To simplify the writing, it will be abbreviated as PPP\$. The database contains 758 observations for 27 European countries over an average time span of 29.0741 years, meaning that 25 observations are missing.

TABLE 6 – Descriptive Statistics for GNI per Capita, PPP (constant 2021 international \$) (1995–2023)

	Mean	Std. Dev.	Min	Max	Observations
<i>Overall</i>	42295.39	17120.82	9377.422	102551.8	$N = 758$
<i>Between</i>		15783.51	19124.64	86732.71	$n = 27$
<i>Within</i>		6894.309	18667.06	72265.16	$\bar{T} = 28.0741$

Notes :

The table reports descriptive statistics for Gross National Income (GNI) per capita, expressed in purchasing power parity terms (constant 2021 international dollars), across 27 European countries over the period 1995–2023.

Source : Own calculations based on World Bank data.

On average, a European resident received 42,295.39 PPP\$ during the period, with a standard deviation of 17,120.82 PPP\$ per capita. The minimum recorded GNI per capita was 9,377.42 PPP\$ in Bulgaria in 1997, while the maximum reached 102,551.8 PPP\$ in Luxembourg in 2007.

Regarding country-level averages, Luxembourg exhibits the highest mean GNI per capita, at 86,732.71 PPP\$, whereas Bulgaria has the lowest, at 19,124.64 PPP\$.

The smallest deviation from a country’s own average GNI (18,667.06 PPP\$ per capita) was observed in Cyprus in 2012, highlighting the fact that, in 2012, the GNI per capita expressed the maximum negative deviation regarding the country average. The largest deviation (72,265.71 PPP\$) was detected in Ireland, in 2023. This implies that GNI in Ireland diverged the most from Ireland’s average GNI.

By observing the between end within standard deviation, it appears that, the between standard deviation is larger than the within standard deviation. This may give a hint for a random effect model. However, this must be checked in the dedicating section with statistical test.

Looking at the Figure 18 which represents the GNI for the 27 European countries between 1995 and 2023, it is clear that, the difference may reside more between countries than within countries. It is important to note that data for Luxembourg are very far from the other countries. It is the same observation for Ireland after 2015. These two countries are well know to have very high GNI and GDP due to their fiscal system among other factors. Therefore, the exclusion of these countries may be discussed.

Another observation that emerges from Figure 18 is that gross national income tends to increase over time. Since the series is expressed in PPP constant 2021 international dollars, this upward trend does not reflect inflation effects.

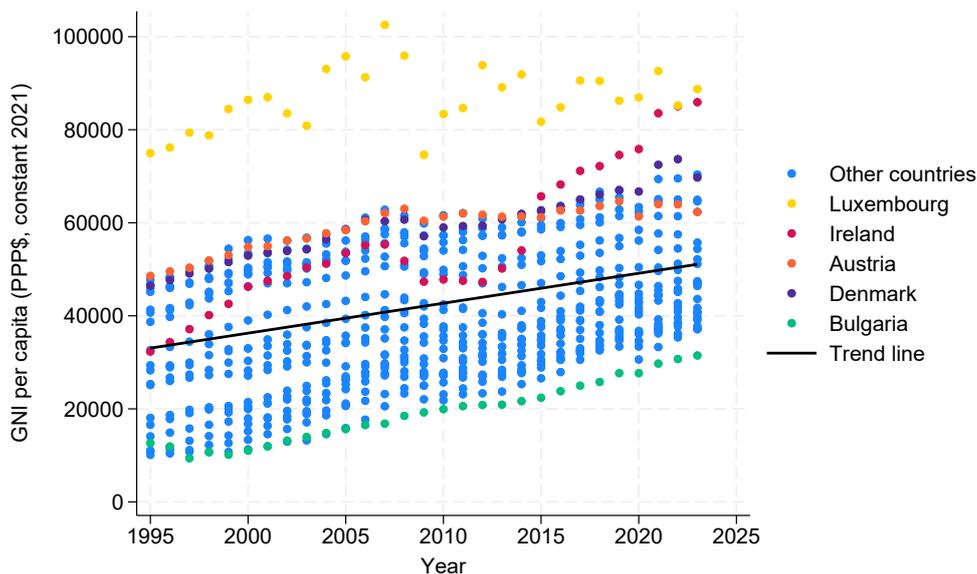
5.2.5 Urbanization

Table 7 reports the descriptive statistics for the share of the population living in urban areas. These statistics can be interpreted as follows.

In Europe, between 1995 and 2023, an average of 71.42% of the population lived in urban areas, with a standard deviation of 12.08%. The lowest annual value was observed in Slovenia in 1996, where 50.50% of the population resided in urban areas. The highest annual value was recorded in Belgium in 2021, with an urbanization rate of 98.95%.

When considering country-level averages over the entire period, Belgium appears as the most urbanised country, with a mean urban share of 98.07%. Conversely, Slovenia is the least urbanised country, with an average of 52.65% of its population living in urban areas.

FIGURE 18 – GNI in 27 European Countries, 1995–2023 (PPP, constant 2021 international dollars)



Notes : The figure presents gross national income in , PPP constant 2021 international \$ across 27 European countries over the period 1995–2023.

Source : Own calculations based on World Bank Open DATA (WORLD BANK, 2025).

TABLE 7 – Descriptive Statistics for Urban Share (1995–2023)

	Mean	Std. Dev.	Min	Max	Observations
<i>Overall</i>	0.7142204	0.1207843	0.5070448	0.9895043	$N = 773$
<i>Between</i>		0.1225148	0.5265354	0.980671	$n = 27$
<i>Within</i>		0.0233389	0.6001755	0.7946225	$\bar{T} = 28.6296$

Notes :

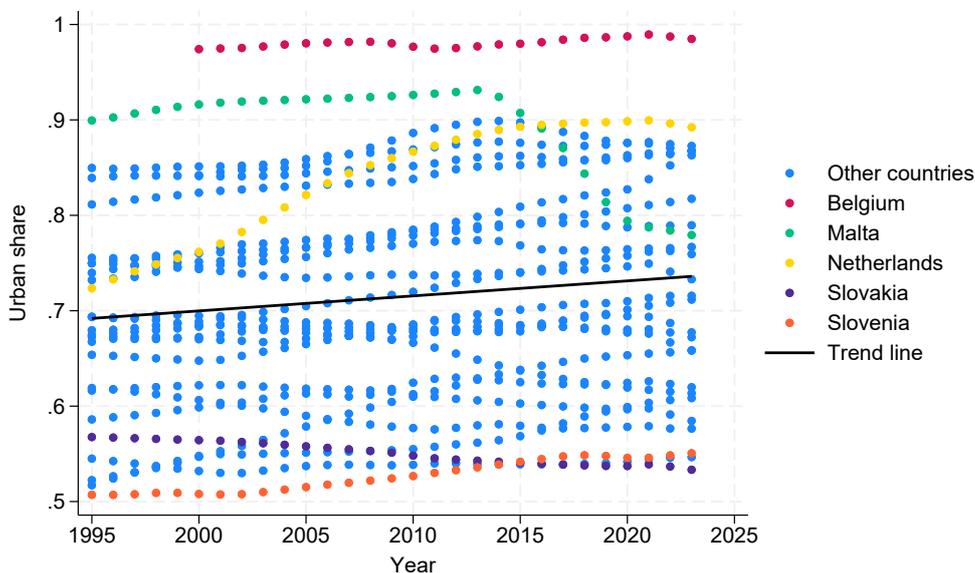
The table presents descriptive statistics for the share of population living in urban areas across 27 European countries over the period 1995–2023. Source : Own calculations based on FAOSTAT population data (FAO, 2025a).

The average within-country deviation—that is, the average distance between a country’s annual observation and its own mean—is 2.33%. Examining the extreme values, the smallest within-country deviation was observed in the Netherlands in 1995, whereas the largest occurred in Greece in 2023.

Overall, cross-country variation (12.25%) is substantially larger than within-country variation (2.33%). This indicates that differences across countries dominate temporal changes within countries. Such a pattern suggests that a random effects model may be more appropriate for the empirical analysis. Naturally, this will be formally assessed using the appropriate statistical tests in the dedicated methodology section.

Additionally, Figure 19 provides an overview of the urban population share across the 27 European countries over the period. Overall, countries tend to exhibit a slight increase in the proportion of people living in urban areas, with the exception of Malta, which shows a noticeable decline after 2015.

FIGURE 19 – Share of population living in urban area across 27 European Countries, 1995–202



Notes : The figure presents share of population living in urban area across 27 European countries over the period 1995–2023.

Source : Own calculations based on FA Annual Population Data (FAO, 2025a).

5.3 Empirical Strategy

5.3.1 Econometric Model Specifications

The following empirical model is used to analyse the demand of beef, poultry, pork, mutton and goat meat, as well as other meat, in the 27 European countries over the period 1995–2023.

For beef, pork, mutton and other meat, relative prices are constructed using poultry as the reference category, leading to the following specifications :

$$\ln q_{it}^{\text{Beef}} = \beta_1 \ln \left(\frac{p_{it}^{\text{Beef}}}{p_{it}^{\text{Poultry}}} \right) + \beta_2 \ln \left(\frac{p_{it}^{\text{Pork}}}{p_{it}^{\text{Poultry}}} \right) + \beta_3 \ln \left(\frac{p_{it}^{\text{Mutton}}}{p_{it}^{\text{Poultry}}} \right) + \beta_4 \ln \left(\frac{p_{it}^{\text{Other}}}{p_{it}^{\text{Poultry}}} \right) \quad (4)$$

$$+ \gamma_1 \ln(\text{GNI}_{it}) + \gamma_2 [\ln(\text{GNI}_{it})]^2 + \delta \text{Urban_Share}_{it} + \alpha_i + \tau_t + \varepsilon_{it}.$$

$$\ln q_{it}^{\text{Pork}} = \beta_1 \ln \left(\frac{p_{it}^{\text{Beef}}}{p_{it}^{\text{Poultry}}} \right) + \beta_2 \ln \left(\frac{p_{it}^{\text{Pork}}}{p_{it}^{\text{Poultry}}} \right) + \beta_3 \ln \left(\frac{p_{it}^{\text{Mutton}}}{p_{it}^{\text{Poultry}}} \right) + \beta_4 \ln \left(\frac{p_{it}^{\text{Other}}}{p_{it}^{\text{Poultry}}} \right) \quad (5)$$

$$+ \gamma_1 \ln(\text{GNI}_{it}) + \gamma_2 [\ln(\text{GNI}_{it})]^2 + \delta \text{Urban_Share}_{it} + \alpha_i + \tau_t + \varepsilon_{it}.$$

$$\ln q_{it}^{\text{Mutton}} = \beta_1 \ln \left(\frac{p_{it}^{\text{Beef}}}{p_{it}^{\text{Poultry}}} \right) + \beta_2 \ln \left(\frac{p_{it}^{\text{Pork}}}{p_{it}^{\text{Poultry}}} \right) + \beta_3 \ln \left(\frac{p_{it}^{\text{Mutton}}}{p_{it}^{\text{Poultry}}} \right) + \beta_4 \ln \left(\frac{p_{it}^{\text{Other}}}{p_{it}^{\text{Poultry}}} \right) \quad (6)$$

$$+ \gamma_1 \ln(\text{GNI}_{it}) + \gamma_2 [\ln(\text{GNI}_{it})]^2 + \delta \text{Urban_Share}_{it} + \alpha_i + \tau_t + \varepsilon_{it}.$$

$$\ln q_{it}^{\text{Other}} = \beta_1 \ln \left(\frac{p_{it}^{\text{Beef}}}{p_{it}^{\text{Poultry}}} \right) + \beta_2 \ln \left(\frac{p_{it}^{\text{Pork}}}{p_{it}^{\text{Poultry}}} \right) + \beta_3 \ln \left(\frac{p_{it}^{\text{Mutton}}}{p_{it}^{\text{Poultry}}} \right) + \beta_4 \ln \left(\frac{p_{it}^{\text{Other}}}{p_{it}^{\text{Poultry}}} \right) \quad (7)$$

$$+ \gamma_1 \ln(\text{GNI}_{it}) + \gamma_2 [\ln(\text{GNI}_{it})]^2 + \delta \text{Urban_Share}_{it} + \alpha_i + \tau_t + \varepsilon_{it}.$$

Where :

- q_{it}^m denotes per capita consumption of meat type m in country i and year t , measured in kilograms per year, with $m \in \{\text{Beef, Pork, Mutton, Other}\}$.
- $p_{it}^{r,m}$ is the nominal producer price of meat type m in country i and year t .
- $\ln \left(p_{it}^{r,m} / p_{it}^{r,\text{Poultry}} \right)$ represents the relative nominal price of meat type m , with poultry used as the reference category.
- $\ln(\text{GNI}_{it})$ is the logarithm of Gross National Income per capita.
- Urban_Share_{it} denotes the share of the population living in urban areas.
- α_i captures country fixed effects.
- τ_t captures year fixed effects.
- ε_{it} is the idiosyncratic error term.

For poultry consumption, a different reference category is used. Specifically, beef prices are taken as the reference, leading to the following specification :

$$\ln q_{it}^{\text{Poultry}} = \beta_1 \ln \left(\frac{p_{it}^{\text{Poultry}}}{p_{it}^{\text{Beef}}} \right) + \beta_2 \ln \left(\frac{p_{it}^{\text{Pork}}}{p_{it}^{\text{Beef}}} \right) + \beta_3 \ln \left(\frac{p_{it}^{\text{Mutton}}}{p_{it}^{\text{Beef}}} \right) + \beta_4 \ln \left(\frac{p_{it}^{\text{Other}}}{p_{it}^{\text{Beef}}} \right) \quad (8)$$

$$+ \gamma_1 \ln(\text{GNI}_{it}) + \gamma_2 [\ln(\text{GNI}_{it})]^2 + \delta \text{Urban_Share}_{it} + \alpha_i + \tau_t + \varepsilon_{it}.$$

Where :

- q_{it}^{Poultry} denotes per capita poultry consumption in country i and year t , measured in kilograms per year.
- $p_{it}^{r,m}$ is the nominal producer price of meat type m in country i and year t .
- $\ln \left(p_{it}^{r,m} / p_{it}^{r,\text{Beef}} \right)$ represents the relative nominal price of meat type m , with beef used as the reference category.
- $\ln(\text{GNI}_{it})$ is the logarithm of Gross National Income per capita.
- Urban_Share_{it} denotes the share of the population living in urban areas.
- α_i captures country fixed effects.
- τ_t captures year fixed effects.
- ε_{it} is the idiosyncratic error term.

Although fixed effects constitute the natural benchmark given the panel structure, the Hausman test is used to assess whether random effects may be appropriate. The standard Hausman test indicates that fixed effects models are more suitable for the pork specification. By contrast, it yields p-values equal to almost one for the beef, mutton and goat, and other meat regressions, and equal to 0.3149 for poultry, implying a non-rejection of the null hypothesis of no correlation between country-specific effects and the explanatory variables in these equations.

Moreover, for some specifications, the Hausman test indicates that the difference between the variance–covariance matrices is not positive definite (STATA CORP, n.d.). To further assess the reliability of these results, the *sigmamore* option was therefore employed. This leads to similar conclusions, except for the beef and poultry regression, for which the null hypothesis is rejected at, respectively, the 10% and 5% significance level. The results of the Hausman tests are reported in Table 21 in the Appendix.

However, even when random effects models are not rejected for mutton and goat and other meat, it is difficult to justify the assumption that country-specific effects are uncorrelated with the explanatory variables for some meat categories but not for others. Consequently, fixed effects models are retained for all estimations throughout the analysis. This choice is more cautious and better aligned with economic theory.

Regarding standard errors, Driscoll–Kraay standard errors are computed using `xtscc` with country fixed effects and year dummies (`i.year`) to correct for heteroskedasticity, autocorrelation, and cross-sectional dependence detected in specifications (HOECHLE, 2007). The detailed results of these diagnostic tests are provided in the following section (Tables 21 and 22).

These tests were conducted to assess whether the assumptions underlying the fixed effects estimator are satisfied and to determine the most appropriate method for calculating standard errors. The detailed justification for these choices is provided in the following section.

5.3.2 Verification of the Assumptions

To ensure the validity of the estimators, it is essential to verify the assumptions underlying the fixed effects estimator.

First, the assumption of linearity in the parameters must be satisfied. The models were constructed to meet this assumption.

Second, the random sampling assumption. The analysis focuses on European Union countries. These countries cannot be considered randomly selected, as EU membership requires meeting specific political, economic, and legal criteria, and member states are geographically clustered and economically integrated. Therefore, the random sampling assumption is violated. However, since this study specifically aims to understand consumption patterns within the EU rather than establish global consumption trends, this limitation does not compromise the main research objectives.

Third, the assumption of no perfect multicollinearity is examined. Based on the pairwise correlations reported in Appendix Tables 16 and 17, as well as in Table 18 and 19, this assumption appears to be satisfied.

To further confirm this result, Variance Inflation Factor (VIF) tests were conducted for each meat category. The resulting VIF values generally range between 1 and 3.32, indicating only moderate multicollinearity, which is not considered problematic in regression analysis. As expected, the inclusion of the squared logarithmic term of GNI leads to very high VIF values for both $\ln(\text{GNI})$ and its squared term. These high values reflect the imposed functional form rather than problematic multicollinearity. The detailed VIF results are reported in Appendix Table 20.

It should be noted that VIFs are computed from auxiliary pooled OLS regressions using the *reg* command, as this diagnostic is not available after panel estimations.

Homoskedasticity is another key assumption of the linear model. It refers to constant variability of the error term. To test this assumption, modified Wald tests for groupwise heteroskedasticity were performed using the *xttest3* command in Stata for each type of meat consumption. At the 1% significance level, all models rejected the null hypothesis of homoskedasticity, indicating the presence of heteroskedasticity.

A Wooldridge test was also conducted to test for autocorrelation in the error term. For the estimators to be consistent, the null hypothesis of no autocorrelation should not be rejected. Unfortunately, this was not the case. The *xtserial* command in Stata returned p-values below the 1% significance level.

The Wald and Wooldridge tests were performed on the base model with Fixed Effect estimator. The p-values from both tests are reported in Appendix Table 21.

Another issue addressed in the analysis concerns the presence of cross-sectional dependence in the dataset. Evidence of cross-sectional dependence was found in most specifications, except those for poultry and beef, for which no evidence of global cross-sectional dependence was detected with the Pesaran CD Test. Cross-sectional dependence refers to a situation in which the residual errors ε_{it} are correlated across countries i at a given point in time t . When detected, this dependence suggests that certain shocks within the European Union may affect multiple countries simultaneously. Such mechanisms could also, in principle, be relevant for beef and poultry markets. Therefore, additional tests were conducted to better understand why no global cross-sectional dependence was identified in these two specifications.

Specifically, three alternative tests were performed : the Breusch–Pagan LM test using the *xttest2* command, Frees’ test using *xtcsd*, *frees*, and the Friedman test using *xtcsd*, *friedman* (SARAFIDIS & WANSBEEK, 2011). The results were mixed. For both the beef and poultry regressions, the Breusch–Pagan LM test rejected the null hypothesis of no cross-sectional independence at the 1% significance level. Frees’ test also rejected this null hypothesis, whereas the Friedman test, like the Pesaran CD test, failed to reject it. A possible explanation for these

mixed results is that cross-sectional dependence in the data may be heterogeneous and characterized by both positive and negative correlations across cross-sectional units. In such a case, these correlations may offset each other, resulting in no clear evidence of a common residual correlation when tests based on average cross-sectional correlations are applied (SARAFIDIS & WANSBEEK, 2011).

Consequently, cross-sectional dependence was explicitly corrected for all regressions in order to have a cautious approach. The results of the Pesaran CD test are reported in Appendix Table 22, while the additional cross-sectional dependence tests performed for beef and poultry are presented in Appendix Table 23.

To test if the inclusion of time dummies (*i.year*) was a good strategy, an F-test for the joint significance of year fixed effects was performed using the *testparm i.year* command in Stata. The p-values obtained from these tests were all equal to zero, indicating that the year fixed effects are jointly significant and should be included in the model (PRINCETON UNIVERSITY LIBRARY, n.d.).

Given the two-way fixed effects structure (country and time) of the dataset, a high-dimensional fixed effects (HDFE) estimator, as developed by CORREIA (2016) and implemented using the *reghdfe* command, was considered an appropriate estimation strategy. However, this estimator allows heteroskedasticity and autocorrelation to be addressed through appropriate variance-covariance adjustments through clustered standard errors but not cross sectional dependence (CORREIA, 2016). However, the presence of cross-sectional dependence in all regressions required the use of the *xtscc* command to compute Driscoll–Kraay standard errors (HOECHLE, 2007), which are robust to heteroskedasticity, serial correlation, and cross-sectional dependence. To maintain control for time fixed effects in these specifications, year dummy variables (*i.year*) were included explicitly in the regressions.

Once the model assumptions had been verified and the inclusion of year fixed effects confirmed, the analysis proceeded with the estimation of the results, which are presented in the next section. All diagnostic tests were conducted on the final set of selected specifications. Table 8 summarizes the estimation strategies adopted for each meat category.

TABLE 8 – Summary of estimation strategies by meat category

Dependent variable	Estimator	Country FE	Year FE	Standard errors
Beef	FE	Yes	Yes	Driscoll–Kraay
Poultry	FE	Yes	Yes	Driscoll–Kraay
Pork	FE	Yes	Yes	Driscoll–Kraay
Mutton and goat	FE	Yes	Yes	Driscoll–Kraay
Other meat	FE	Yes	Yes	Driscoll–Kraay

Notes : FE denotes fixed effects estimation. Driscoll–Kraay standard errors are computed using the *xtscc* command and are robust to heteroskedasticity, serial correlation, and cross-sectional dependence. Country fixed effects are included in all specifications and year fixed effects are implemented through year dummy variables.

6 Results

This section presents the results of the different regressions performed to estimate the meat demand in the European Union between 1995 and 2023.

TABLE 9 – Regression Results by Meat Type Using Relative Prices (base poultry real price)

Variable	ln(Beef)		ln(Pork)		ln(Mutton)		ln(Other)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
<i>Relative prices (reference : Poultry)</i>								
ln(Rel. Beef)	-0.160	(0.139)	0.057	(0.102)	-0.091	(0.134)	-0.120	(0.200)
ln(Rel. Pork)	-0.122	(0.151)	-0.096	(0.084)	-0.199	(0.140)	-0.247	(0.185)
ln(Rel. Mutton)	0.054	(0.038)	0.177***	(0.037)	0.270*	(0.157)	-0.108	(0.133)
ln(Rel. Other)	0.392***	(0.110)	0.080	(0.085)	0.119	(0.117)	0.296***	(0.090)
<i>Income</i>								
ln(GNI)	-8.318***	(2.403)	6.046**	(2.29)	0.481	(4.564)	15.648*	(8.491)
(ln(GNI)) ²	0.394***	(0.117)	-0.268**	(0.116)	0.0396	(0.858)	-0.707	(0.417)
<i>Urbanization</i>								
Urban Share	0.935**	(0.431)	1.269***	(0.334)	3.260***	(0.731)	5.840***	(1.079)
<i>Model diagnostics</i>								
Observations	490		490		490		490	
within R-squared	0.1698		0.3915		0.3724		0.4352	
Country FE	Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes	
Number of groups	27		27		27		27	

Notes : Dependent variables are natural logarithms of per capita meat consumption (kg/year). All regressions use fixed effects with Driscoll–Kraay standard errors robust to heteroskedasticity, serial correlation, and cross-sectional dependence. Significance levels : * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Values are reported to third decimal places.

TABLE 10 – Regression Results for Poultry Consumption Using Relative Prices (base beef real price)

Variable	Coef.	Std. Err.
<i>Income</i>		
ln(GNI)	9.553***	(2.890)
[ln(GNI)]²	−0.443***	(0.140)
<i>Urbanization</i>		
Urban Share	2.193***	(0.337)
<i>Relative prices (reference : Beef)</i>		
ln(Poultry/Beef)	0.0865**	(0.041)
ln(Pork/Beef)	−0.0134	(0.065)
ln(Mutton/Beef)	0.022	(0.037)
ln(Other/Beef)	0.026	(0.099)
Constant	−49.961***	(14.840)
<i>Model diagnostics</i>		
Observations	490	
within R-squared	0.4216	
Country FE / Year FE	Yes / Yes	
Number of groups	27	

Notes : Dependent variable is the natural logarithm of per capita poultry consumption (kg/year). Poultry regression uses fixed effects with Driscoll–Kraay standard errors. * p<0.10, ** p<0.05, *** p<0.01. Values are reported to third decimal places.

6.1 Beef Consumption

The analysis begins with the results obtained for estimated beef demand. The model achieves a within R^2 of 0.1698 by using the 490 observations for beef consumption across 27 European countries over the period 1995–2023 (Table 9).

The coefficient on the relative price of beef can be interpreted as an elasticity, given the logarithmic specification of the model. Specifically, a 1% increase in the price of beef relative to poultry is associated with a 0.16% decrease in beef consumption (standard error = 0.139). This coefficient is not statistically significant and carries the expected negative sign, consistent with standard consumer demand theory. Importantly, this elasticity captures the effect of a change in the price ratio (beef relative to poultry), not the absolute beef price alone. The estimated elasticity, with an absolute value below unity, indicates that beef demand may be price-inelastic in the European Union.

To contextualize this result, it is interesting to compare it with existing literature. GALLET (2010)’s meta-analysis of meat demand studies reports median own-price elasticities for beef ranging from -0.40 to -0.60 in developed economies. In the European Union, the meta-analysis of BOUYSSOU et al. (2023) highlighted an unconditional own price elasticity for beef of -0.75. The estimate of -0.16 falls below these ranges. Several methodological factors may explain this difference. First, our specification uses relative prices rather than absolute prices, which directly captures substitution patterns within the meat basket.

Second, the consumption data of this analysis include food-away-from-home (FAFH) consumption, meaning restaurant, institutional catering, and school canteens in addition to household purchases, as describe in Section 5.1. This differs from most elasticity studies, which rely on household survey data capturing only at-home consumption. With FAFH consumption, consumers do not directly observe input prices, menu options are constrained, and institutional procurement often operates under long-term contracts. Since FAFH is included in the quantity consumed in this analysis, the aggregate elasticity reflects a weighted average of the at-home segment and the away-from-home segment. This compositional difference likely is a source of difference in the estimated elasticity compared to studies focusing exclusively on household purchases.

Another possible explanation could be that meat demand was more elastic in the past, as GALLET (2010)’s analysis is based on data mostly prior to 2000. It is therefore possible that the price elasticity of meat demand has evolved over time. Naturally, this question requires further investigation.

Regarding the cross-price effects, the coefficient on relative pork prices is negative but statistically insignificant at the 10% level (-0.122 with s.e. 0.151). While economic theory would predict positive signs, indicating that higher pork relative prices lead to substitution toward beef, the observed negative coefficients may reflect either weak complementarity or, more likely, imprecise estimation. Given the lack of statistical significance and the small magnitude, it can be concluded that changes in pork price relative to poultry do not significantly affect beef consumption in the sample.

The coefficients on relative mutton prices is positive but also statistically insignificant at the 10% level (0.054 with s.e. 0.038). It can be interpreted as an increase by 1% of the relative price of mutton may be associated with an increase of 0.054 % of beef consumption. This result follows economic theory as it exhibits positive signs, indicating that higher mutton prices lead to substitution toward beef. However, regarding the lack of statistical significance and the very small magnitude, it can be concluded that changes in relative mutton prices to poultry do not significantly affect beef consumption in our sample.

In the literature, BOUYSSOU et al. (2023) exposed a positive cross-price elasticity between the price of pork and the consumption of beef indicating a substitution relationship as expected by economic theory. Unfortunately, they do not assess implicitly the cross-price elasticity of

mutton. FOUSEKIS et REVELL (2000) did it for the UK between 1989 to 1999 and found as expected positive coefficient.

Table 9 shows a positive effect of changes in the price of other meat relative to poultry prices on beef consumption. Specifically, a 1% increase in the relative price of other meat is associated with a 0.3922% increase in beef consumption. This coefficient is statistically significant at the 1% level, with a standard error of 0.11. The category of other meat includes products that are consumed in relatively small quantities and already have relatively high nominal prices, placing them among the most expensive meat categories. An increase in their prices may therefore induce consumers to substitute away from these meats toward beef, which is more widely consumed and may be perceived as a more accessible alternative.

Examining the impact of income on beef consumption, the model reveals a U-shaped relationship between GNI per capita and beef demand. Specifically, the estimated coefficient on $\ln(\text{GNI})$ is negative (-8.318), while the coefficient on its squared term is positive (0.394). Both coefficient are significant at the 1% level.

This pattern suggests that, at lower income levels, increases in income are associated with declining beef consumption, whereas after reaching a turning point, higher income leads to renewed growth in beef demand. This relationship is described by Engel curves, which capture how consumption responds to changes in income. The estimated coefficients imply a minimum at 38,081.032 PPP (constant 2021 international dollars). Below this threshold, beef consumption decreases as income increases, indicating that beef behaves as an inferior good over this income range.

Beyond the turning point, beef consumption increases with income, reflecting a transition to a normal good. Although the Engel curve becomes convex over this range, suggesting increasing income responsiveness, the maximum income elasticity observed in the sample is approximately 0.78, which remains below the theoretical threshold of unity. Therefore, beef cannot be classified as a luxury good in the strict microeconomic sense. Instead, within the observed income range, beef behaves as a normal good at higher income levels (DEATON & MUELLBAUER, 1980).

The estimated turning point occurs at a GNI per capita of 38,081.032 PPP (constant 2021 international dollars). An examination of the countries included in the analysis indicates that all 24 countries had reached this income level in 2023 and are therefore situated on the upward-sloping segment of the income-beef consumption relationship. Three countries, Latvia, Bulgaria and Slovakia have not yet reach this level of GNI per capita.

In the literature, income is often replaced by total consumption expenditure, which is the variable available in the meta-analysis of BOUYSSOU et al. (2023). They report an uncompensated expenditure elasticity of 0.77 for the European Union, which is consistent with the characteristics of a necessity good.

The final control variable considered is the share of the population living in urban areas. The results indicate that an increase of one percentage point in the urban population share is associated with a 0.935% increase in beef consumption. This coefficient is statistically significant at the 5% level and has a standard error of 0.431.

For comparison, MILFORD et al. (2019) reported a positive effect of urbanization on ruminant meat consumption (coefficient : 8.6, s.d. 5.8) using global data in 2005 and 2011. The substantially smaller coefficient in the current study may reflect differences in geographic scope (EU-specific vs global), the time period analysed, or the fact that European countries have largely completed their urbanization transition. Indeed, the average share of the population living in urban areas in the sample was 71.42%. With this limited remaining within-country variation in urban shares, making the effect difficult to identify precisely in our sample.

6.2 Pork Consumption

The second set of regression results presented in Table 9 relates to pork consumption in the European Union between 1995 and 2023. The regression is based on 490 country–year observations for 27 European countries and achieves a within R-squared of 39.15%.

Examining the impact of the relative beef price, the results indicate that a 10% increase in the relative price of beef is associated with a 0.57% increase in pork consumption. However, this effect is not statistically significant at the 10% level (standard error = 0.102). The positive sign of the coefficient may suggest a substitution between beef and pork. This result aligns with the literature. Indeed, BOUYSSOU et al. (2023) estimated a compensated cross-price elasticity for pork regarding the price of beef of 0.15 in the European Union. This result was conditional on meat demand and emphasized only positive cross-price elasticities around the world. Thus difference in coefficient is expected.

Where, then, might this difference originate? Interpreted in relative terms, the result implies that when beef becomes 10% more expensive relative to poultry, consumers tend to slightly increase their pork consumption. One possible explanation relates to income effects stemming from the increase in beef prices. Given that beef represents a substantial share of household meat expenditure, an increase in its relative price reduces the real income available for overall consumption, including pork. This negative income effect may marginally reduce pork consumption if pork is a necessity, leading to a Marshallian elasticity that is lower than the Hicksian elasticity, in line with the Slutsky decomposition (DEATON & MUELLBAUER, 1980, p. 62).

Second, and more generally across the entire dataset, this study is based on total food available for consumption rather than solely on food consumed at home. As a result, food-away-from-home consumption is also included. In such contexts, consumers are likely to be less aware of relative price differences between meat types, which may further attenuate substitution responses.

Subsequently, Table 9 reports what can be interpreted, with caution, as the own-price elasticity of pork. The results indicate that a 10% increase in the relative price of pork is associated with a 0.96% decrease in pork consumption in Europe. The coefficient carries the expected negative sign. However, its magnitude is relatively small, suggesting that pork consumption is inelastic with respect to its relative own price. It should be noted that this coefficient is not statistically significant at the 10% level and has a standard error of 0.084.

In the literature, BOUYSSOU et al. (2023) report an uncompensated own-price elasticity of pork equal to -0.79 . Similarly, based on 665 observations, GALLET (2010) find an average own-price elasticity for pork of -0.78 . Although the signs of these elasticities are consistent with the results obtained in the current analysis, the magnitude of the estimated elasticity is smaller.

As discussed previously, the use of relative prices rather than absolute prices may partly explain this difference. In addition, the inclusion of food-away-from-home (FAFH) consumption is likely to be a major contributing factor, as it represents the main distinction between this study and most existing meta-analyses.

The following coefficient to interpret is the elasticity between pork consumption and the relative price of mutton. The coefficient of 0.177 was found statistically significant at the 1% level with a standard error of 0.037. This may be interpreted as, an increase of the mutton relative price regarding poultry by 10% may be associated with an increase of pork consumption by 1.77%. The sign of this coefficient evokes a substitute relationship between mutton and pork consumption.

Comparing this result to the existing literature, it arises that, a study done in the United Kingdom for the period 1989-1999 found also evidence of substitution effect between the price of lamb and the pork consumption (FOUSEKIS & REVELL, 2000). However, their Hicksian Elasticity being 0.391, they interpreted this as a limited substitute as the change in pork

consumption relative to lamb price. In addition, they estimated a Marshallian Elasticity of 0.281, smaller to the Hicksian's one. This Marshallian elasticity may be compared to the coefficient respectively studied in the current analysis. This finding may further support the interpretation of pork as a necessity good.

For the cross-price elasticity related to the other meat category, the situation appears similar to that observed for the cross-price elasticity with respect to mutton, pointing toward a substitution effect. The estimated coefficient is 0.080 (standard error : 0.085), but it is not statistically significant at the 10% level. This may be interpreted as a 1% increase in the relative price of other meat compared to poultry may be associated with a 0.08% increase in pork consumption, although this effect cannot be confirmed statistically. As other meat categories are rarely included in the literature, comparability with previous studies remains limited. However, the small coefficient indicates a limited substitution.

Regarding the influence of GNI on pork consumption, the model estimates a coefficient of 6.046 (standard error 2.29), statistically significant at the 5% level, for the logarithm of GNI. The coefficient on the squared logarithmic term of GNI is estimated at -0.268 (standard error 0.116), significant at the 5% level.

This specification implies an inverted U-shaped relationship between income and pork consumption, with a turning point estimated at 79,654.605 PPP (constant 2021 international dollars). However, this level of GNI is reached by only two countries in the sample : Luxembourg since 1999 and Ireland since 2021. Consequently, the observed relationship is primarily characterized by a positive association between income and pork consumption over the entire income range considered.

A detailed analysis of the estimated income elasticities by country indicates that pork behaved as a superior good in Bulgaria between 1996 and 2001, in Lithuania between 1995 and 1996, in Latvia between 1995 and 1998, and in Romania between 1995 and 2001. By contrast, pork appears to be an inferior good in Ireland and Luxembourg after surpassing the income threshold, while it behaves as a necessity good in the remaining countries and years. Overall, these results suggest that pork consumption generally exhibits the characteristics of a necessity good (DEATON & MUELLBAUER, 1980).

Regarding the findings of previous studies, the meta-analysis conducted by BOUYSSOU et al. (2023) reports an estimated uncompensated expenditure elasticity of 0.50 for the European Union, which is consistent with the classification of meat as a necessity good. In addition, WHITTON et al. (2021) identifies a tipping point of approximately USD 40,000 in GDP per capita worldwide over the period 2000–2019. Beyond this threshold, further increases in GDP per capita do not appear to be associated with higher levels of total meat consumption. This threshold is nevertheless lower than the one identified in the present analysis. This difference may stem from the fact that WHITTON et al. (2021) estimates the relationship at the global level, rather than focusing exclusively on the European Union.

The last coefficient relates to the effect of urbanisation on pork consumption. The results suggest that a one percentage point increase in the share of the urban population is associated with a 1.269% increase in pork consumption. This coefficient is statistically significant at the 1% level, with a standard error of 0.334.

The positive sign is consistent with the findings of MILFORD et al. (2019), who also report that meat consumption tends to increase with urbanisation worldwide. They further identify the share of the urban population as the third most important driver of global meat consumption. However, in this database, the urbanisation rate is relatively high and exhibits limited variation, as shown in Table 7. This limited within-country variation may explain the relatively modest magnitude of the estimated effect in the European sample.

6.3 Mutton and Goat Consumption

The following section discusses the results presented in Table 9 regarding the consumption of mutton and goat meat. These results are based on the same specification and estimation method described earlier and summarised in Table 8. The estimation exhibits a within R-squared of 37.24% and is based on the 490 available observations.

Starting with the cross-price impact of the relative price of beef regarding poultry, it appears that an increase of 10% of the relative price of beef may be associate with a decrease of mutton and goat consumption by 0.62%. This coefficient is not significant at the 10 % level and has a standard deviation of 0.14.

The estimated cross-price elasticity between beef prices and mutton consumption is negative, suggesting that an increase in the relative price of beef by 1 % is associated with a decrease in mutton demand by 0.091% (s.e : 0.134). This sign of cross-price elasticity is theoretically associated with complementary goods. At first sight, this may seem at odds with the usual expectation of substitutability between meats. However, FOUSEKIS et REVELL (2000) report a very small positive Hicksian cross-price elasticity (around 0.05) for United Kingdom between 1989 and 1999, indicating only weak substitution in compensated terms. Given that, it is possible that a rise in beef prices may generate a negative income effect, reducing overall meat consumption, including mutton. In such a context, the negative Marshallian cross-price elasticity found here can be interpreted as the result of a negative income effect dominating a very small substitution effect. And this negative sign is also align with the Marshallian cross-price elasticity, -0.113, found by FOUSEKIS et REVELL (2000). Furthermore, the use of relative prices in the present specification implies that the estimated elasticities are not directly comparable to those obtained in a structural demand system such as the one used by FOUSEKIS et REVELL (2000) and therefore may be responsible of the difference between coefficients.

The second coefficient can be interpreted as the cross-price elasticity between the relative price of pork and mutton consumption. The results suggest that a 1% increase in the relative price of pork is associated with a 0.199% decrease in mutton consumption (s.e. = 0.140). This negative cross-price elasticity may indicate that mutton and pork behave as complementary goods. However, the same reasoning as for the relative price of beef appears to apply : an increase in the price of pork reduces real income, potentially outweighing the positive substitution effect. It should also be noted that the estimated coefficient is not statistically significant, and that the larger coefficient reported by FOUSEKIS et REVELL (2000), relative to that for beef, suggests that the observed difference may also stem from estimation uncertainty.

In addition, the decomposition between Hicksian and Marshallian elasticities in FOUSEKIS et REVELL (2000) does not reflect the same pattern, as both elasticities are positive, indicating substitution rather than complementarity. Differences in sample composition (countries and time period), estimation methods, and variable construction may contribute to this discrepancy.

The next coefficient estimated in the regression was the relative price of mutton and goat. It appears that, if the relative price of mutton regarding poultry becomes 1% more expensive, the consumption of mutton increase by 0.270%. This coefficient is significant at the 10% level and has a standard error of 0.157. Naturally, this finding does not align with the law of demand (VARIAN, 2019). Indeed, when the price of a good increase, its consumption tend to decrease. Moreover, GALLET (2010) and FOUSEKIS et REVELL (2000) exposed negative own-price elasticity. However here, it is not really the price of mutton only but its relative price regarding the price of poultry. However, doing the same regression with the real price also lead to a positive own-price elasticity. This coefficient will be discussed more in detail with the estimated income elasticity.

Looking now at the coefficient estimated regarding the income, it appears that, both coefficient were positive and not significant at the 10 % level. In particular, 0.481 (s.e. : 5.564) for $\ln(GNI)$ and 0.0396 (s.e. : 0.858) for $[\ln(GNI)]^2$ These coefficient suggest that the Engel

curve is increasing and convex over the income range considered. In addition, by calculating the elasticity by country by year, the minimal elasticity in the database is 1.20 and the maximal is 1.39. Indicating that mutton and goat may be superior goods.

The results obtained here contrast with those reported in FOUSEKIS et REVELL (2000), who estimated an expenditure elasticity of 0.588 for lamb in the United Kingdom over the period 1989–1999. One possible explanation for this discrepancy lies in the geographical scope of their analysis, which focused on England, Scotland, Wales and Northern Ireland. As illustrated in Figure 6, Ireland (and more broadly the UK) historically exhibits much higher levels of mutton and goat consumption than most European countries (KANERVA, 2013).

Differences in identification strategy and modelling choices may also account for part of the divergence, particularly since the coefficients obtained here were not statistically significant under the quadratic income specification. To partially test this hypothesis, the model was re-estimated using only the logarithmic form of GNI (excluding the quadratic term). Under this specification, the coefficient became 1.2848 (standard error 0.3086, significant at the 1% level), while the remaining coefficients remain relatively stable. In a log–log model, this estimate can be interpreted as an income elasticity, suggesting that mutton and goat behave as superior goods for the 27 European countries over the period 1995–2023.

To assess the coherence of the estimated own-price and income elasticities for mutton and goat, the Slutsky equation can be expressed in elasticity form as follows (DEATON & MUELLBAUER, 1980, p. 62) :

$$e_{ik} = e_{ik}^* - e_i w_k \quad (9)$$

where e_{ik} denotes the Marshallian (uncompensated) own-price elasticity, e_{ik}^* the Hicksian (compensated) own-price elasticity, w_k the budget share of mutton and goat, and e_i the income elasticity of demand.

Given the estimates obtained in this study ($e_{ik} = 0.27$ and $e_i = 1.2848$), the Slutsky decomposition yields :

$$e_{ik}^* = 0.27 + 1.2848 w_k \quad (10)$$

Since the budget share w_k is strictly positive, this implies that the Hicksian elasticity would be even larger than the Marshallian one. Such a configuration is inconsistent with standard consumer theory, as a positive own-price elasticity combined with a positive income elasticity (especially above unity) cannot correspond to a Giffen good. This suggests that the estimated price coefficient is unlikely to reflect a genuine behavioural response, but may instead capture price endogeneity (DEATON & MUELLBAUER, 1980). In addition, mutton consumption shows limited within variation, which may reduce the ability to accurately estimate the true effect.

The next relationship analysed concerns the relative price of the other meat category. It appears that a 1% increase in the relative price of other meat is associated with a 0.119% increase in mutton and goat consumption. This coefficient is not statistically significant and has a standard error of 0.117. Given the heterogeneity of this category, comparison with specific meat types is difficult. However, this uncompensated cross-price elasticity suggests a small substitution effect between these two meat categories. Therefore, consumers would tend to purchase mutton instead of other meat categories when the price of the latter increases.

Finally, the coefficient for urban share is 3.260 (standard error : 0.731), statistically significant at the 1% level. According to the literature, the share of population living in urban areas was found to have a positive impact on total meat consumption worldwide in 2000 and 2011 (MILFORD et al., 2019). However, KANERVA (2013) reports a significant negative relationship between sheep consumption and urbanisation in Hungary and the United Kingdom over the period 1961–2007. The author explains this relationship in the United Kingdom by noting

that the country has historically been a high consumer of mutton, but that rising urbanisation may have contributed to the erosion of certain consumption traditions. As mutton and goat consumption is relatively limited in other countries (see Figure 6), the opposite sign observed in the present analysis may be related to differences in consumption levels across countries.

In conclusion, this equation seems affected by issues concerning the implied own-price elasticity. These limitations will be further addressed in Section 8.

6.4 Other Meat Consumption

This section of the analysis focuses on the coefficient estimated for the consumption of other meat types. While the four most consumed meats were analysed separately, certain meat consumption does not fall into it. These later were included in order to provide a more complete picture of meat consumption in Europe. However, it should be noted that this category represents a relatively low level of consumption.

The inclusion of an other meat category is uncommon in the literature. One exception is BOUYSSOU et al. (2023), who estimate own-price and expenditure elasticities for an aggregated category that also includes mutton. As a result, their definition does not correspond to the one adopted in this study. This limits the comparability of the findings with those of previous research.

Looking at the gross national income, it appears that the coefficient of $\ln(\text{GNI})$ is 15.648, significant at the 10% level with a standard error of 8.491. Regarding the coefficient of the quadratic form of $\ln(\text{GNI})$, the estimated coefficient is -0.707 (standard error : 0.417). This coefficient was not found statistically significant. These opposite signs suggest an inverted U-shaped Engel curve, with positive income elasticity for income levels below a certain threshold and negative elasticity beyond it.

By looking at the estimated income elasticities, it appears that for some countries *other meat* may behave as a luxury good. Indeed, Bulgaria, Croatia, Cyprus, Czechia; Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia exhibit income elasticities above unity, at least three years, implying superior behaviour.

Other countries display income elasticities between 0 and 1, suggesting that the other meat category can be considered a necessity in all countries except Bulgaria and Luxembourg. Moreover, all remaining countries exhibit elasticities between 0 and 1 for at least six years during the sample period.

Finally, some countries appear to have passed the threshold where income elasticity becomes negative : Austria, Germany, Denmark, Ireland, Luxembourg, Netherlands and Sweden. For these countries, *other meat* becomes an inferior good.

The estimated tipping point is 64,241.522 PPP (constant 2021 international dollars). Beyond this level of GNI, the consumption of other meat tends to decrease as income increases. Note that some countries appear in more than one elasticity category, which is expected since the quadratic specification allows income elasticities to vary with GNI over time.

Analysis now the coefficient linking the relative price of beef to the consumption of the other category, it appears that a 1% increase in the relative price of beef with respect to poultry may be associated with a 0.120% decrease in the consumption of other meat. Such a result suggests complementarity between the two meat types. To verify this interpretation, the Slutsky decomposition (Equation 9) is used to analyse how the sign of the Hicksian elasticity depends on the income elasticity (DEATON & MUELLBAUER, 1980, p. 62).

First, in countries where other meat exhibits a positive income elasticity, a negative Marshallian cross-price elasticity combined with a positive income effect leads to a Hicksian cross-price elasticity that is smaller in absolute value, thereby reducing the degree of complementarity between the two goods. By contrast, in countries where other meat behaves as an inferior good and displays a negative income elasticity, the Hicksian cross-price elasticity tends to be larger in absolute value, reinforcing the complementarity between the two meats.

The cross-price elasticity of the relative price of pork may follow a similar path. The estimated Marshallian cross-price elasticity with respect to the relative price of pork (relative to poultry) is -0.335 (standard error : 0.175), significant at the 10% level.

The next variable considered is the relative price of mutton to poultry. The estimated coefficient is -0.108 (standard error = 0.133) and is not statistically significant. This estimate can be interpreted as indicating that a 1% increase in the relative price of mutton is associated

with a 0.108% decrease in other meat consumption. As discussed for the Marshallian cross-price elasticity with respect to the relative price of beef, the income effect reinforces complementarity in countries where other meat behaves as an inferior good, while it weakens complementarity in countries where other meat exhibits a positive income elasticity.

Although these estimated coefficients are not statistically significant at conventional levels. They suggest weak or inconclusive evidence of complementarity between prices of beef, pork, mutton, and other meat consumption.

Looking now at the coefficient associated with a change of the relative price of other meat regarding poultry. The model estimated that an increase of 1 % of the relative price of other meat may be associated with an increase in other meat consumption by 0.296 % (standard error 0.09 and significant at the 1% level). As for the model for mutton and goat, it is not usual to find such result. Indeed, such a result would be at odds with standard demand theory (VARIAN, 2019), particularly in the presence of strong statistical significance. Nevertheless, the estimate may suffer from bias arising from the limited within variation in consumption or from potential reverse causality between consumption and price. These concerns will be further addressed in Section 8.

The last coefficient to analyse is the one associated with urban share. The model estimates that a one–percentage point increase in the population living in urban areas may be associated with an increase of 5.84 in other meat consumption (standard error : 1.079), significant at the 1% level. This may indicate that living in urban areas provides consumers with access to a wider variety of meat products. This result is consistent with the idea that urban environments offer more diverse distribution channels, cultural influences and consumption opportunities compared to rural settings (MILFORD et al., 2019).

This subsection is less developed due to the heterogeneity of this meat category and the limited number of comparable studies or statistically significant relationships. Moreover, the limited variation in consumption may restrict the additional insights that can be drawn from the results.

6.5 Poultry Consumption

As mentioned in the methodology section, the specification for poultry consumption differs from the previous models. Relative prices were computed with respect to real beef prices, and fixed-effects estimations with Driscoll–Kraay standard errors were used to estimate the coefficients (HOECHLE, 2007). The simplified results of this regression are presented in Table 8. The number of observations used in the regression is 490 and it reaches a within R-square of 42.16%.

Looking first at GNI, the regression estimates a coefficient of 9.553 (standard error : 2.890), significant at the 1% level. For the quadratic term of GNI, the estimated coefficient is -0.443 (standard error : 0.140), also significant at the 1% level. These two coefficients indicate an inverted U-shaped Engel curve. For countries with GNI below the turning point, poultry consumption appears to increase with income, suggesting that poultry is perceived as either a necessity good or a superior. Beyond this threshold, consumption decreases with income, indicating an inferior good. This peak in meat consumption aligns with the findings of MILFORD et al. (2019) who found turning point in overall meat consumption around USD 40,000 of GDP per capita which is around the tipping point found for poultry.

Indeed, the estimated turning point is 47,917.681 PPP (constant 2021 international dollars). Within the dataset, 12 out of the 27 countries reach this level at some point during the sample period, namely Austria (29 periods), Belgium (28 periods), Denmark (27 periods), Finland (24 periods), France (20 periods), Germany (26 periods), Ireland (18 periods), Italy (21 periods), Luxembourg (29 periods), Malta (5 periods), the Netherlands (28 periods), and Sweden (24 periods).

Using the estimated coefficients and GNI to compute income elasticities at the country–year level, the minimum estimated elasticity is -0.6744 and the maximum is 1.4449. Overall, five countries record an income elasticity greater than unity at least once over the 29-year period : Bulgaria (10 periods), Latvia (7 periods), Lithuania (6 periods), Poland (2 periods), and Romania (10 periods). Countries exhibiting negative income elasticities—indicating that poultry behaves as an inferior good—are those that have surpassed the income threshold. In contrast, the remaining countries display income elasticities between 0 and 1, suggesting that poultry generally behaves as a necessity good.

Turning to urbanization, the estimated coefficient is 2.193 (standard error : 0.337), significant at the 1% level. A one-percentage-point increase in the urban population share is associated with a 2.193% increase in poultry consumption. This aligns with the literature. Indeed, MILFORD et al. (2019) also found urbanization to be among the strongest drivers of meat demand globally.

Turning to the relative price of poultry with respect to beef, the coefficient indicates that a 1% increase in this relative price is associated with an increase of poultry consumption by 0.0865%. The standard error is 0.0663, and the coefficient is not statistically significant. This result suggests that when poultry becomes more expensive relative to beef, consumption still increases. This result appears to contradict the law of demand (VARIAN, 2019). Examining the construction of the coefficient can help explain this outcome.

Firstly, this coefficient can be decomposed as the own-price elasticity (with respect to poultry’s own price) minus the cross-price elasticity (with respect to beef price). The literature reports a negative own-price elasticity for poultry, as found by BOUYSSOU et al. (2023) for the EU and also by GALLET (2010); cross-price elasticities with respect to beef are generally positive, as documented by BOUYSSOU et al. (2023) and FOUSEKIS et REVELL (2000). Together, this should theoretically yield a negative coefficient. A positive coefficient would imply complementarity between poultry and beef, which is not supported by most studies.

To verify this result within our dataset, a regression using real prices was conducted. It also leads to a positive and significant (at the 10% significant level) own-price elasticity for poultry

and a negative cross-price elasticity with respect to beef price.

These estimates provided by Table 8 correspond to the Marshallian (uncompensated) price elasticity, combining substitution and income effects (DEATON & MUELLBAUER, 1980). Using the Slutsky decomposition in Equation 9 provides further insight (DEATON & MUELLBAUER, 1980, p. 62).

For countries with income elasticity greater than one, where poultry behaves as a superior good, the income effect is positive. This implies that the Hicksian elasticity should exceed the Marshallian elasticity, reinforcing the concern that the current coefficient is inconsistent with theory. For countries where poultry appears as a necessity good (elasticity between 0 and 1), the Slutsky decomposition leads similarly to a positive Hicksian elasticity and greater Hicksian compared to the Marshallian one.

Finally, for countries where poultry behaves as an inferior good (negative income elasticity), the result becomes uncertain. A negative Hicksian elasticity consistent with demand theory would require a sufficiently negative income elasticity combined with a high expenditure share for poultry. This requires that : Using the Slutsky decomposition stated in Equation 9 :

$$e_{ik} = e_{ik}^* - e_i w_k \quad \Rightarrow \quad e_{ik}^* = e_{ik} + e_i w_k$$

To obtain a compensated (Hicksian) elasticity that is negative, the income effect must dominate the Marshallian effect :

$$e_{ik}^* < 0 \quad \Rightarrow \quad e_{ik} + e_i w_k < 0 \quad \Rightarrow \quad w_k > \frac{|e_{ik}|}{|e_i|}$$

With our estimates $e_{ik} \approx 0.0865^*$ and the minimum income elasticity $e_i \approx -0.6744$, we obtain :

$$w_k > \frac{0.0865}{0.6744} \approx 0.17 \quad (12.83\%)$$

Since the minimum estimated income elasticity in the dataset is -0.6744 , this would require a budget share above 12.83%, which is not plausible given observed poultry consumption patterns in European countries.

Overall, the result is not statistically significant, therefore the possibility that the true relationship is negative cannot be excluded. Nevertheless, the positive estimate may indicate a potential endogeneity issue in the price variable. This limitation will be further discussed in Section 8.

The next variable considered is the relative price of pork. The estimated coefficient is -0.0134 (standard error = 0.065) and is not statistically significant. This estimate can be interpreted as suggesting that a 1% increase in the relative price of pork with respect to beef is associated with a 0.0134% decrease in poultry consumption.

By contrast, the meta-analysis conducted by BOUYSSOU et al. (2023) reports a cross-price elasticity of 0.04 for the European Union, indicating a small degree of substitution involving pork. The discrepancy between these results may stem from the lack of statistical significance of the estimated coefficient in the present analysis. It may also reflect the role of income effects : in countries where income elasticity is positive, the income effect may offset the negative cross-price elasticity, or at least lead to a Hicksian cross-price elasticity that is smaller in absolute value than the corresponding Marshallian elasticity. Finally, differences in coefficients may also arise from the method used to measure food consumption, as the inclusion of food consumed away from home (FAFH) may blur the estimated relationships.

Finally, Table ?? reports positive coefficients for the cross-price elasticities associated with the relative prices of mutton and other meat (see Equation 8). The results indicate that a 1% increase in these relative prices is associated with an increase in poultry consumption of 0.022%

(s.e. = 0.037) for the relative price of mutton and 0.026% (s.e. = 0.099) for the relative price of other meat. Although neither coefficient is statistically significant, both exhibit the expected positive sign, suggesting potential substitution between these meats and poultry. Consistent with this interpretation, FOUSEKIS et REVELL (2000) also estimates a positive cross-price elasticity between poultry consumption and mutton prices in the United Kingdom over the period 1989–1999.

When poultry exhibits a positive income elasticity, the pure substitution effect between these meats and poultry is likely to be stronger than indicated by the Marshallian cross-price elasticities reported here. By contrast, in countries where poultry behaves as an inferior good, the corresponding Hicksian cross-price elasticity would be smaller than the estimates obtained in the present study.

7 Discussion : Theoretical Assumptions

7.1 Properties of Demand

According to economics, demand functions satisfy several theoretical properties DEATON et MUELLBAUER (1980).

The first one is adding-up, meaning that the sum of all individual demands equals total expenditure. This property cannot be verified in the present analysis, since total expenditure is proxied by Gross National Income and the demand system does not include all goods. Testing this condition would require either incorporating all consumption categories or restricting the expenditure measure to meat expenditure only, in which case total expenditure and total demand should correspond. DEATON et MUELLBAUER (1980)

The second property is homogeneity of degree zero for Marshallian demand : multiplying all prices and income by a common scalar does not change consumption quantities. In practice, this implies that only relative prices and real income matter, which is consistent with the use of relative meat prices and GNI expressed in constant PPP international dollars in this analysis.

The third and fourth properties relate to the Slutsky substitution matrix, which must be symmetric and negative semi-definite. This ensures that own-price effects are non-positive and reflects the Law of Demand, whereby an increase in the price of a good cannot increase its compensated demand (DEATON & MUELLBAUER, 1980).

The empirical results suggest that some theoretical properties are not satisfied. Several estimated own-price elasticities are positive, indicating that consumption increases when price rises. This contradicts both economic theory and previous empirical findings, such as the meta-analysis by GALLET (2010). These violations likely reflect biased coefficients due to endogeneity.

Endogeneity may also contribute to the apparent violation of the Slutsky symmetry property. For instance, the estimated cross-price elasticities between pork and mutton are not symmetric, which is inconsistent with theory. This asymmetry may stem from endogeneity, but could also result from estimating demand equations separately rather than within a full demand system.

Regarding preferences, a common assumption is that preferences are homothetic. This implies that multiplying income by a scalar increases consumption by the same scalar. In such a case, Engel curves are linear through the origin (VARIAN, 2019). However, this assumption is often unrealistic (VARIAN, 2019). Therefore, this analysis relaxes this property by allowing for a quadratic relationship between income and consumption.

The results reveal inverted U-shaped Engel curves for poultry, pork, and other meat, with mostly significant coefficients. Beef exhibits a U-shaped curve, while mutton shows an increasing pattern, although coefficients are not statistically significant for mutton and goat and other meat analysis.

Since the quadratic income term was not significant for mutton and other meat, additional tests were performed. A Wald test assessed whether the quadratic coefficient equals zero to determine the relevance of linear Engel curves. The test failed to reject the null hypothesis for both categories. A simplified model excluding the quadratic term was then estimated, and a Wald test of unitary income elasticity also failed to reject the null. This suggests that mutton and other meat consumption is consistent with homothetic preferences.

Overall, the evidence rejects homotheticity for beef, pork, and poultry, while mutton and other meat appear compatible with this assumption.

8 Limitations

Naturally, a master’s thesis comes with its own set of limitations. The first set relates to the database. The data used were exclusively open-source. First, the consumption figures are based on the quantity of meat available for consumption. This does not reflect the exact amount of meat actually consumed but rather an approximation, which is an overestimation regarding the construction of the Food Supply Balance sheet, as explained in Section 5.1.1.

Secondly, the use of this apparent consumption data contrasts with most studies, which typically rely on household survey data (GALLET, 2010). Yet, survey-based measures often lack cross-country and longitudinal comparability, particularly over a long period such as the one analysed here. As a result, differences in data construction may limit the direct comparability of the estimated coefficients with previous findings.

In addition, the fact that consumption is measured at the apparent level rather than at the household level may also generate noise, making consumer behaviour harder to detect and potentially contributing to the unsatisfactory results.

Regarding price data, as previously explained, it was very challenging to find consumer price databases. Consequently, producer prices were used in the analysis as a proxy for consumer prices, which were not available. While producer prices are generally expected to follow consumer prices, certain shocks may affect them differently, and their absolute levels also differ.

Some issues were detected regarding the estimated coefficients. In particular, certain results did not align with standard consumer theory nor with previous empirical findings. The estimated own-price elasticities for mutton, other meat and poultry were positive, which is counter-intuitive from a demand perspective. For mutton and other meat, this may be partly explained by the limited within-country variation in consumption, reducing the ability of the model to detect price responsiveness. However, poultry consumption displays much larger variation (Table 2), making a data-driven explanation less likely. A more plausible interpretation is that the estimated price coefficient is biased due to reverse causality between consumption and producer prices.

The observations used in the regression represent market equilibrium points where prices and quantities are jointly determined. When demand increases (through preferences, health perceptions or cultural trends), producers may respond by adjusting prices upward, and vice versa. As a result, price becomes endogenous, since it is simultaneously influenced by demand shocks which also affect consumption. The estimated coefficient may therefore capture both the causal effect of price on consumption and the reverse effect of consumption on price, producing bias in either direction. Even with country and year fixed effects, time-varying unobserved shocks remain uncontrolled, leading to correlation between prices and the error term and violating the exogeneity assumption. This issue could be addressed in future research using instrumental variables and Two-Stage Least Squares estimation (WOOLDRIDGE, 2002).

Regarding the econometric specification, a simple linear log–log model was employed. However, alternative approaches may be more appropriate for estimating elasticities within a system of simultaneous demand equations. First, the Seemingly Unrelated Regressions (SUR) framework (ZELLNER, 1962) could be considered. Second, beyond single-equation log–log models, demand elasticities could be estimated using frameworks specifically designed for demand analysis, such as the Almost Ideal Demand System (AIDS) or the Quasi-Ideal Demand System (QUAIDS), which were identified as the most commonly applied methods in the meta-analysis by GALLET (2010). These approaches would allow the estimation of a full system of equations and could better ensure compliance with key theoretical properties of demand, including the symmetry of the Slutsky substitution matrix.

Concerning the specification of the equations, other studies have included additional variables, such as the unemployment rate (KAROUNTZOS et al., 2025), vegetable prices, area

per capita, Muslim population share, and economic globalisation (MILFORD et al., 2019). The omission of these variables in the present analysis may have introduced bias if they were correlated with a meat consumption and an explanatory variable. For example, 'social globalisation', as used by MILFORD et al. (2019), may be correlated both with meat consumption and with the share of the population living in urban areas. In a case like this, the coefficient of urban share would be biased. Therefore, including a broader set of independent variables would be an important avenue for future research on meat consumption in Europe.

As a final remark, the coefficients should not be interpreted as causal effects but rather as conditional correlations. The primary limitation is the endogeneity of producer prices discussed above. Additionally, the sample is not randomly drawn but consists of all EU member states over a specific period (1995–2023), which limits the generalisability of findings to other regions or time periods.

9 Conclusion

The main objective of this master’s thesis was to describe meat consumption patterns in Europe and identify their main economic and socio-demographic drivers, with a specific distinction by meat type. In other words, the thesis seeks to estimate an empirical demand function consistent with the theoretical framework in which consumer demand results from utility maximisation under a budget constraint (DEATON & MUELLBAUER, 1980).

Although the thesis does not directly quantify the environmental impacts of meat consumption, it contributes to this field by improving our understanding of the determinants of meat intake in Europe. Such knowledge is essential for designing policy tools aimed at reducing meat consumption in line with environmental and sustainability targets.

Regarding the methodology, each meat type was analysed using a specific demand equation. Diagnostic tests revealed heteroscedasticity and autocorrelation in the data, as well as cross-sectional dependence. The Hausman test suggested that fixed effects were the most appropriate estimator for pork and poultry. However, given the structure of the database, a cautious approach was adopted, and a fixed-effects estimator was used for all regressions. To correct for cross-sectional dependence, heteroscedasticity and autocorrelation, fixed-effects models with Driscoll–Kraay standard errors were implemented, while year dummies were added to capture common temporal shocks (HOECHLE, 2007).

The results suggest that income elasticities do not generally conform to the homothetic preference framework (VARIAN, 2019). For pork and poultry, the income–consumption relationship exhibits an inverted U-shape, indicating that demand tends to decline once income exceeds a certain threshold. Several countries have already reached or surpassed this turning point (47,917.681 PPP for poultry and 79,654.605 PPP for pork), implying potential saturation of demand at higher income levels. Below these thresholds, income elasticity is positive, while beyond them it becomes negative, suggesting that the good behaves as inferior at higher income levels.

For the other meat category, the estimated Engel curve also indicates an inverted-U pattern, although coefficients are not statistically significant, and homotheticity could not be rejected. For mutton and goat, results suggest a linear Engel curve, and Wald tests do not reject homothetic preferences. In contrast, beef consumption appears U-shaped, implying inferior-good behaviour below 38,081.032 PPP and normal-good behaviour above this threshold.

Regarding cross-price elasticities, results indicate that beef consumption increases when the relative price of other meat rises, reflecting a substitution effect (significant at the 1% level). Additionally, coefficients for pork and mutton indicate both substitution and complementarity effects, but they are asymmetric across equations, which violates the Slutsky symmetry condition. Their interpretation is therefore limited, and future work could reconsider these relationships using full demand-system approaches such as AIDS or QUAIDS.

Most other cross-price elasticities were not statistically significant. Given the likely presence of endogeneity, the substitution effects estimated here should be interpreted with caution.

Finally, the coefficient associated with urbanisation shows positive and significant association with meat consumption. This finding is consistent with MILFORD et al. (2019), although potential endogeneity cannot be ruled out.

This master’s thesis also aims to contribute to the discussion on possible means of reducing meat consumption in Europe. Meat consumption is well documented to have negative environmental impacts, and several studies, such as FESKENS et al. (2013), have also raised concerns regarding its effects on human health.

Descriptive statistics show that pork is the most consumed meat in Europe (38.4 kg per capita), followed by poultry (20.37 kg per capita) and beef (14.98 kg per capita). They also reveal a decline in per capita consumption of beef, mutton and other meat over time, while pork

consumption appears relatively stable and poultry consumption shows an increasing trend, as documented in the existing literature (MILFORD et al., 2019).

The literature further indicates that beef production is among the most environmentally damaging forms of meat production (NOTARNICOLA et al., 2016). Consequently, policies targeting pork and beef consumption could have a substantial impact on both overall meat consumption and environmental outcomes.

Despite potential endogeneity bias, urbanisation displays a consistently positive association with meat consumption across meat types. This suggests that developments in urban areas may play a particularly important role in shaping consumption patterns. Promoting alternative diets through public awareness campaigns and community-based initiatives may therefore be effective. A relevant example is the ban on meat advertising in public spaces implemented by the city of Haarlem in the Netherlands. Although such a ban may appear simple, comparable measures have proven effective in reducing tobacco consumption, as shown by BLECHER (2008). Drawing inspiration from policies applied to goods whose consumption is strongly driven by behavioural factors rather than prices, such as tobacco, could thus be beneficial.

WESTHOEK et al. (2011) find that behavioural changes in Europe could generate environmental benefits extending beyond EU borders. However, they also note that if a reduction in beef consumption were offset by increased consumption of other meats, such as poultry, the environmental gains would be attenuated. Raising consumer awareness about the environmental impact of different production methods—through information campaigns or advertising restrictions—could therefore be part of a comprehensive strategy addressing all meat categories.

The present study does not accurately identify own-price elasticities, limiting conclusions regarding price responsiveness. Nevertheless, BONNET et al. (2020) report relatively small (in absolute value) predicted own-price elasticities for beef, poultry, pork and other meat, indicating generally inelastic demand. As a result, traditional market-based taxation policies may have only a limited direct effect on reducing meat consumption. When demand is inelastic, taxes tend to increase consumer prices with only modest reductions in quantities consumed, while imposing regressive welfare costs that disproportionately affect low-income households, thereby raising equity concerns.

Beyond the results of this study, several contributions offer insights into potential policy instruments for influencing meat consumption. In particular, BONNET et al. (2020) distinguish between fiscal, informational and behavioural measures.

Regarding fiscal instruments, they suggest that targeting specific meat categories, such as beef or mutton, could significantly reduce overall meat consumption while limiting costs for consumers.

In the informational domain, proposed tools include labelling schemes, public information campaigns and, in the longer term, educational programmes targeting younger generations, who may be more receptive to environmental concerns.

Finally, meat consumption is deeply embedded in cultural norms, habits and psychological factors. As with smoking, behavioural instruments therefore play a crucial role. These include tailored communication strategies or initiatives such as “meat-free days,” which may act as a “foot-in-the-door” approach by demonstrating the feasibility of diets with reduced meat intake (BONNET et al., 2020).

Overall, behavioural change appears to be a key component of any effective strategy to reduce meat consumption in Europe. While the European Union has focused extensively on the production side, most notably through the Farm to Fork Strategy which promotes sustainable production practices, behavioural change and sustainable distribution (EUROPEAN COMMISSION, 2020), this study suggests that greater emphasis on demand-side and behavioural policies may be warranted.

When the topic of this master’s thesis was chosen in 2024, no study on meat consumption in

the European Union for the period 2000 to 2022 using an econometric approach similar to that of MILFORD et al. (2019) was identified. In May 2025, however, KAROUNTZOS et al. (2025) published an econometric analysis of meat consumption in Europe. While this paper is highly relevant, it differs in certain respects from the present thesis. Specifically, their analysis focuses on total meat consumption without distinguishing between meat types. This distinction was considered valuable for the present research, as it adds complexity to the discussion of meat consumption. This is particularly relevant because the environmental impact varies across meat types (NOTARNICOLA et al., 2016) and because shifts in the composition of meat consumption have been observed (WHITTON et al., 2021). In compensation, this decision to disaggregate by meat type reduced the number of observations per model, which may have affected the statistical significance and precision of certain estimated coefficients. The limitations of this master's thesis will be discussed in more detail in Section 8.

10 Appendices

TABLE 11 – List of countries included in the analysis with associated codes

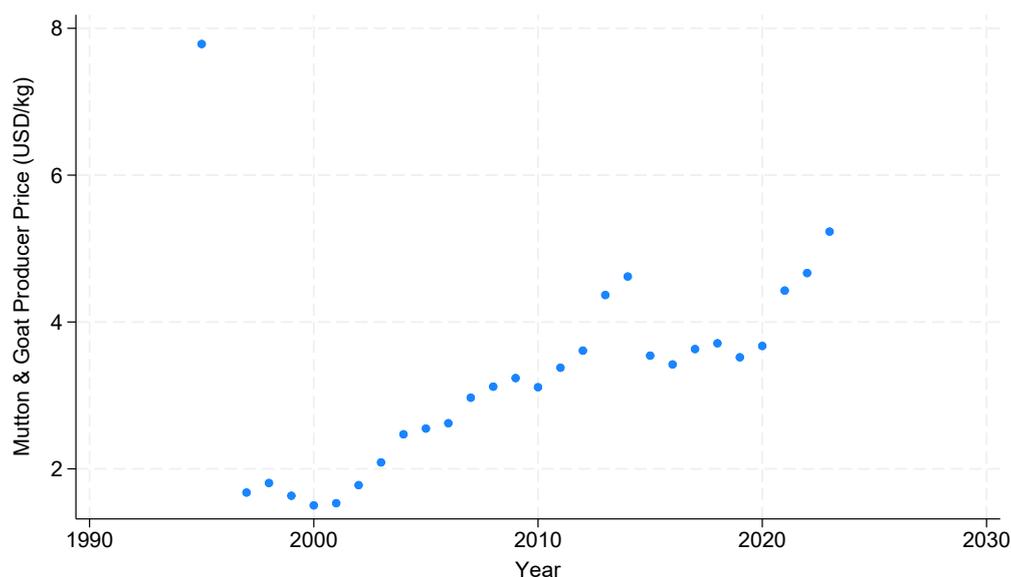
Country	Code	Country	Code ^a
Austria	AUT	Italy	ITA
Belgium	BEL	Latvia	LVA
Bulgaria	BGR	Lithuania	LTU
Croatia	HRV	Luxembourg	LUX
Cyprus	CYP	Malta	MLT
Czechia	CZE	Netherlands ^b	NLD
Denmark	DNK	Poland	POL
Estonia	EST	Portugal	PRT
Finland	FIN	Romania ^b	ROU
France	FRA	Slovakia	SVK
Germany	DEU	Slovenia	SVN
Greece	GRC	Spain	ESP
Hungary	HUN	Sweden	SWE
Ireland	IRL		

Notes :

^a : Codes used to identify the countries in the database.

^b : Countries excluded from the analysis due to insufficient data on meat consumption.

FIGURE 20 – Mutton and Goat Producer price for Finland between 1995 and 2023 (USD/kg)



Notes :

The figure presents producer prices in USD per kilogram for mutton and goat across 27 European countries over the available period.

Source : Own calculations based on FAOSTAT producer price data.

TABLE 12 – Description of Variables Used in the Analysis

Variable	Description	Source
Country	27 European Union member countries included in the analysis	–
Year	Annual data for the period 1995–2023	–
GNI per capita	Gross National Income per capita, PPP (constant 2021 international dollars)	WORLD BANK, 2025 ^d
Population	Total population (thousands)	FAO, 2025a ^c
Urban population	Share of the population living in urban areas (%)	FAO, 2025a ^c
Harmonized Index of Consumer Prices	Annual average HICP for meat (COICOP classification), base 2015 = 100	EUROSTAT, 2024b ^f
<i>Food supply quantity (kg/capita/year)</i>		
Beef	Bovine meat available for human consumption	FAO, 2025d, FAO, 2025e ^b
Poultry	Poultry meat available for human consumption	FAO, 2025d, FAO, 2025e ^b
Pork	Pork meat available for human consumption	FAO, 2025d, FAO, 2025e ^b
Mutton/goat	Mutton and goat meat available for human consumption	FAO, 2025d, FAO, 2025e ^b
Other meat	Other meat products available for human consumption	FAO, 2025d, FAO, 2025e ^b
<i>Producer prices (USD per kg)</i>		
Beef price	Producer price of beef	FAO, 2025b ^e
Pork price	Producer price of pork	FAO, 2025b ^e
Poultry price	Producer price of poultry	FAO, 2025b ^e
Mutton/goat price	Producer price of mutton and goat	FAO, 2025b ^e
Other meat price	Producer price of other meat	FAO, 2025b ^e

Notes :

^b FAO Food Balance Sheets and Food Balance Sheets (Historic), accessed November 1, 2025.

^c FAOSTAT Population module, accessed November 2, 2025.

^d World Bank Open Data, GNI per capita PPP indicator (NY.GNP.PCAP.PP.KD), accessed November 2, 2025.

^e FAO Producer Prices Database, accessed November 2, 2025.

^f Eurostat, Harmonised Index of Consumer Prices (HICP) for meat, downloaded November 9, 2025.

TABLE 13 – Categories included for the computation of average meat prices

Meat Type	Code	Description
Beef	867	Meat of cattle with the bone, fresh or chilled
	947	Meat of buffalo, fresh or chilled
Pork	1035	Meat of pig with the bone, fresh or chilled
Poultry	1058	Meat of chickens, fresh or chilled
	1069	Meat of ducks, fresh or chilled
	1073	Meat of geese, fresh or chilled
	1080	Meat of turkeys, fresh or chilled
Mutton/Goat	977	Meat of sheep, fresh or chilled
	1017	Meat of goat, fresh or chilled
Other Meat	1108	Meat of asses, fresh or chilled
	1111	Meat of mules, fresh or chilled
	1141	Meat of rabbits and hares, fresh or chilled

Note : Codes correspond to FAOSTAT product codes used for producer prices.

TABLE 14 – Descriptive statistics of relative price variables (regarding poultry nominal price)

Variable	Mean	Std. Dev.	Min	Max	Observations
Beef/Poultry Price Ratio					
Overall	0.4330	0.4576	-1.1384	2.0498	N = 539
Between	–	0.4057	-0.2624	1.6076	n = 27
Within	–	0.2101	-0.9955	1.0122	T-bar = 19.963
Pork/Poultry Price Ratio					
Overall	-0.1432	0.4572	-1.3250	0.7850	N = 549
Between	–	0.4327	-1.0266	0.7049	n = 27
Within	–	0.2049	-0.9682	0.5686	T-bar = 20.333
Mutton/Poultry Price Ratio					
Overall	0.6046	0.4555	-1.1179	1.8177	N = 563
Between	–	0.3977	-0.1678	1.2308	n = 27
Within	–	0.2697	-0.7310	1.2320	T-bar = 20.8519
Other Meat/Poultry Price Ratio					
Overall	0.2941	0.5675	-1.1229	1.5982	N = 570
Between	–	0.5264	-0.9614	1.4912	n = 27
Within	–	0.2519	-0.7986	1.0975	T-bar = 21.111

Note : Values are reported to four decimal places. Variables represent the ratio of each meat price to beef price (in USD per kg). These variables are not log-transformed. Source : Own calculations based on the data described in Table 12.

TABLE 15 – Descriptive statistics of relative price variables (regarding beef nominal price)

Variable	Mean	Std. Dev.	Min	Max	Observations
Poultry/Beef Price Ratio					
Overall	-0.4330	0.4576	-2.0498	1.1384	N = 539
Between	–	0.4057	-1.6076	0.2624	n = 27
Within	–	0.2101	-1.0122	0.9955	T-bar = 19.963
Pork/Beef Price Ratio					
Overall	-0.5704	0.3512	-1.6360	0.6434	N = 570
Between	–	0.3470	-1.4470	0.1167	n = 27
Within	–	0.1688	-1.1238	0.2072	T-bar = 21.1111
Mutton/Beef Price Ratio					
Overall	0.1467	0.4027	-0.8574	1.1179	N = 584
Between	–	0.3653	-0.8277	0.7520	n = 27
Within	–	0.1840	-0.7596	0.9440	T-bar = 21.6296
Other Meat/Beef Price Ratio					
Overall	-0.1591	0.5597	-1.8949	1.6987	N = 549
Between	–	0.5194	-1.1723	1.1673	n = 27
Within	–	0.1864	-1.1224	0.4645	T-bar = 20.3333

Note : Values are reported to four decimal places. Variables represent the ratio of each meat price to beef price (in USD per kg). These variables are not log-transformed. Source : Own calculations based on the data described in Table 12.

TABLE 16 – Correlations between meat consumption and explanatory variables

	ln(Beef)	ln(Pork)	ln(Mutton and Goat)	ln(Other Meat)
ln (GNI)	0.4600	0.3061	0.2141	0.4183
(ln (GNI)) ²	0.4677	0.2974	0.2165	0.4170
Urban Share	0.4022	-0.0815	0.1451	0.4319
Relative Price of Beef	0.1471	0.0174	0.0578	0.0559
Relative Price of Pork	0.0148	-0.1989	-0.0163	-0.0917
Relative Price of Mutton	0.0858	0.0344	0.2335	-0.0340
Relative Price of Other	-0.0408	0.0356	0.1189	0.0054

Note : Own calculations based on the different data sources described in Table 12. Correlations are pairwise and based on available observations. Relative prices are defined as the ratio of each meat type's nominal price to the poultry price.

TABLE 17 – Correlations between poultry consumption and explanatory variables

	ln(Poultry)
ln (GNI)	0.2099
(ln (GNI)) ²	0.1988
Urban Share	-0.0562
Relative Price of Poultry	-0.2842
Relative Price of Pork	-0.2246
Relative Price of Mutton	0.0618
Relative Price of Other	-0.0063

Note : Own calculations based on the different data sources described in Table 12. Correlations are pairwise and based on available observations. Relative prices are defined as the ratio of each meat type's nominal price to the beef price.

TABLE 18 – Correlation matrix of explanatory variables - For all regressions except Poultry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ln(GNI)	1.000						
(2) (ln(GNI)) ²	0.9995	1.000					
(3) Urban share	0.4872	0.4928	1.000				
(4) Relative Beef Price	-0.0705	-0.0805	0.0019	1.000			
(5) Relative Pork Price	-0.2741	-0.2797	0.0348	0.7050	1.000		
(6) Relative Mutton Price	0.0150	0.0068	0.0706	0.6201	0.6085	1.000	
(7) Relative Other Price	-0.0867	-0.0981	-0.2009	0.4000	0.5163	0.4248	1.000

Note : Pairwise correlation coefficients between explanatory variables. Own calculations based on data described in Table 12. Relative prices are defined as the ratio of each meat type's nominal price to the poultry price.

TABLE 19 – Correlation matrix of explanatory variables — For poultry regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ln(GNI)	1.000						
(2) (ln(GNI)) ²	0.9995	1.000					
(3) Urban share	0.4872	0.4928	1.000				
(4) Relative poultry price	0.0705	0.0805	-0.0019	1.000			
(5) Relative pork price	-0.3635	-0.3566	0.0420	0.4027	1.000		
(6) Relative mutton price	0.1777	0.1768	0.1157	0.4507	0.3758	1.000	
(7) Relative other meat price	-0.1228	-0.1252	-0.1372	0.4354	0.4434	0.3460	1.000

Note : Pairwise correlation coefficients between explanatory variables. Own calculations based on the data described in Table 12. Relative prices are defined as the ratio of each meat type's real producer price to the real beef price.

TABLE 20 – Variance Inflation Factors (VIF) by Model

Variable	All regressions	Poultry regression
ln(GNI)	2164.89	2164.89
(ln(GNI)) ²	2191.15	2161.15
Urban share	1.52	1.52
Relative price of beef	2.57	–
Relative price of poultry	–	1.85
Relative price of pork	3.32	1.97
Relative price of mutton	1.94	1.63
Relative price of other meat	1.57	1.53
Year	1.28	1.28
Mean VIF	542.28	541.98

Note : Own calculations based on the data sources described in Table 12. The column “All regressions” refers to the beef, pork, mutton and other meat specifications, in which relative prices are defined with poultry as the reference category. The poultry regression uses beef as the reference price. Variance inflation factors are computed from auxiliary pooled OLS regressions. The specification of the explanatory variables is kept unchanged relative to the main econometric models.

TABLE 21 – P-values from Hausman, Hausman with *sigmamore* option, Modified Wald, and Wooldridge tests

Dependent variable	Hausman	Hausman (<i>sigmamore</i>)	Modified Wald	Wooldridge
Beef	0.9994	0.0696	0.0000	0.0000
Poultry	0.3149	0.0101	0.0000	0.0001
Pork	0.0006	0.0000	0.0000	0.0005
Mutton and Goat	1.0000	0.4876	0.0000	0.0001
Other Meat	1.0000	0.9762	0.0000	0.0005

Note : The null hypothesis of the Hausman test is that individual effects are uncorrelated with the regressors ; rejection of H_0 indicates that the fixed effects specification is preferred. The Modified Wald test assesses the presence of group-wise heteroskedasticity in fixed-effects models, while the Wooldridge test examines first-order autocorrelation in panel data.

Source : Own calculations based on the data sources described in Table 12.

TABLE 22 – Pesaran CD Test for Cross-Sectional Dependence

Meat type	p-value	Cross-sectional dependence
Beef	0.9587	No
Poultry	0.3484	No
Pork	0.0563	Yes at 10% significance level
Mutton	0.0027	Yes
Other meat	0.0114	Yes at 5% significance level

H₀ : No cross-sectional dependence. Rejecting H₀ indicates the presence of cross-sectional dependence.

Own calculation based on the different data source describe in Table 12 All tests are made on fixed effect models with clustered standard error at the country's level.

TABLE 23 – Additional cross-sectional dependence tests for Beef and Poultry

Test	Beef	Poultry	CSD
Breusch–Pagan LM test (xttest2)	0.0000	0.0000	Yes
Frees' test (xtcsd, frees)	Rejected at 1%	Rejected at 1%	Yes
Friedman test (xtcsd, friedman)	0.6300	1.0000	No

Notes : The table reports p-values where available. Frees' test does not provide p-values; instead, the null hypothesis of cross-sectional independence is rejected when the test statistic exceeds the critical values reported by FREES (1995). Breusch–Pagan LM and Friedman tests are reported using p-values. Tests were conducted on the specification exposed in Section 5.3.1.

11 References

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EXECUTIVE SUMMARY

From its environmental impact to the rising prevalence of diet-related diseases, meat consumption stands as one of the most pressing global challenges. This master's thesis investigates the main factors influencing meat consumption in the European Union, distinguishing between beef, poultry, pork, and mutton/goat. The objective is to provide evidence-based insights to inform public policies aimed at promoting more sustainable diets.

The analysis relies on a panel dataset covering 27 European Union countries over the period 1995–2023, combining data from the FAO and the World Bank. Following a series of diagnostic tests, fixed-effects models with time fixed effects were estimated using Driscoll–Kraay standard errors to account for cross-sectional dependence, heteroskedasticity, and autocorrelation.

Results indicate that income elasticity may depend on the level of gross national income per capita, suggesting that peak levels of pork and poultry consumption may be reached within the European Union. Urbanisation emerges as a positive and statistically significant determinant across all meat categories, indicating its central role in future policy design. Price elasticities show limited statistical significance, underscoring the importance of non-price factors and the need for demand-system approaches to better capture substitution patterns.

Policy recommendations therefore emphasise behavioural interventions, such as targeted communication, education campaigns as primary tools, with taxation serving as a complementary measure. These approaches can address the cultural and habitual dimensions of meat consumption while supporting the EU's sustainability goals.

KEYWORDS : Meat consumption, European Union, Food Policy, Sustainable food systems

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