Beef consumption across 43 countries: The influence of economic factors and animal welfare standards

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Abstract

This study examines the economic and non-economic determinants of per-capita beef consumption across 43 countries from 2015 to 2022. To this end, a pooled log-log Ordinary Least Squares regression model with clustered standard errors was employed. The included independent variables are GDP per capita, beef prices, food price inflation, consumption of alternative protein sources and animal protection index. Expanding from previous studies that only focus on income and price, this research includes Animal Protection Index, an underexplored variable. By integrating Engel's Law and Maslow's Hierarchy of Needs into the analytical framework, the study captures both basic and higher levels of human needs that might explain beef consumption. The results show that income remains the most consistent predictor of beef consumption while fish acts as a substitute and poultry is considered a complement. Moderate levels of animal welfare legislation are associated with higher beef intake, indicating nuanced relationships between societal values and consumption patterns. Diagnostic testing ensures model reliability and Engel curve figures illustrate how income elasticities vary by animal welfare standards. These findings highlight the need for policies that promote the consumption of sustainably sourced fish to reduce beef consumption.

Keywords: Beef, demand, income-elasticity, OLS, API

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Abbreviations

Abbreviation	Description
CAP	Common Agricultural Policy
CPI	Consumer Price Index
EKC	Environmental Kuznets Curve
FAO	Food and Agricultural Organization
FBS	Food Balance Sheets
GDP	Gross Domestic Income
KG	Kilograms
Ln	Natural Logarithm
Log	Logarithm
OLS	Ordinary Least Squares
OVB	Omitted Variable Bias
USD	US Dollars
USDA	United States Department of Agriculture
WTO	World Trade Organization

1. Introduction

Human meat consumption has evolved over thousands of years, being shaped by biology, environment, economy and culture (Aiello & Wheeler 1995). Early humans' ability to hunt supported survival in harsh conditions and brain development. With the rise of agriculture, domesticated animals became essential to food systems (Zeder, 2008). Religious dietary rules, such as Islamic pork prohibitions and Hindu reverence for cows, illustrate food's cultural significance (Cooking School Guide, 2024). The 20th century brought industrialized meat production, transforming beef into a widely available commodity through development in agriculture storage and transport (Cottle & Kahn 2014, p.6-8). Government policies, like EU's Common Agriculture Policy further reinforced beef production with subsidies, sustaining high consumption levels even among growing environmental concerns (Swedish Society for Nature Conservation, 2021).

Similar patterns are observed globally. Countries such as the United States, China, Japan and Brazil have implemented comparable support systems, ranging from the U.S. Farm Bill (U.S. Department of Agriculture, 2025) and Chinese agricultural subsidies (Boehme, 2025) to Japan's protectionist tariffs (Imaizumi, 2021) and Brazil's credit support for meat exporters. While the structure of these programs varies, they collectively prioritize food security, rural development and economic competitiveness, often reinforcing meat-heavy production systems without fully integrating sustainability goals (Vallone & Lambin 2023; Adams et al. 2025).

Today's global beef consumption patterns reflect this layered history. Economic factors such as income and food prices remain strong drivers of meat demand, particularly in lower-income regions where beef remains a luxury product (Sans & Combris 2015). However, in higher-income regions and urbanized societies, consumption decisions are increasingly shaped by ethical concerns, animal welfare awareness and environmental sustainability (OECD, n.d.; Ammann et al. 2023). Environmental data shows that beef production is among the most emission-intensive forms of agriculture, contributing substantially to climate change and land degradation (OECD, n.d.).

Nutritionally, while beef provides valuable protein and micronutrients, such as iron and vitamin B12 (Klurfeld, 2018), concerns about overconsumption and links to chronic diseases have prompted greater scrutiny. Several studies have associated high red meat consumption with increased cardiovascular disease, colorectal cancer and type 2 diabetes (WHO, 2025). In response, some public health authorities have updated their dietary guidelines by recommending limited red meat intake to no more than 350-500 grams per week (The Public Health Agency of Sweden, 2025). Simultaneously, the rise of social media and digital platforms has amplified global awareness of food ethics, including sustainability and animal welfare issues (Klurfeld, 2018). Given the significant health risks and substantial environmental costs, reducing red meat consumption has become a critical priority for both public health policy and climate action (FAO, 2013).

Some research has established both empirical and theoretical foundations for understanding the determinants of beef consumption, with income repeatedly identified as a central driver (Grigg, 1995; Sans & Combris, 2015; Tonsor et al. 2018; Kmeťková & Ščasný, 2022). In recent years, additional attention has been given to factors such as food prices, dietary preferences and ethical considerations. However, many macro-level studies (e.g., Grigg, 1995; Sans & Combris, 2015; Tonsor et al. 2018; Ammann et al. 2024) still neglect institutional and cultural influences such as animal welfare legislation and dietary restrictions that may significantly affect consumption patterns. Furthermore, a lack of diagnostic testing in several of these analyses limits their methodological reliability (see Grigg, 1995; Tonsor et al. 2018; Ammann et al. 2024). This study responds to these gaps by incorporating a broader range of variables and ensuring statistical reliability through diagnostic evaluation.

This study investigates a range of economic and non-economic factors influencing per capita beef consumption across countries. The economic factors of my interest include income (GDP per capita), beef prices and food inflation (Food CPI). The non-economic factors are animal welfare index (API) and consumption of alternative protein sources such as poultry, fish, pulses and an interaction term between pork and Muslim majority. By applying a pooled OLS regression model to panel data from 43 countries over the period 2015-2022, the research seeks to provide a more comprehensive understanding of how beef consumption is influenced not only by economic development, but also by policy around animal welfare. In doing so, the study contributes to existing literature by integrating underexplored variables, particularly animal welfare legislation into a quantitative framework.

2. Literature review

Previous research consistently shows that meat consumption is shaped by both economic and cultural factors. For example, an early study by Grigg (1995) analyzed cross-sectional data from the FAO Food Balance Sheets to examine global patterns of protein intake. His descriptive and comparative analysis revealed a strong positive relationship between income level and the share of animal-based protein in the diet. High-income countries were found to consume more meat, especially beef, while lower-income countries relied more on plant-based proteins such as cereals and pulses. Grigg also emphasized that cultural and religious norms independently influence food choices, noting, for example, India's low meat consumption despite rising incomes and the avoidance of pork in Muslim-majority countries. These findings highlight that while economic means enable higher meat intake, cultural context often constrains it (Grigg, 1995).

A more contemporary perspective is provided by Sans and Combris (2015), who employed a longitudinal analysis of meat consumption trends from 1961 to 2011 using FAO data. They confirmed income as a central explanatory factor for increased meat intake but also underscored the growing importance of non-economic influences, such as ethical concerns, animal welfare and environmental awareness particularly in high-income countries. Their study suggested that future trends in meat consumption may also be driven by shifting societal values, not only income growth. Furthermore, the authors divided their analysis into three historical periods (1961-1977, 1977-1993 and 1993-2011) to capture shifts in global economic structures and societal values. This temporal segmentation allows them to assess whether the drivers of meat consumption have evolved, particularly whether income remains the dominant factor or whether ethical and environmental concerns have become more influential in recent decades. However, the simplicity of their method introduces limitations, the regression models rely solely on income as an explanatory variable, omitting price effects, cultural variation and dietary preferences. Additionally, the use of aggregated country-level data restricts the ability to identify within-country differences and causal dynamics (Sans & Combris, 2015).

To build on these foundational insights, more recent studies have applied econometric techniques to assess the sensitivity of meat consumption to specific variables. A recent study by Kmeťková and Ščasný (2022) contributes to the debate by estimating income elasticities for animal-based food and protein consumption across 178 countries and 19 years (2000-2018). Using panel data and an OLS regression model with fixed effects, the authors examine how GDP per capita relates to the share and quantity of animal-based foods in national diets. In addition to income, their models include variables such as urbanization and population growth.

Their findings provide empirical support for the Environmental Kuznets Curve (EKC) hypothesis “meat consumption increases with income up to a certain point, approximately 81,500$ GDP per capita, after which it begins to decline”. This inverted U-shaped relationship suggests that high-income countries, increased environmental awareness and ethical concerns may begin to offset purely economic drivers. Specifically, their findings indicate that in low-income countries, meat remains a luxury good demonstrated by elasticities greater than one, while in high-income societies, meat consumption is less responsive to income growth. The study strengthens the view that while income remains a key determinant of meat consumption, its effect is nonlinear and shaped by broader sustainability transitions (Kmeťková & Ščasný, 2022).

The report Assessing Beef Demand Determinants (Tonsor, Lusk and Schroeder, 2018) provides a comprehensive analysis of the economic, informational and demographic factors that influence beef consumption in the United States. The study's primary objective is to update and deepen understanding of how price, income, media coverage and consumer attitudes shape demand for beef. To achieve this, the authors apply a multi-method approach combining econometric modeling, content analysis and survey-based preference measurements. To estimate consumer responsiveness to meat prices, Tonsor et al. (2018) apply a Rotterdam demand system using quarterly data from 1970 to 2017. The model includes separate demand equations for beef, pork, chicken, other food and non-food goods, allowing estimations of own-price, cross-price and expenditure elasticities. Different time periods (1988-2017, 1988-2007, 2008-2017) are analyzed using two price series, USDA Choice (an official quality grade with a moderate level of marbling) and All-fresh beef (all fresh beef products, regardless of whether they have been officially graded or not). Results show that beef demand has become less price elastic over time (-0.645 in 1988-2007 vs. -0.450 in 2008-2017). No diagnostic tests are reported, limiting assessment of model robustness (Tonsor et al. 2018).

In a complementary analysis, the authors examine how media and medical coverage influence demand by tracking the monthly frequency of keywords in news and scientific publications between 1980 and 2017. Using data from Lexis-Nexis and Medline, they identify 12 themes, such as taste, climate, safety, veganism, animal welfare, cancer etc. and correlate their prevalence with changes in beef demand. Positive framing around taste and flavor shows the strongest positive effect, animal welfare shows an increase in demand and mentions of veganism and climate concerns are linked to declines in beef demand. In addition to price- and information-based analysis the study incorporates consumer preference data from the Food Demand Survey (FooDS), collected monthly between 2013 and 2017 with over 48 000 respondents. Participants completed choice experiments comparing beef (steak and ground beef), pork, chicken and other food options while rating various food values such as taste, safety, freshness, animal welfare and environmental impact. Results show that taste, appearance and freshness are consistently the most important attributes driving beef choice, while environmental and animal welfare concerns play a smaller but growing role (Tonsor et al. 2018).

Rathnayaka et al. (2021) conducted an analysis of consumer demand for animal-derived foods, including beef, chicken, pork, muton, eggs and fish across seven

Asian countries: Hong Kong, Japan, the Philippines, Singapore, Sri Lanka, Taiwan and Thailand. Utilizing the Rotterdam demand system, the study estimated both conditional and unconditional own-price, cross-price and income elasticities. The model incorporates variables such as per capita consumption quantities, retail prices for each food item and total expenditure on animal-derived foods. Data were sourced from national statistical agencies and FAO databases, covering periods ranging from 1980-2016, depending on the country. Results showed that, in most countries, beef is considered a necessity and exhibits price inelastic demand. Notably, in Japan and Taiwan, beef was identified as a luxury good, with income elasticities exceeding one. Cross price elasticity estimates indicated a high degree of substitutability between beef and other animal-derived foods, particularly pork and chicken. The econometric model did not explicitly control for cultural factors such as religion, though the authors acknowledge their relevance in shaping consumption patterns. For instance, in predominantly Hindu or Buddhist regions such as Sri Lanka, beef consumption may be restricted due to religious beliefs. Similarly, pork consumption is limited in countries with large Muslim populations, such as parts of the Philippines (Rathnayaka et al. 2021).

A more recent cross-national study by Ammann et al. (2024), investigates how consumers in five European countries (Czechia, Germany, Spain, Sweden and the United Kingdom) prioritize different product attributes when purchasing meat and dairy. Using survey data from over 3000 participants, the study applied OLS regression analysis to explore how consumers rank 18 product attributes including animal welfare, environmental impact, healthiness and price. The results show that freshness was consistently rated as the most important attribute across all countries, followed by quality and taste. Animal welfare emerged as the third most important factor in Sweden, Switzerland and the UK, although it ranked lower in Spain and Czechia. Price and healthiness also influenced consumer choices but varied more across the countries. Although the study offers valuable insights into values-based consumption across national contexts, it does not report diagnostic tests for the OLS model, limiting the ability to assess the reliability of its statistical findings (Jeanine Ammann a et al. 2024).

Together, these studies provide an empirical and conceptual basis for analyzing the drivers of beef consumption. While income remains a consistently strong driver, more recent research highlights the role of food price, dietary norms and emerging ethical concerns. However, previous, macro-level analyses often exclude institutional variables such as animal welfare legislation or cultural factors like religious dietary restrictions. This thesis builds on and extends existing research by applying pooled OLS regression to panel data from 43 countries. By combining economic indicators (GDP, prices inflation) with underexplored non-economic (API, religion) variables specifically in macro-level analyses, this study provides a more comprehensive understanding of how these factors jointly influence per capita beef consumption.

3. Theoretical framework

This study draws on two key theoretical perspectives to interpret and contextualize patterns in beef consumption across countries: Engel's Law and Maslow's Hierarchy of Needs. Together, these frameworks offer insights into the influence of both economic (GDP and prices) and non-economic (API levels, religion) factors associated with beef consumption.

3.1 Engel's law

Engel's Law posits that as household income increases, the proportion of income spent on food tends to decline, although absolute spending may rise. This principle is particularly relevant for analyzing how demand for specific food types, such as meat, responds to changes in income. In low-income countries, meat is often treated as a luxury good, with consumption rising disproportionately with income. As countries become wealthier, meat consumption may plateau or even decline, reflecting a non-linear or inverted U-shaped relationship, a pattern that aligns with Engel's aggregation.

3.2 Maslow's hierarchy of needs

According to Maslow's Hierarchy of needs, individuals prioritize basic physiological needs (e.g., food, shelter) before attending to higher-order needs such as self-actualization or ethical concerns. In this context, beef consumption in lower-income regions is driven by nutritional necessity, whereas in higher-income countries, consumption patterns may increasingly reflect ethical considerations (e.g., animal welfare, environmental sustainability). As individuals meet their basic needs, they may shift from seeking calorie-dense animal proteins toward more plant-based or ethically produced alternatives, especially in societies with rising health awareness and ethical consumerism.

3.3 Integration into analysis

These two frameworks together help explain how both economic and non-economic factors shape beef consumption. Engel's law illustrates how rising income affects the quantity and type of food consumed, reducing the share of income spent on staples as meat. At the same time, Maslow's hierarchy of needs suggests that once basic material needs are satisfied, individuals with higher incomes may place greater importance on ethical considerations such as animal welfare, when making food choices. This implies that economic capacity and non-economic factors can jointly influence not only how much beef is consumed, but also the conditions under which it is produced.

Although animal welfare standards apply at the production level, they can indirectly influence consumer behavior. In countries with stronger standards institutional transparency, labeling and media coverage increase public awareness, encouraging ethically motivated dietary shifts (Alonso et al. 2020). This may lead to reduced meat consumption of substitution with plant-based alternatives. In contrast, countries with lower welfare standards may see weaker consumer responses due to limited awareness. The emphasis and clarity of animal welfare labels may influence consumer demand by aligning with widely shared ethical concerns (Ammann et al. 2024). Together, they allow this study to move beyond purely economic drivers and engage with the ethical dimensions of meat consumption through Animal Protection Index.

4. Data

This analysis is based on a dataset covering the years 2015-2022 for a selection of 43 countries. The sample includes countries from all major world regions and spans a broad economic range, from low- to high-income countries based on nominal GDP per capita. As shown in Figures 1 and 2, studied countries are highlighted by green, red, and blue colors. They are classified by the World Bank's income thresholds from 2022 using the Atlas method (World Bank, 2022; World Bank, n.d.)

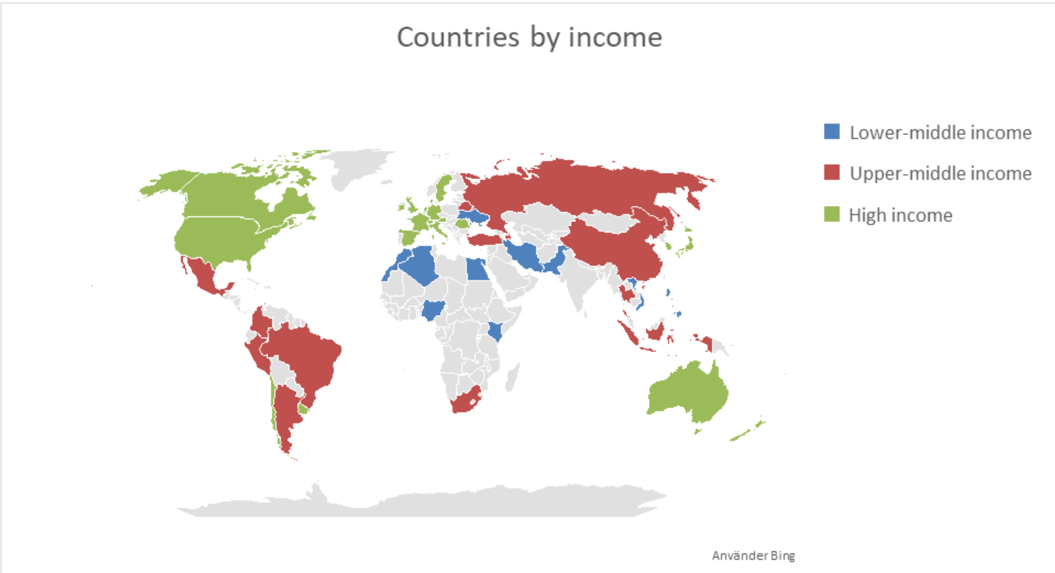


Figure 1. Countries by income

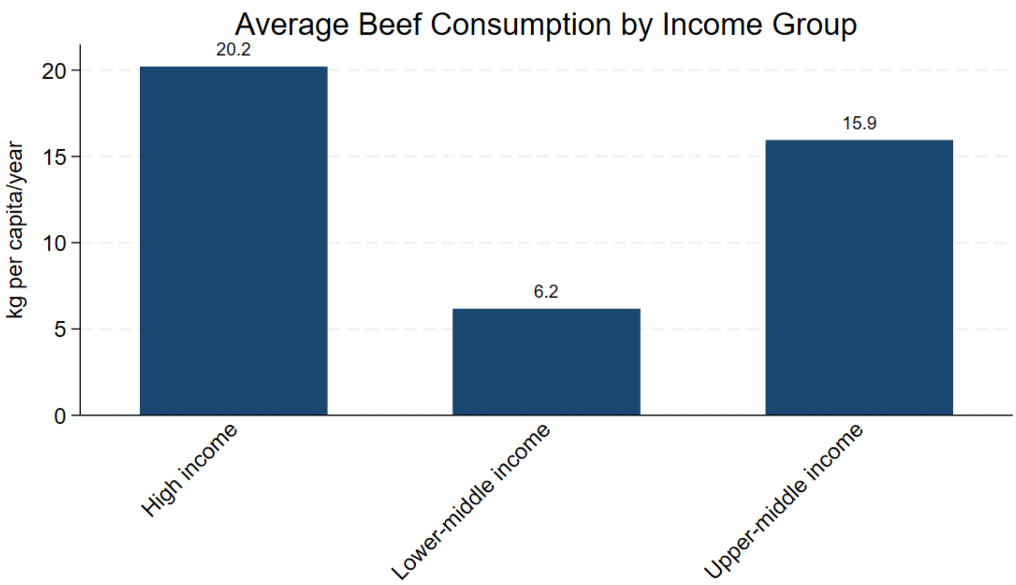


Figure 2. Average beef consumption by income group

Most of the data were collected from The Food and Agriculture Organization (FAO) database[1], Numbeo[2] while animal protection index and religions were sourced from Animal Protection index (API)[3] and World Population Review[4]. The dataset includes both economic and non-economic variables, each described below:

4.1 Key dependent variable

The dependent variable in this study is per capita beef consumption for 43 countries covering 8 years, measured in kilograms per person per year, as reported in FAOSTAT Food Balance Sheets (FBS). This variable reflects total availability of beef (bovine) meat for human consumption.

Per capita beef consumption was measured in kilograms per person per year. This value is derived from the "Food" category in the FBS, which reflects only the portion of domestic bovine meat intended for human consumption, after subtracting quantities used for feed, seed, industrial use, processing losses and waste. The calculation follows FAO's standardized accounting framework for food supply where domestic supply of bovine meat is defined as:

$$\text{Domestic Supply} = \text{Production} + \text{Imports} - \text{Exports} \pm \text{Stock Changes}$$

This equation captures the total amount of bovine meat available in the country from all sources. Imports increase and exports decrease the domestic supply. Stock changes account for increases or drawdowns in national reserves and are included to ensure annual accuracy.
From this total supply, the quantity allocated to non-food uses is subtracted and the remaining amount is classified under the "Food" category, representing the volume of beef available for human consumption. It is a proxy for beef consumption because this measure does not directly reflect actual household purchases or intake, it provides a harmonized and internationally comparable indicator of apparent consumption, which is used to study dietary trends and food system performance across countries and over time (FAO, 2017).

4.2 Key independent variables

To examine potential substitution effects, the model also includes per capita consumption of poultry, pork and fish measured using the same FAO indicator. Like beef, these variables are expressed in kilograms per capita per year and

[1] https://www.fao.org/faostat/en/#data
[2] https://www.numbeo.com/cost-of-living/prices_by_country.jsp?displayCurrency=USD&itemId=121
[3] https://api.worldanimalprotection.org/
[4] https://worldpopulationreview.com/

reflect the supply of alternative protein sources that may compete with beef in household diets.

Pork and Muslim Interaction: Based on data from World Population Review, a dummy variable was created and coded as 1 if more than 30 percent of the population is Muslim. This was interacted with ln_Pork (the natural log of per capita pork consumption) to reflect how religions may moderate pork's role as a substitute for beef. The share of Hindu population was considered as a potential control variable due to religious dietary restrictions on beef. However, in the dataset used nearly all countries report values below 2% (Hackett et al. 2022), resulting in extremely low variation. Given the risk of introducing instability without substantive insight, the variable was excluded from the final specification.

Gross Domestic Product (GDP) per capita (nominal): Data on GDP per capita was collected from the FAO database. The GDP per capita is expressed in USD and nominal terms, reflecting the monetary value of all finished goods and services produced within a country in a given year, without adjusting for inflation. Using nominal GDP ensures consistency with other nominal variables in the analysis, such as beef prices.

Beef Price (Proxy variable): Data on beef prices was collected from Numbeo, an online platform that aggregates user-reported price information across countries. Specifically, the price of one kilogram of beef round (or equivalent back leg red meat) in nominal USD was used as the measure for beef prices. Since no consistent alternative dataset is available that provides consumer prices for beef, Numbeo was chosen as the most viable source. Beef round price was selected as a proxy for general beef prices based on its representativeness in the global beef supply. It accounts for approximately 22-24% of a dressed carcass (Holland et al. n.d.) and is commonly used in ground beef, which is the most consumed form of beef in both high- and middle- income countries. For example, in the United States, ground beef accounts for over 40% of retail beef sales (Speer n.d.). Moreover, beef round is widely used in traditional dishes in Latin America, Asia, the Balkans and sub-Saharan Africa, underscoring its relevance in mass-market and culturally embedded consumption.

In terms of market structure, beef round together with chuck constitutes nearly 49% of the carcass, are priced similarly and dominate affordable, high volume beef products (Saner and Buseman, 2024). Higher value cuts like loin and rib are less relevant for the average consumer globally. These cuts are also commonly imported by countries to meet domestic demand, while more premium cuts are exported, further supporting beef round's relevance in trade-adjusted pricing exposure (Meat and Livestock Australia, 2023). Although this proxy may understate prices in niche or premium segments, it provides a consistent and realistic indicator of average beef price levels experienced by households across countries.

Food Consumer Price Index (Food CPI): To Control for changes in food price levels over time, a food Consumer Price Index (Food CPI) variable was included in the model. The Food CPI data was obtained from FAO and reflects the annual variation in the price of a standardized basket of food products across countries. Since this analysis focuses on beef consumption and beef prices, controlling for overall food inflation ensures that the estimated elasticities are not biased by broader shifts in food costs.

Animal protection index (API): This categorical and time-invariant variable was obtained from the World Animal Protection organization. It reflects the degree of animal welfare legislation and enforcement in each country, based on legal frameworks, implementations and penalties. The index ranges from A (strongest protections) to G (weakest protections). It should be noted that no country currently upholds the A level of API, thereby B is noted as the highest level for this variable.
For use in regression analysis, the categories were numerically recorded from 1 (G) to 6 (B), so that higher values reflect stronger levels of animal protection. The index remains constant over time and thus captures structural, institutional differences rather than short-term variation (World Animal Protection | Animal Protection Index n.d.).

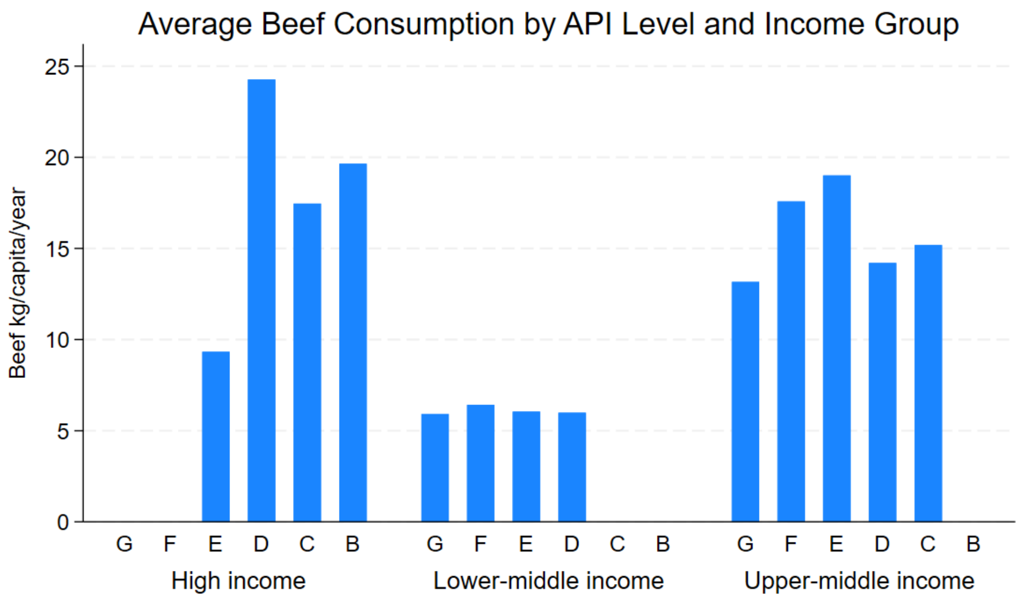


Figure 3. Average Beef Consumption by API Level and Income Group

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
$Country$	344	23.488	13.641	1	46
$Year$	344	2018.5	2.294	2015	2022
$\ln(Beef\ consumption)$	344	2.479	0.814	0.207	3.956
$\ln(GDP)$	344	9.478	1.194	7.165	11.571
$\ln(Beef\ prices)$	344	2.333	0.507	1.292	3.980
$API\ Levels$	344	3.907	1.363	1	6
$\ln(Poultry)$	344	2.975	0.776	-0.174	4.059
$\ln(Fish)$	344	2.730	0.822	0.293	4.057
$\ln(Pulses)$	344	1.077	0.999	-3.912	2.939
$\ln(Pork\ and\ Muslim\ Interaction)$	344	-0.259	1.034	-4.605	0.531
$\ln(FPI)$	344	4.786	0.296	4.527	6.981

Table 1. Descriptive Statistics

5. Method

To estimate the determinants of beef consumption, a pooled Ordinary Least Square regression model was employed. A scatterplot of the raw data suggests a non-linear relationship between income and beef consumption, consistent with Engel's curve. To address this curvature and allow for elasticity-based interpretation, all continuous variables were log-transformed. Given the panel structure of the data, robust standard errors clustered at the country level were used to correct for heteroskedasticity and intra-group correlation over time. Although a panel-data estimator such as fixed effects would typically be appropriate, it was not used in this context due to the inclusion of the time-invariant variables (e.g. the Animal Protection Index), which would have been dropped under a fixed effects specification. To complement the regression result, Engel's curves were also generated: one based on the full dataset and one displaying separate fitted lines for each level of the Animal Protection Index (API). These visualizations help illustrate how the relationship between income and beef consumption may vary depending on data composition.

Due to multicollinearity between GDP and API as shown in Table 3, two different model specifications were estimated to assess the reliability of the results. Model 1 is a full model, while Model 2 excludes API. Comparing these models allows for a more nuanced interpretation of how income, price and animal welfare standards relate to per capita beef consumption under different assumptions about data quality and multicollinearity.

Model 1 (Full model):

$$ln(Beef\ consumption_{it}) = \beta_0 + \beta_1 ln(GDP_{it}) + \beta_2 ln(Beef\ prices_{it}) + \beta_3 ln(Poultry_{it}) + \beta_4 ln(Fish_{it}) + \beta_5 ln(Pulses_{it}) + \beta_6 ln(Pork\ and\ Muslim\ Interaction_{it}) + \beta_7 ln(FPI_{it}) + \sum_{k=2}^{K} API_{ik} + \varepsilon_{it}$$

Model 2 (No API):

$$ln(Beef\ consumption_{it}) = \beta_0 + \beta_1 ln(GDP_{it}) + \beta_2 ln(Beef\ prices_{it}) + \beta_3 ln(Poultry_{it}) + \beta_4 ln(Fish_{it}) + \beta_5 ln(Pulses_{it}) + \beta_6 ln(Pork\ and\ Muslim\ Interaction_{it}) + \beta_7 ln(FPI_{it}) + \varepsilon_{it}$$

$\boldsymbol{ln(Beef\ consumption_{it})}$: The dependent variable in natural logarithm (log) of per capita beef consumption (kg/person/year) in country i at time t.

$\boldsymbol{\beta_0}$**:** The constant term showing the expected log-beef consumption when all independent variables are 1 ($ln(1) = 0$).

$\boldsymbol{ln(GDP_{it})}$**:** Natural log of nominal Gross Domestic Income (GDP) per capita (USD) in country i at time t, a proxy for income level. β_1 captures the income elasticity of beef consumption.

$\boldsymbol{ln(Beef\ prices_{it})}$**:** Natural log of the retail price for beef (USD/kg) in country i at time t. β_2 measures price elasticity of beef demand.

$\boldsymbol{ln(Poultry_{it})}$**:** Natural log of per capita poultry consumption (kg/year) in country i at time t. β_3 indicates whether poultry acts as a substitute or complement.

$\boldsymbol{ln(Fish_{it})}$**:** Natural log of per capita fish consumption (kg/year) in country i at time t. β_4 captures substitution effects between fish and beef.

$\boldsymbol{ln(Pulses_{it})}$**:** Natural log of per capita pulse consumption (e.g. beans, lentils) (kg/year) in country i at time t. β_5 reflects how plant-based proteins relate to beef consumption.

$\boldsymbol{ln(Pork\ and\ Muslim\ Interaction_{it})}$**:** Interaction between the log of pork consumption (kg/person/year) and a binary variable equal to 1 if a country has 30% Muslim population in country i at time t. β_6 estimates how pork-beef substitution is moderated by religious dietary restrictions.

$\boldsymbol{ln(FPI_{it})}$**:** Natural log of Food Price Index in country i at time t, a control for general food price inflation. β_7 adjusts for cost-of-living effects on food consumption.

$\boldsymbol{\sum_{k=2}^{K} API_{ik}}$**:** Time-invariant categorical variables for Animal Protection Index levels that measures how institutional animal welfare standards affect beef consumption in country i, depending on its membership in API category k.

$\boldsymbol{\varepsilon_{it}}$**:** Error term captures unobserved variation not explained by the included variables.

5.1 Diagnostic testing and model assumptions

To evaluate the validity of the OLS assumptions, a series of diagnostic tests were conducted and summarized in Table 2 and 3. These tests were applied to both Model 1 and Model 2 to assess linearity, normality, homoscedasticity, independence of error terms, multicollinearity and exogeneity (Stock & Watson 2020, p.715)

5.1.1 Linearity

Linearity was tested using Ramsey RESET test (Ramsey, 1969). The null hypothesis of the test states that the model has no omitted variables or incorrect functional form. The test yielded a p-value of 0.135 for Model 1 and 0.232 for Model 2, a high p-value (above 0.05) suggests that there is insufficient evidence to reject the null hypothesis (Stock & Watson 2020, p.181). This can also be confirmed by looking at the residual plot in Figure 4. The residuals look randomly and symmetrically distributed around zero.

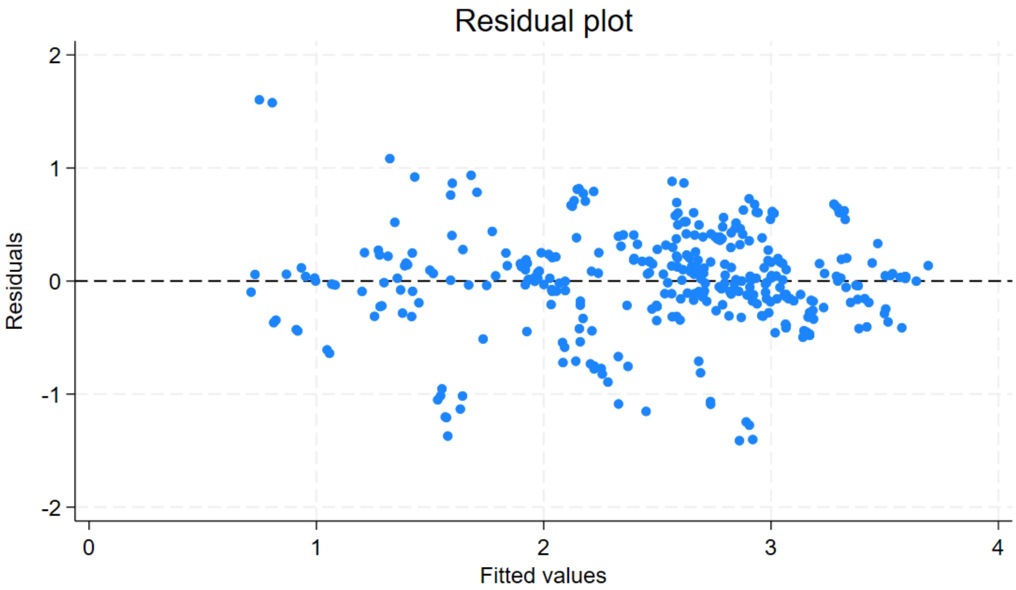


Figure 4. Residual plot

5.1.2 Normal distribution of the residuals

To assess the normality of the residuals, both visual and statistical diagnostics were conducted. Figure 5 for Model 1 shows a histogram of the residuals with a fitted normal density curve. The distribution appears approximately symmetrical and centered around zero. Although we can see that the left and right sides are not perfectly symmetrical. This suggests that the residuals may be skewed on the right side.

The Skewness- Kurtosis test result in Table 2 shows whether the distribution of the residuals deviates significantly from normality. In both models p-values were below 0.005, indicating non-normal residuals (Stock & Watson 2020, p.181). Violating normality affects the accuracy of small-sample (N<100) hypothesis tests and confidence intervals (Stock & Watson 2020, p.162). However, given the relatively large sample size (N=344), the Central Limit Theorem (CLT) justifies the use of OLS by ensuring that coefficient estimates remain asymptotically normal. As a result, standard inference (t-test and p-values) remains valid despite non-normal residuals. (Stock & Watson 2020, p.696, 704)

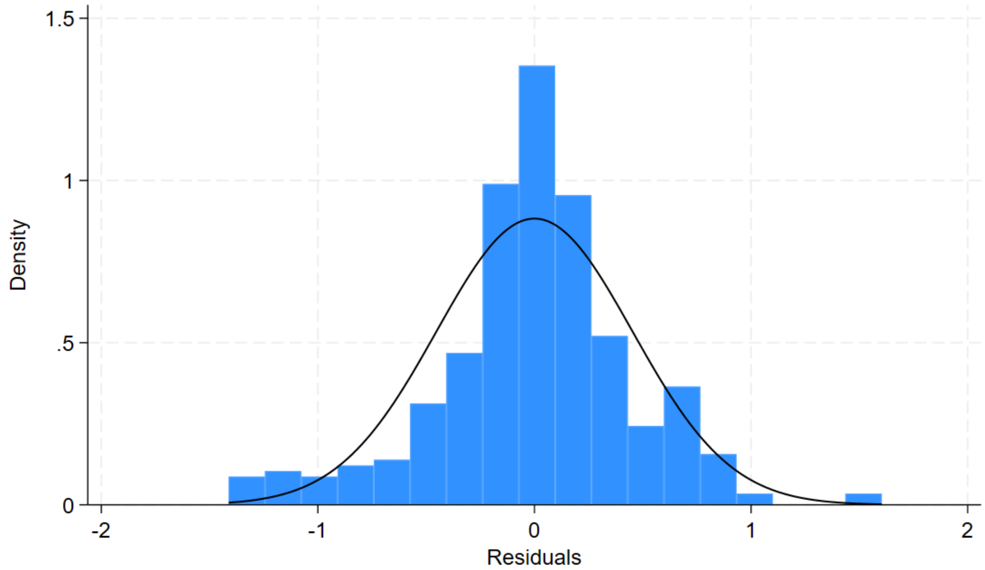


Figure 5. Histogram

5.1.3 Homoscedasticity

If homoscedasticity (equal variance of residuals) and independence of error terms assumptions are violated, the standard errors will be incorrect, leading to invalid inference. These were addressed by using clustered standard errors at the country level (clusters) (Stock & Watson 2020, p.206). This method adjusts for both unequal variance and potential correlation within areas, making the model more resistant to these violations (Stock & Watson 2020, p.188-194).

Diagnostic tests	Model 1	Model 2
RESET (p-value)	0.135	0.232
Skewness-Kurtosis	0.0000	0.0005
Adjusted R-square	0.681	0.674

Table 2. Diagnostic tests

5.1.4 Multicollinearity

If multicollinearity (perfect linear relationships) is present, it will be mathematically impossible to estimate coefficients (Stock & Watson 2020, p.206). This was tested using the Variance Inflation Factor (VIF). VIF measures how strongly each independent variable is correlated with the others. Values above 5 or 10 may indicate multicollinearity. As shown in Table 3, some API variables and GDP showed elevated VIF values due to their structural correlation, which is theoretically expected. To address this, model comparisons were made with and without API to evaluate the impact on the results (Stock & Watson 2020).

Variable	VIF Model 1	VIF Model 2
$\ln(GDP)$	6.85	3.61
$\ln(Beef\ prices)$	3.45	2.98
$\ln(Poultry)$	1.82	1.49
$\ln(Fish)$	1.79	1.55
$\ln(Pulses)$	1.48	1.12
$\ln(Pork\ and\ Muslim\ Interaction)$	1.94	1.19
$\ln(FPI)$	1.33	1.20
API level 2	4.35	
API level 3	5.01	
API level 4	8.12	
API level 5	5.66	
API level 6	6.89	
Mean VIF	4.06	1.88

Table 3. VIF results

5.1.5 Observations are independent and identically distributed

The assumption that observations are independent and identically distributed (i.i.d.,) implies that the observations are both independent from each other and drawn from the same underlying distribution (Stock & Watson 2020, p.158). If this assumption is violated OLS is no longer Best Linear Unbiased Estimator and standard errors are biased, undermining inference (Stock & Watson, 2020). This assumption is often violated in panel data, where observations with the same unit (e.g., country) may be correlated. To address this, the model uses clustered standard errors, which adjusts for within-clusters dependence (Stock & Watson, 2020).

5.1.6 Autocorrelation

Autocorrelation occurs when the error term in one time period is correlated with the error term in another time period. If the errors are serially correlated, OLS estimators remain unbiased and consistent, but the usual standard errors are incorrect (Stock & Watson, 2020). This can be spotted by looking at a residual plot in Figure 4, showing no signs of autocorrelation as the residuals appear randomly scattered around zero without a pattern. The simplest solution according to the book is to use errors that are robust to serial autocorrelation as clustered standard errors (Stock & Watson, 2020).

5.1.7 No outliers

Figure 6 represents a boxplot of $\ln(Beef\ consumption)$ across the different API levels (G to B). If large outliers are present, they can distort OLS estimates (Stock & Watson 2020, p.159). Notably the countries with API level D exhibit a wide range of beef consumption, both a lower minimum and the highest maximum values suggesting heterogeneity within that group. This may reflect underlying cultural, political or economic differences. While this observation enriches the data it may also reduce precision in estimating the group's average effect.

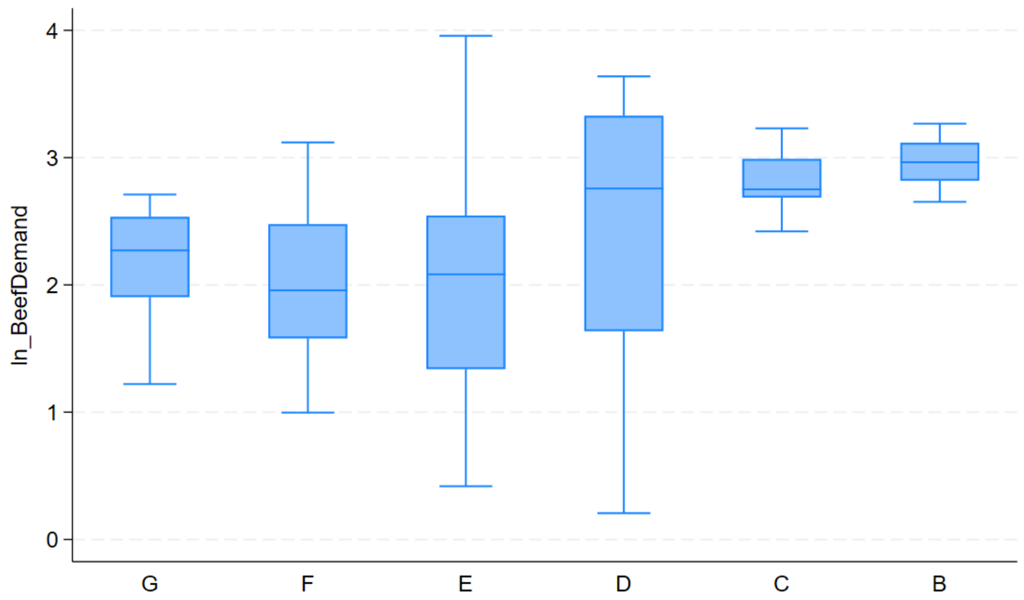
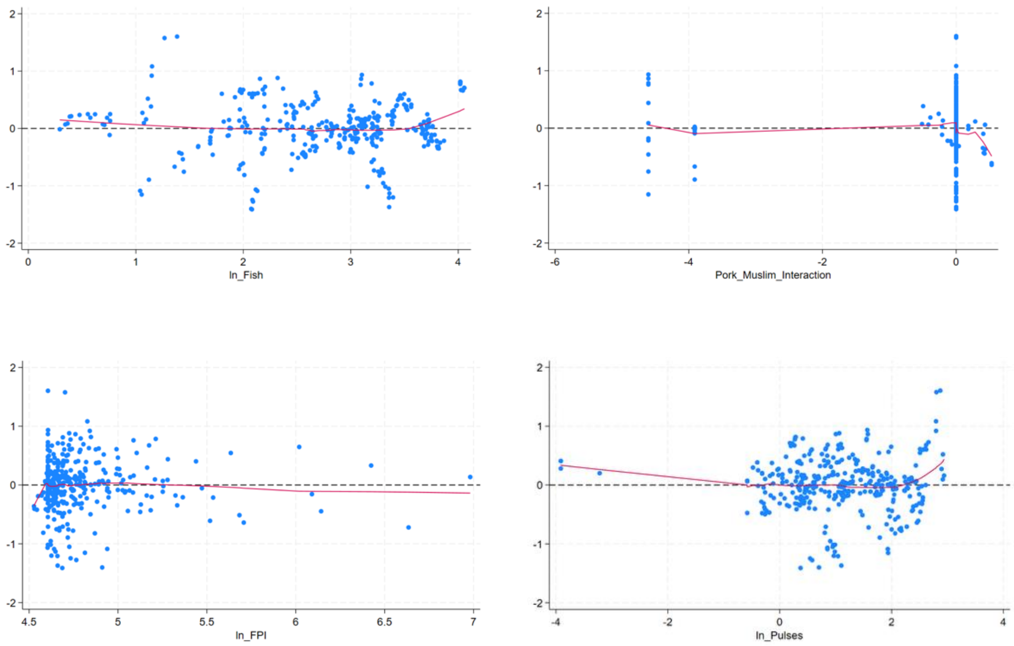


Figure 6. Boxplot

5.1.8 Exogeneity

Exogeneity is a key assumption that the independent variables in the regression must be uncorrelated with the error term in order to ensure unbiased and consistent coefficient estimates (Stock & Watson, 2020). To further assess the exogeneity assumption empirically, residual plots were generated for each explanatory variable. Each plot included a LOWESS smoothing line to visually detect any systematic patterns in the residuals. As plotted in Table 4 the expected mean of residuals greatly deviates from the zero line for most of the independent variables, suggesting the error term may correlate with the corresponding regressor. These findings do not confirm endogeneity but highlight the importance of cautious interpretation, particularly for variables theoretically at risk of reverse causality or omitted variable bias (Stock & Watson 2020, p.213).

Endogeneity could theoretically arise if, for instance, reverse causality exists or if unobserved cultural or policy-related factors simultaneously affect both food preferences (as reflected in the API level) and income. A key challenge in addressing omitted variable bias, which is one of the sources of endogeneity, lies in the fact that many theoretically important factors are difficult or impossible to quantify and thus cannot be included in the model. Some of these factors are the specific amount and type of food waste, culturally embedded dietary traditions and personal or ethical values related to food choices. Furthermore, certain variables that would ideally be controlled for may exhibit perfect or near-perfect collinearity with included regressors, making it statistically infeasible to estimate their separate effects. However, potential endogeneity is addressed through theoretical justification and careful model specification. The inclusion of the API variable, which is time-invariant, is motivated by structural differences in food systems and societal preferences, rather than by direct behavioral feedback from meat demand. Thus, the regressors are assumed to be plausibly exogenous, following the conceptual framework laid out by Stock and Watson (2020, chapter 12).



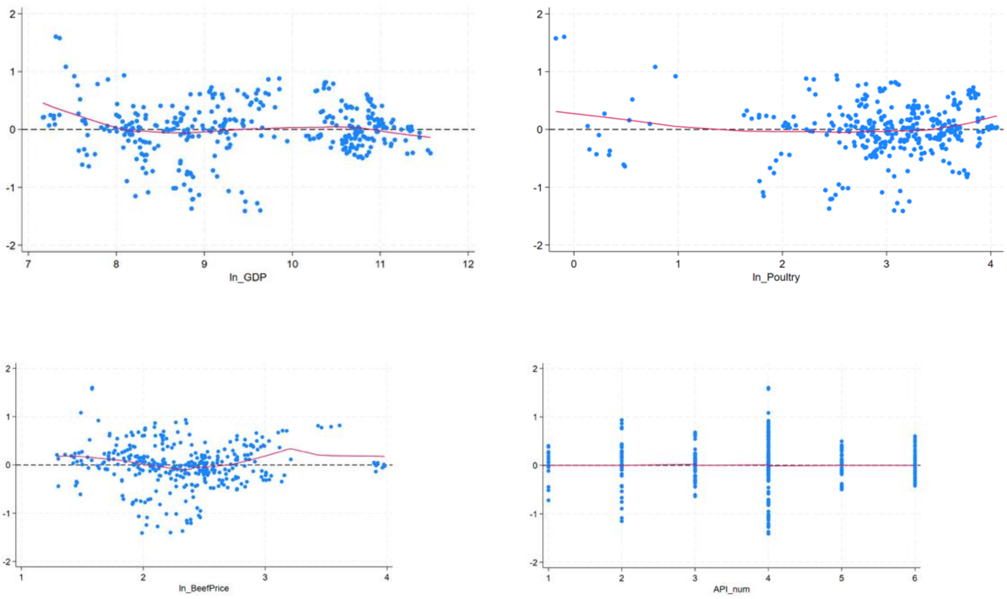


Table 4.Exogeneity

6. Results

VARIABLES	Model 1 (Full Model)	Model 2 (No API)
$\ln(GDP)$	0.580***	0.549***
	(0.110)	(0.0868)
$\ln(Beef\ prices)$	-0.205	-0.245
	(0.185)	(0.173)
$\ln(Poultry)$	0.408***	0.406***
	(0.131)	(0.116)
$\ln(Fish)$	-0.462***	-0.417***
	(0.106)	(0.0872)
$\ln(Pulses)$	0.0258	0.0255
	(0.0698)	(0.0641)
$\ln(Pork\ and\ Muslim\ Interaction)$	-0.0438	-0.0763
	(0.0525)	(0.0601)
$\ln(FPI)$	0.124	0.0918
	(0.137)	(0.195)
API level 2	0.478*	
	(0.267)	
API level 3	0.354**	
	(0.172)	
API level 4	0.278	
	(0.249)	
API level 5	0.312	
	(0.206)	
API level 6	0.172	

	(0.200)	
Constant	-3.412***	-2.710**
	(1.070)	(1.179)
Observations	344	344
Adjusted R-squared	0.681	0.674

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Regression results

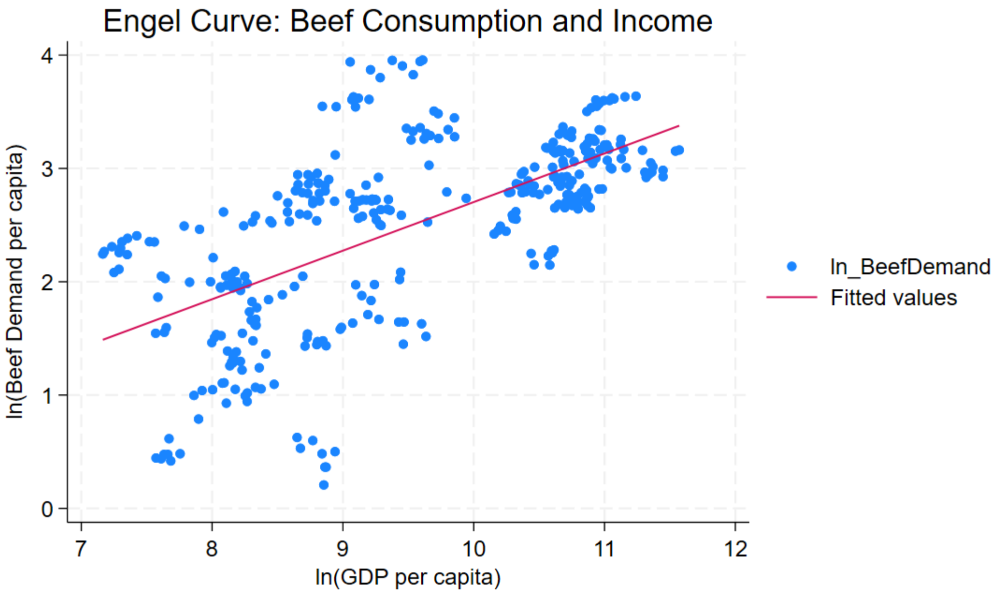


Figure 7. Engel Curve: Beef consumption and Income

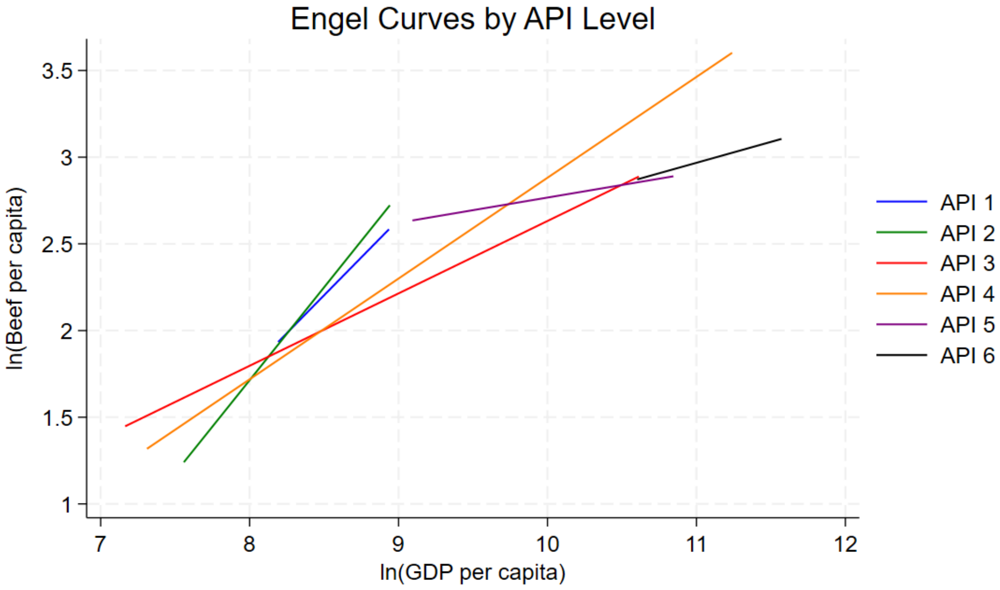


Figure 8. Engel curves by API level

7. Discussion and result interpretation

This study set out to examine the determinants of per capita beef consumption across 43 countries, focusing on how income, beef prices and animal welfare standards explain the beef consumption. These findings confirm that economic variables, particularly income remain central in shaping beef consumption globally. However, ethical and cultural factors such as institutional animal welfare standards and food substitution patterns, play increasingly important roles, especially in high-income countries.

Table 5 presents the results from two log-log OLS regression models. In both specifications, income ($ln(GDP)$)shows a strong and statistically significant positive effect on beef consumption. Specifically, a 1% increase in GDP per capita is associated with an estimated 0.58% increase in beef consumption in Model 1 and 0.55% in Model 2, both significant at the 1% level. These results support the hypothesis that beef consumption increases with income, in line with Engel's aggregation theory. They are also in line with earlier research by Grigg (1944) and Kmeťková & Ščasný (2022), which highlight the central role of income growth in dietary transitions toward more meat-intensive consumption, particularly in emerging economies.

As economic development progresses, it is often accompanied by broader structural and societal changes such as digitalization, cultural diffusion and globalization of food systems. The global meat market, including industrial livestock production, meat trade and the operations of multinational food corporations, has become embedded in both developed and developing countries. Through the expansion of cold-chain logistics and the standardization of processed meat products, beef and other meat types have become widely accessible, reinforcing their status as convenient food staples.

At the same time, government policies such as agricultural subsidies and trade protection, seen in the CAP, U.S. Farm Bill and China's rural support programs continue to reinforce meat-heavy food systems without fully integrating environmental concerns (Vallone & Lambin, 2023). While beef provides valuable nutrients, the environmental and public health costs of expanding consumption are significant. As beef consumption increases in low- and middle-income countries, so too will associated emissions, land degradation and water use (FAO, 2013). These patterns underscore the need for future policy to anticipate not just current consumption patterns but also the long-term implications of economic development on food system sustainability.

$Ln(Beef\ prices)$ and $ln(FPI)$ were not statistically significant determinants of beef consumption in either model. While $ln(Beef\ prices)$ showed the expected negative sign, $ln(FPI)$ was positively signed, contrary to theoretical expectations that higher food prices would reduce demand. However, given the lack of statistical significance, these results should not be interpreted further. Similar findings are reported in Tonsor et al. (2018), where price-related variables also yielded non-significant results.

However, the absence of a significant price ($ln(Beef\ prices)$) effect does not necessarily imply that economic policy instruments such as subsidies are irrelevant. Public subsidies and other price-stabilizing mechanisms may reduce natural price variation, thereby dampening consumers sensitivity to cost. Subsidies shape the broader structural conditions by supporting supply, maintaining low retail prices and reinforcing beef as a normative part of the diet, subsidies can amplify income-driven demand growth even in absence of price responsiveness. This may explain why beef consumption continues to increase in many countries despite relatively stable or even rising prices.

$Ln(Pulses)$ and $ln(Pork\ and\ Muslim\ Interaction)$ do not show statistically significant effects either. Although the interaction term between $\ln(Pork\ and\ Muslim\ Interaction)$ was not statistically significant, it remains conceptually important given its potential to capture culturally influenced consumption patterns. As mentioned in the introduction, cultural and religious factors are not easily captured in macroeconomics because of the challenges of quantifying them, yet they play a substantial role in shaping the national food demand.

The results also show strong substitution effects between $ln(Fish)$ and $ln(Beef\ consumption)$, with fish showing a statistically significant negative relationship with beef consumption. In contrast, $ln(Poultry)$ displays a positive and significant association, indicating it may function as a complementary good rather than a substitute (Table 5). These findings align with Tonsor et al. (2018), who reported consistently low and only weakly positive cross-price elasticities between chicken and beef (-0.044 to 0.083) across multiple time periods. These low elasticities indicate that consumers do not strongly shift between chicken and beef in response to price changes, which supports the interpretation that the two are often consumed in parallel rather than as direct substitutes.

In Model 1, which includes API level, results indicate that countries with higher API levels tend to have slightly higher beef consumption than the reference category (API level 1), but only API levels 2 and 3 are statistically significant and at the 10% and 5% levels, respectively. This may reflect underlying cultural or economic heterogeneity across API levels. This may suggest that moderate levels of animal protection are associated with greater beef consumption, possibly reflecting a transitional stage in dietary behavior where economic development supports both higher meat intake and emerging welfare norms. However, looking at Table 3, this pattern could be explained by multicollinearity between $ln(GDP)$ and API levels. Since stronger animal protection correlates with higher national income shown in Figure 6, much of the explanatory power may already be absorbed by $ln(GDP)$. Additionally, API category 6 includes relatively few observations, which widens confidence intervals shown in Table 5.

While Maslow's hierarchy of needs suggest that ethical concerns such as animal welfare become more relevant as income rises, the result of this study complicates that assumption. The API results challenge the idea that increased ethical awareness necessarily leads to reduced meat intake. Instead, the findings may reflect a phase where rising income allows for both higher consumption and stronger animal welfare policies, without a shift toward ethical restraint.

Figure 8 shows the disaggregated Engel's curves by API level, allowing for comparison across different food systems. While all API levels show a positive income-consumption relationship, the slopes vary, suggesting differences in income elasticities of beef consumption. For example, API levels 1 and 2 display steeper slopes, indicating higher responsiveness to income changes, whereas API levels 5 and 6 show flatter trends. This difference implies that the role of income in shaping beef consumption is moderated by underlying food system characteristics. The visual results from Figures 7 and 8 support the regression findings and suggest that while income is a key driver of beef consumption, its impact varies depending on broader food system orientation and food preferences.

Furthermore, the disaggregated Engel's Curves (Figure 8) reveal that at the highest API level (API 6), the slope of beef consumption in relationship to income flattens, suggesting diminishing marginal increases in consumption as ethical concerns begin to play a stronger role. It is also in line with the findings of Kmeťková & Ščasný (2022), which found that at 81 500 $ of GDP per capita, meat demand should decline.

Additionally, the Engel's Curve (Figure 8) for countries with the highest level of API, API 6 is steeper than for API 5. This suggests that countries with more stringent animal welfare policies, do not necessarily suppress their demand for beef. On the contrary, it may coexist with increased consumption volumes, reflecting a context in which wealthier countries choose to consume more meat that aligns with their ethical and regulatory frameworks. This pattern underscores the distinction between regulating how meat is produced and shaping how much meat is consumed.

The constant term in both models is negative and statistically significant. Since all variables are logarithmic, this constant reflects the expected log-level of beef consumption when all explanatory variables are equal to one (e.g., $e^0 = 1$). When converted back to levels, the constant corresponds to a baseline consumption of approximately 33 grams of beef per capita per year (e.g., $e^{-3{,}412} = 0.0033\, kg$) an unrealistically low but theoretically interpretable value. This reflects the model's estimate for beef consumption in a hypothetical scenario with minimal levels of income, prices and other drivers and does not undermine the model's validity or its interpretation within realistic data range.

The adjusted R-squared values shown in Table 5 are similar across both models, 0.681 in Model 1 and 0.674 in the Model 2, indicating that the explanatory power is not substantially driven by the inclusion of the API variables.

7.1 Policy recommendation

Since income is the strongest predictor of beef consumption, future policy must address the structural link between rising income and increasing beef consumption. Rather than limiting income growth, which is neither desirable nor realistic. Governments can redirect consumption patterns through income-sensitive interventions. One approach is to promote sustainable protein alternatives through subsidies.

This aligns with the study's findings, which highlight the role of fish as a viable substitute for beef. Encouraging sustainable fish consumption could therefore be an effective strategy for reducing beef consumption. Targeted policies such as consumer education and support for sustainable fisheries may encourage this dietary shift. However, simply promoting fish consumption or subsidizing fisheries will not make a significant impact at the national level without broader systemic change. Fish stocks have declined in recent decades, harming marine ecosystems and biodiversity. While fish farms offer some relief, it comes with its own issues such as disease spread and restricted animal welfare.

To reduce pressure on marine resources, global cooperation and stricter regulation are essential. Measures such as banning destructive trawling methods, enforcing seasonal fishing bans during spawning periods and applying real penalties for violation are important. Some progress has been made through international agreements like UN's sustainable development goal 14 and WTO negotiations on fisheries subsidies, but implementation remains limited. On a local level, certain countries have introduced fishing regulations that have led to positive outcomes in specific areas, but without broader international enforcement, these improvements remain limited.

In addition to promoting sustainable alternatives, policymakers could consider phasing out subsidies for industrial beef production. As FAO (2013) points out, livestock production is a major contributor to global greenhouse gas emissions. Maintaining subsidies that artificially lower beef prices reinforce unsustainable consumption patterns and distort market signals. Redirecting these financial supports toward low-emission and more efficient production systems, practices such as improved feed management and animal health services can help reduce emissions per unit of output.

FAO (2013) also highlights that financial instruments such as "beneficiary pays" subsidies and "polluter pays" mechanisms (e.g. emission taxes or tradable permits) are among the most economically efficient tools for incentivizing climate-smart livestock practices. These mechanisms either reward mitigation efforts or impose a cost on high-emission systems, helping to internalize environmental costs and align producer behavior with sustainability goals. Choosing the appropriate instrument will depend on each country's institutional capacity and political feasibility, but both represent critical levers in the transition toward more beef production.

7.2 Study limitations

This study offers valuable insights into determinants of beef consumption across 43 countries, however, several limitations must be considered to properly contextualize the findings. One critical issue concerns data quality, which underpins the reliability of any analysis. Panel datasets can vary significantly in their sources, collection methods and reporting accuracy. For example, inconsistencies in how countries report agricultural and consumption statistics may introduce wrong observations or bias.

Another complex challenge is the quantification of non-economic factors, particularly cultural influences. Variables such as dietary norms, ethical attitudes and dietary traditions toward beef consumption are difficult to measure, yet they play a central role in shaping consumer behavior. In this study, the Animal Protection Index was used to capture some aspects of these ethical dimensions. Such measures are limited and rely on subjective scoring and may not fully capture societal nuances.

Methodologically, the study employs a pooled OLS regression model, which represents a simplified abstraction of reality. The model operates solely on the numerical values inputted and identifies statistical associations rather than causal relationships.
While this study offers valuable insights into determinants of beef consumption across 43 countries, several limitations must be acknowledged to contextualize the findings. While regression remains a central tool in empirical research, its results should be interpreted with caution and seen as indicative rather than definitive.

The model also depends on several restrictive assumptions. To meet the linearity and distributional requirements of OLS, some outlier countries, such as Poland, India and Malaysia were removed due to unusually low beef consumption values. While this improved model fit, it also introduced a trade-off by excluding potentially meaningful cases that could affect generalizability of the results by omitting observations.

Additionally, multicollinearity among variables limited the inclusion of potentially important control variables such as education levels, urbanization rates and population growth. The exclusion of these factors raises concern about omitted variable bias. While GDP per capita is assumed to partially proxy for broader developmental dynamics. Nevertheless, future research with more refined data could better disentangle these effects.

Another key assumption in the model is exogeneity. Although GDP per capita and beef prices were treated as exogenous variables in this analysis, potential, reverse causality cannot be ruled out. For instance, rising GDP per capita may increase consumer demand for beef, which in turn could drive up beef prices, rather than the other way around. Similarly, changes in meat consumption patterns might influence animal welfare legislation, which is captured by API, rather than being influenced by it. While theoretical justification supports the directionality assumed in this study, further robustness checks such as instrumental variable approaches would strengthen causal claims.

Overall, the results should be seen as a contribution to the broader empirical understanding of global beef consumption patterns, rather than a definitive predictor of future behavior. As data availability and modeling techniques evolve, future research can refine and extend the conclusion presented here.

8. Conclusion

This study investigated the drivers of per capita beef consumption across 43 countries between 2015 to 2022, combining economic factors such as income and beef prices with non-economic variables such as animal welfare legislation and dietary substitutes. Income emerged as the strongest predictor consistent with other studies, fish acted as a substitute and animal welfare index was associated with higher beef intake. Methodologically, the use of pooled OLS with clustered standard errors and log-transformed variables ensured consistent, elasticity-based interpretation.

Income is the strongest driver of beef consumption, suggesting that future policies must steer demand as income rises. Promoting sustainable fish production and consumption through education, targeted subsidies and stricter fishing regulations offers one pathway. However, global cooperation is needed to manage marine resources sustainably. Phasing out subsidies for high-emission beef production and redirecting support toward climate-smart practices further reduce environmental impact. Financial tools like mitigation subsidies and emission taxes are effective ways to align production with climate goals.

The study is limited by potential endogeneity, multicollinearity and potential omitted variable bias restricting causal interpretation. Future research could benefit from instrumental variable approach and more observations to capture the drivers of global beef consumption.

References

Adams, N., Sans, A., Trier Kreutzfeldt, K.-E., Arias Escobar, M.A., Oudshoorn, F.W., Bolduc, N., Aubert, P.-M. & Smith, L.G. (2025). Assessing the impacts of EU agricultural policies on the sustainability of the livestock sector: a review of the recent literature. Agriculture and Human Values, 42 (1), 193–212. https://doi.org/10.1007/s10460-024-10595-y

Aiello, L.C. & Wheeler, P. (1995). The Expensive-Tissue Hypothesis: The Brain and the Digestive System in Human and Primate Evolution. Current Anthropology, 36 (2), 199–221

Alonso, M.E., González-Montaña, J.R. & Lomillos, J.M. (2020). Consumers' Concerns and Perceptions of Farm Animal Welfare. Animals : an Open Access Journal from MDPI, 10 (3), 385. https://doi.org/10.3390/ani10030385

Ammann, J., Mack, G., El Benni, N., Jin, S., Newell-Price, P., Tindale, S., Hunter, E., Vicario-Modroño Vicario-Modroño, V.V.-M., Gallardo-Cobos, R., Sánchez-Zamora, P., Miškolci, S. & J. Frewer, L. (2024). Consumers across five European countries prioritise animal welfare above environmental sustainability when buying meat and dairy products - ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0950329324000818 [2025-05-27]

Ammann, J., Mack, G., Irek, J., Finger, R. & El Benni, N. (2023). Consumers' meat commitment and the importance of animal welfare as agricultural policy goal. Food Quality and Preference, 112, 105010. https://doi.org/10.1016/j.foodqual.2023.105010

Boehme, M. (2025). China releases new ag subsidies for 2025. DCZ - Sino-German Agricultural Centre. https://www.dcz-china.org/2025/03/29/china-releases-new-ag-subsidies-for-2025/ [2025-05-27]

Cooking School Guide (2024). The History of Beef: From Ancient Times to Modern Day - Cooking School Guide. https://cookingschoolguide.com/the-history-of-beef-from-ancient-times-to-modern-day/ [2025-05-27]

Corichi, N.S., Jonathan Evans, Ariana Monique Salazar, Kelsey Jo Starr and Manolo (2021). 10. Religion and food. Pew Research Center. https://www.pewresearch.org/religion/2021/06/29/religion-and-food/ [2025-05-27]

Cottle, D. & Kahn, L. (2014). Beef Cattle Production and Trade. Csiro Publishing.

FAO (red.) (2013). Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities. FAO.

FAO (2017). Guidelines for the compilation of Food Balance Sheets. https://openknowledge.fao.org/server/api/core/bitstreams/f80bc794-2b23-40d0-8a0d-886229f3fcc7/content? [2025-05-27]

Folkhälsomyndigheten (2025) [The Public Health Agency of Sweden]. Riktlinjer och rekommendationer om mat [Guidelines and recommendations on food] https://www.folkhalsomyndigheten.se/livsvillkor-levnadsvanor/mat-fysisk-aktivitet-overvikt-och-obesitas/mat/riktlinjer-och-rekommendationer-om-mat/ [2025-05-27]

Grigg, D. (1995). The pattern of world protein consumption. Geoforum, 26 (1), 1–17. https://doi.org/10.1016/0016-7185(94)00020-8

Hackett, Conrad, Stonawski, Tong, Kramer, Shi & Zanetti. (2022). Religious Composition by Country, 2010-2050. Pew Research Center. https://www.pewresearch.org/religion/feature/religious-composition-by-country-2010-2050/ [2025-05-27]

Holland, R., Loveday, D. & Ferguson, K. (n.d.). University of Tennessee Institute of Agriculture.

Imaizumi, A. (2021). Summary of Japan's Livestock and Egg Support Programs (u.å.). https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Summary%20of%20Japan%27s%20Livestock%20and%20Egg%20Support%20Programs_Tokyo_Japan_06-21-2021.pdf [2025-05-27]

Jeanine Ammann, Gabriele Mack, Nadja El Benni, Shan Jin c, Paul Newell-Price, Sophie Tindale, Erik Hunter, Victoria Vicario-Modroño, Rosa Gallardo-Cobos, Pedro Sánchez-Zamora, Simona Miškolci h, & Lynn J. Frewer (2024). Consumers across five European countries prioritise animal welfare above environmental sustainability when buying meat and dairy products - ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0950329324000818 [2025-05-27]

Klurfeld, D.M. (2018). What is the role of meat in a healthy diet? Animal Frontiers: The Review Magazine of Animal Agriculture, 8 (3), 5–10. https://doi.org/10.1093/af/vfy009

Kmeťková, D. & Ščasný, M. (2022). Income elasticity for animal-based protein and food supply. https://www.econstor.eu/bitstream/10419/272796/1/181735891X.pdf

Meat and Livestock Australia (n.d.). Market snapshot, Beef and Sheepmeat. https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/os-markets/red-meat-market-snapshots/north-america_2022-mla-industry-insights-market-snapshot_revised-300323.pdf? [2025-05-27]

Naturskyddsföreningen [Swedish Society for Nature Conservation]. (2021). CAP: Miljarderna som påverkar EU:s jordbruk [CAP: The billions that influence EU agriculture]. Naturskyddsföreningen [Swedish Society for Nature Conservation]. https://www.naturskyddsforeningen.se/artiklar/cap-miljarderna-som-paverkar-eus-jordbruk/ [2025-05-27]

OECD (n.d.). Measuring the Environmental Performance of Agriculture. OECD. https://www.oecd.org/en/data/dashboards/measuring-the-environmental-performance-of-agriculture.html [2025-05-27]

Ramsey, J.B. (1969). Tests for Specification Errors in Classical Linear Least-Squares Regression Analysis. Journal of the Royal Statistical Society. Series B (Methodological), 31 (2), 350–371

Rathnayaka, S.D., Selvanathan, S. & Selvanathan, E.A. (2021). Demand for animal-derived food in selected Asian countries: A system-wide analysis. Agricultural Economics, 52 (1), 97–122. https://doi.org/10.1111/agec.12609

Saner, R. & Buseman, B. (2024). How Many Pounds of Meat Can We Expect From A Beef Animal? | UNL Beef | Nebraska. https://beef.unl.edu/beefwatch/2020/how-many-pounds-meat-can-we-expect-beef-animal/? [2025-05-27]

Sans, P. & Combris, P. (2015). World meat consumption patterns: An overview of the last fifty years (1961–2011). Meat Science, 109, 106–111. https://doi.org/10.1016/j.meatsci.2015.05.012

Speer, N. (n.d.). Changes in the Ground Beef Market and What it Means for Cattle Producers.

Stock, J.H. & Watson, M.W. (2020). Introduction to Econometrics. Fourth. Pearson Education.

Tonsor, G.T., Lusk, J.L. & Schroeder, T.C. (2018). Assessing Beef Demand Determinants. https://www.beefboard.org/wp-content/uploads/2019/06/Assessing-Beef-Demand-Determinants_FullReport.pdf

U.S. Department of Agriculture (2025). Farm Bill | Home. https://www.usda.gov/farming-and-ranching/farm-bill [2025-05-27]

Vallone, S. & Lambin, E.F. (2023). Public policies and vested interests preserve the animal farming status quo at the expense of animal product analogs. One Earth, 6 (9), 1213–1226. https://doi.org/10.1016/j.oneear.2023.07.013

WHO (2025). Cancer: Carcinogenicity of the consumption of red meat and processed meat (2015). https://www.who.int/news-room/questions-and-answers/item/cancer-carcinogenicity-of-the-consumption-of-red-meat-and-processed-meat/ [2025-05-27]

World Animal Protection | Animal Protection Index (n.d.). https://api.worldanimalprotection.org/ [2025-05-27]

World Bank (2022). New World Bank country classifications by income level: 2022-2023. World Bank Blogs. https://blogs.worldbank.org/en/opendata/new-world-bank-country-classifications-income-level-2022-2023 [2025-05-27]

World Bank (n.d.). World Bank country classifications by income level for 2024-2025. World Bank Blogs. https://blogs.worldbank.org/en/opendata/world-bank-country-classifications-by-income-level-for-2024-2025 [2025-05-31]

Zeder, M.A. (2008). Domestication and early agriculture in the Mediterranean Basin: Origins, diffusion, and impact. Proceedings of the National Academy of Sciences, 105 (33), 11597–11604. https://doi.org/10.1073/pnas.0801317105

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