Consumer Demand for Meat Products in the United States: A Structural Change Analysis

Abena Duku Damuah[1]

Abstract

The demand for meat product in the United States has significantly evolved due to economic and structural changes. Economic determinants such as relative prices and consumer income, as well as other factors such as changing consumer preferences, health concerns, food safety information, and changing consumer demographics have significant impact on meat consumption. Understanding how these dynamics influence meat demand is crucial for stakeholders in the meat industry, including producers, marketers, and policymakers. This paper examines how structural changes likes recession influence the demand for meat in the United States. Using a time series data from 1980-2021, the paper employs the Rotterdam model to estimate the structural changes in the demand for beef, pork and chicken. The findings suggest that beef, pork and chicken were luxury good. Consumers will substitute away from beef to pork and chicken. The dotcom recession and COVID-19 pandemic did not have any significant effect on meat products, however, the Great Recession had a positive impact on pork demand.

Keywords: Meat Demand, Rotterdam model, Recession

Acknowledgement: The findings and conclusions presented in this publication are those of the author.

[1] PhD Student at the Department of Agricultural Economics, Kansas State University, Manhattan Kansas, USA. Email: addamuah@ksu.edu

Introduction

The demand for meat products has significantly evolved over time due to various factors. These include economic determinants such as relative prices and consumer income, as well as other factors such as changing consumer preferences, health concerns, food safety information, climate change, and changing consumer demographics (Rodriguez and Eales, 2012; Tonsor et al., 2010). Among these, recessions and economic downturns represent significant periods of structural change, influencing consumer behavior and preferences in notable ways. Understanding these dynamics is crucial for stakeholders in the meat industry, including producers, marketers, and policymakers.

Several structural changes exist in the demand for meat. Chavas (1983) highlights that supply and demand elasticities are not static and can evolve in response to economic shocks, which may lead to permanent changes in consumer and producer behavior. These structural changes can stem from various factors, including technological advancements, shifts in consumer preferences, and institutional changes. Recognizing and accounting for these structural shifts is essential for accurately modeling and forecasting market behaviors.

Chavas (1983) developed a method for investigating structural changes in meat demand during the 1970s, highlighting how economic shocks and shifting consumer preferences can alter demand patterns over time. Rodriguez and Eales, (2012) assessed structural changes in U.S. meat demand over fifty years (1960-2009) using the Inverse Almost Ideal Demand System (IAIDS), focusing on the impacts of macroeconomic variables such as inflation. Darko & Eales, (2013) also assessed the impact of the U.S. meat demand before and after the Great Recession.

This research seeks to extend and update these analyses by examining structural changes in U.S. consumer demand for meat products from 1980 to 2022. The study focuses on the influence of economic shocks, evolving consumer preferences, and major inflationary periods such as the Great Recession and the COVID-19 pandemic on the demand for meat. The study employs the Rotterdam model to provide a robust framework for identifying and quantifying meat demand shifts over time.

This study utilizes time series data to analyze the structural changes in consumer demand for meat products in the United States over the period from 1980 to 2022. Specifically, the research employs data on consumption and retail prices for beef, chicken, and pork, sourced from various USDA databases. This study focuses on pork, chicken, and beef, since it is the most widely consumed meat products in the United States.

This study provides valuable insights into the dynamic nature of meat consumption. The results of this study show that beef, pork, and chicken are luxury goods. Consumers substitute away from beef to pork and chicken. Though the dot-com recession and the COVID-19 pandemic did not have any significant impact on the three meat products, the Great Recession positively impacted pork demand.

Literature Review

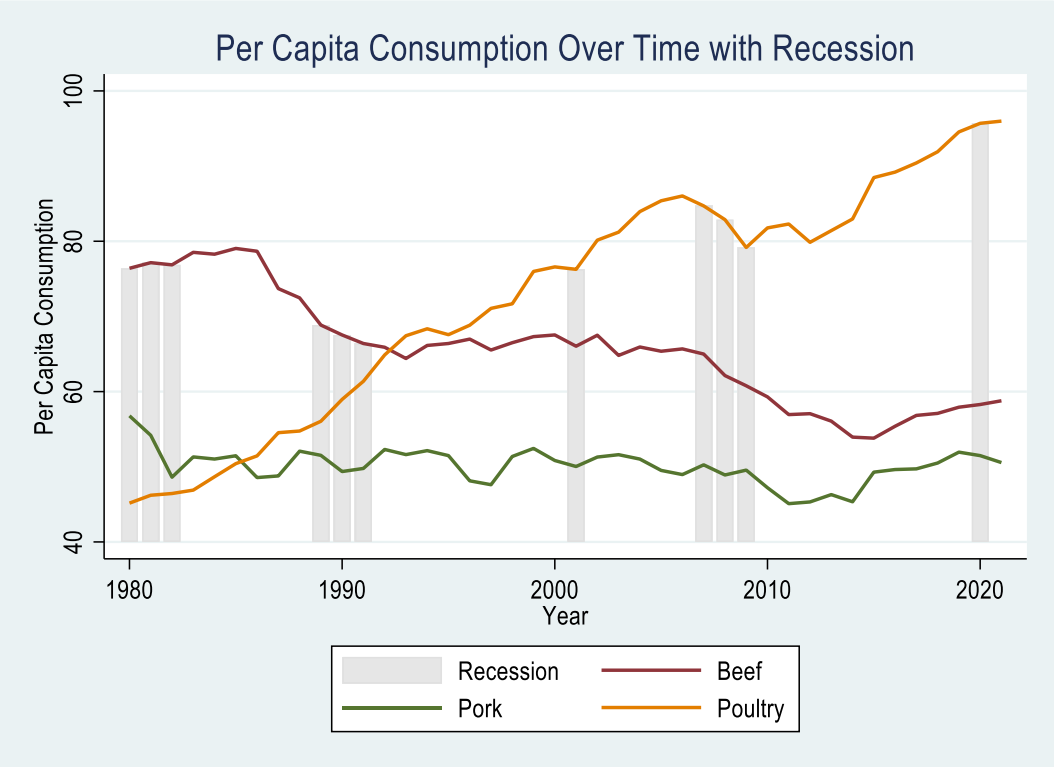
Demand for Meat Products

Meat products represent a significant share of the U.S. consumer food expenditures (Daniel et al., 2011; Tonsor et al., 2021; Tonsor & Lusk, 2022). American meals have traditionally revolved around meat consumption, however, preferences in meat demand have evolved over time (Rodriguez & Eales, 2012). The availability of chicken in the U.S. has more than doubled since

1980 (Figure 1), further fueling chicken consumption. The demand for chicken has grown increasingly over time, while beef consumption has decreased. In 2021, Americans consumed 97 pounds of broiler chickens per capita, compared to 59 pounds of beef (Tonsor & Lusk, 2022; USDA, ERS, n.d.-a). Chicken is mostly consumed due to its affordability, versatility, and perceived health benefits. Red meat still makes up a significant amount of the meat consumed in the United States, despite the trend toward poultry consumption (Daniel et al., 2011). Pork consumption has experienced fluctuations, with per capita consumption at 51 pounds in 2021 (Tonsor & Lusk, 2022), expected to increase by 2033. In 2022, pork sales amounted to $7.3 billion. While not as dominant as beef or poultry, pork remains a staple in many American diets, influenced by cultural preferences and product diversity.

Shift from beef to chicken is not entirely caused by relative prices and income (Eales & Unnevehr, 1993). The shift in preference from beef to poultry is concentrated on specific products and challenges the idea that health concerns have been the primary factor driving this change. Studies (Chavas, 1983; Eales and Unnevehr, 1993) have shown that health concerns may not necessarily be the driving force behind the shift from beef to chicken. Demand for convenience may shift the demand from beef cuts to chicken processed and whole chicken birds. Broiler chickens and turkeys are primary commodities in the U.S. poultry meat industry (Cheney et al., 2001).

Figure 1: Annual Per Capita Meat Consumption, 1980-2021



Structural Changes

Macro-level economic shocks such as unprecedented global recession, triggered by a financial crisis due to consumer credit in the U.S., and the COVID-19 pandemic influence micro-level consumption choices. Recession reduces household income, causes significant changes in food prices, and increases consumer uncertainty, which can potentially affect the demand for meat (Darko and Eales, 2013). Figure 1 presents the annual per capita consumption of beef, chicken, and pork over recession periods. Per capita consumption of beef steadily declined during the 1990 recession and continued to decrease over the years. While per capita chicken consumption increased by 113%, beef and pork decreased by 23% and 11% between the period 1980 to 2021. Though the population has increased over the period, total meat consumption has also increased.

Empirical Application

This study adopts the Rotterdam demand model to investigate structural changes in consumer demand for beef, pork, and chicken, focusing on the influence of major economic recessions. The Rotterdam model, a flexible and theoretically consistent demand system, expresses changes in budget shares of goods as linear functions of changes in logarithmic prices and total expenditure (Theil, 1965; Barten 1966). Specifically, it estimates how changes in meat prices and total food expenditure influence shifts in consumption patterns. To assess structural changes, I introduce dummy variables for specific recession periods into the model to test whether price responsiveness and marginal expenditure shares change during recessions. These dummies account for significant macroeconomic downturns such as the 2001 dot-com recession, 2008 financial crisis, and the COVID-19 pandemic, where income constraints may have pushed consumers to shift demand toward more affordable meat options, such as chicken over beef (Tiffin & Arnoult, 2010; Moschini & Moro, 1994). Previous studies have shown that recessions tend to influence not only the level of meat consumption but also its composition and responsiveness to prices, highlighting the need for models that allow for structural breaks (Andreyeva et al., 2010; Darko & Eales, 2013).

The study uses the absolute price version of the Rotterdam model, which consists of three equations related to beef, pork, and chicken. The Rotterdam model has been widely used in meat demand analysis (Tonsor et. al. 2010). The model can be estimated to satisfy adding-up, homogeneity, and symmetry restrictions suggested by demand theory.

The absolute price version of the model is specified as in equation (1)

$$w_{it} dlnq_{it} = b_i dln\,\bar{x} - \sum_j c_{ij}\, dlnp_{jt} + e_i R + v_{it} \qquad (1)$$

Where;

$$dln\,\bar{x} = dlnx - \sum w_k dlnp_k = \sum w_k q_k \qquad (2)$$

$$b_i = w_i e_i = p_i \frac{\partial q_i}{\partial x}$$

$$c_{ij} = w_i e_{ij}^* = \frac{p_i p_j s_{ij}}{x}$$

Where w_{it} is the budget share of the ith good (i = 1,2,3); d is the standard first difference operator ($dlnY_t = \ln(Y_t) - \ln(Y_{t-1})$); q_{it} is the quantity of good i consumed at time t; $dln\,\bar{x}$ (eq. 2) is the proportional change in real expenditure; the parameter b_i is the marginal propensity to spend on the ith good; s_{ij} refers to the substitution effect of a change in the price of good j on the demand for good ith when real income is held constant, it is known as the $(i, j)th$ term of the Slutsky matrix; p_{jt} is the price of the jth good at time t; R is our recession dummy variable, v_i is a random error term; and b_i, c_{ij}, and e_i are parameters to be estimated

The model is subject to the following theoretical restrictions:

$$\sum_{i=1}^{3} b_i = 1 \;\; for\; Engel\; aggregation$$

$$\sum_{i=1}^{3} c_{ij} = 0 \;\; for\; linear\; homogeneity$$

$$c_{ij} = c_{ji} \;\; for\; symmetry$$

In the demand system estimation, one share of the equation is omitted to avoid singularity in the error variance-covariance matrix, which arises from the adding-up condition. The parameters of the excluded equation are subsequently recovered using theoretical restrictions. Specifically, linear homogeneity, symmetry, and Engel aggregation are imposed to ensure the model is consistent with economic theory. These restrictions not only preserve the theoretical validity of the demand system

but also reduce the number of independent parameters to be estimated, thereby improving the efficiency and robustness of the estimation process.

The demand equations are used to generate compensated and uncompensated prices and expenditure elasticities. The model was estimated using iterative seemingly unrelated regression (ITSUR). Hausman specification tests were used to determine if prices and meat expenditures are endogenous (Cheney et al., 2001; Tonsor et al., 2010). The right-hand side variables were identified as endogenous, and the model addressed this endogeneity using the two-stage least squares (2SLS) approach. The two-stage least squares (2SLS) approach is a widely recognized method used to correct for endogenous variables in econometric models. In the first stage, prices were regressed on exogenous instruments, including lagged prices, population, and time trend variables, to generate predicted values. The instruments, lagged prices, are assumed to be correlated with current prices, but not with the contemporaneous error term, making them suitable instruments. Population is often considered an exogenous variable in price models, as it is likely to influence prices through demand factors but does not directly correlate with short-term fluctuations in prices. Time trend variables are often used to capture long-term shifts in the market or policy changes that affect prices but are unrelated to the current error term. The predicted prices from the first stage were then incorporated into the ITSUR equations. This substitution removes the endogeneity problem by ensuring that the price variable is no longer correlated with the error term. The demand equations included recession indicators to capture the effects of different economic periods and estimate the structural changes. The recession indicator was a dummy variable defined as 1 for recession in that year and 0 if there was no recession.

Data

Annual data covering 1980 to 2021 are used in the estimation. The beef, pork, and chicken quantities represent yearly retail value in pounds. Beef, pork, and chicken prices are yearly average retail prices ($/pound). Chicken data focused on only broilers. The poultry industry is dominated by broiler chicken (Cheney et al., 2001). Retail meat consumption data and retail price data series of beef, pork, and chicken were obtained from the U.S. Department of Agriculture's Economic Research Service (USDA, ERS). Food expenditures were calculated as the sum of all meat (beef, pork, chicken) expenditures. All prices were inflation-adjusted dollars, deflated by the 2021 CPI. The meat quantity data was sourced from the food availability data by the U.S. Department of Agriculture's Economic Research Service. Food availability data is historical and chronological population-based and disappearance data that is provided by the USDA. Recession indicators and consumer price index data were collected from the Federal Reserve Bank of St. Louis (FRED, 2025). The FRED system compiles macroeconomic indicators in a host of areas. The CPI index was collected in a monthly format and averaged over every yearly period. The nominal prices were transformed to real prices using consumer price indices. Table 1 presents the summary statistics of the data. The average price of beef, pork, and chicken is 5.84, 4.21, and 2.53 $/pound, respectively. On average, there were about 65.60, 50.12, 72.56 pounds of beef, pork, and chicken consumed annually.

Table 1: Summary Statistics of the Data Variables

Variable	Mean	Std. dev.	Minimum	Maximum
Per capita beef consumption [a]	65.60	7.32865	53.80902	79.04538
Per capita pork quantity [a]	50.12	2.302128	45.09269	56.77958
Per capita poultry quantity [a]	72.56	15.47563	45.16303	95.98685
Retail Beef Price ($/lbs.)[b]	5.84	0.76	4.61	7.68
Retail Pork Price ($/lbs.)[b]	4.21	0.37	3.67	5.21
Retail Poultry Price ($/lbs.)[b]	2.53	0.37	1.99	3.20
Recession_2001(Dot-bomb Recession)[c]	0.024	0.15	0	1
Recession_2008 (The Great Recession)[c]	0.071	0.26	0	1
Recession_2020 (COVID-19 Pandemic)[c]	0.024	0.15	0	1

[a] Values in pounds per person per year

[b] Inflation-adjusted dollars (deflated by CPI, 2021 =100)

[c] Measured as a dummy in the period recession occurred.

Results

Table 2 presents the coefficient estimates for the Rotterdam model. The ITSUR estimates were computed after applying the homogeneity and symmetry constraints, with one equation removed to prevent the error covariance matrix from becoming singular. The Engel aggregation (adding up) constraints covered in the previous section were used to recover the parameters of the omitted equation. The model's goodness of fit measure (R2) indicates approximately 70% and 86% variation for beef and pork, respectively. In the Rotterdam demand model, all own price elasticities are negative. This is in line with the theory of demand, which posits an inverse relationship between prices and quantity demanded of a good. However, the demand model does not provide valuable insight; therefore, focus is placed on the estimated elasticity.

In analyzing the structural changes in the demand for meat products, I included recession indicators in my model. I focused on three recession periods, which were the dot-com recession (Recession 2001), the Great Recession (Recession 2008), and the COVID-19 pandemic (Recession 2020). The recession variables were included as a dummy variable for periods with these recessions. I assessed the impact of the individual recession on the demand for each meat product. The coefficient on

recession indicators was generally small and statistically insignificant, except for the Great Recession on pork demand. The Great Recession indicator had a positive effect on pork demand. Thus, there was about a 0.6% increase in pork demand during the Great Recession. This may be because consumers turned to more affordable sources of protein like chicken and pork in response to lower income influenced by the recession. The Great Recession, however, was associated with a decrease in beef demand and on chicken demand, though these effects were not statistically significant. Beef is generally considered to be highly income elastic, thus when income drops during recession periods, households may reduce consumption of higher cost goods like beef. Both the COVID-19 pandemic and the dot-com recession were associated with higher beef but reduced pork demand; however, these estimates were not statistically significant. The dot-com recession had a negative impact on chicken demand, but the COVID-19 had a positive impact on chicken demand, these estimates were not statistically significant. The COVID-19 pandemic phases of widespread lockdowns, restrictions and supply chain led to increased home cooked meals and an increase in demand for affordable proteins like chicken. Chicken is also perceived as leaner and healthier protein relative to other red meat. During the pandemic, many consumers sought healthier eating options in an effort to boost their immune system and avoid the potential risks.

Table 2: Coefficient estimates of the Rotterdam model, 1980 - 2021.

	Quantities		
Variables	Beef	Pork	Chicken
Expenditures	0 .423 ***	0.384***	0.193***
	(0.076)	(0.047)	(0.073)
Beef prices	-0.135***	0.103***	0.033
	(0.030)	(0.020)	(0.030)
Pork prices	0.081***	-0.109***	0.029***
	(0.027)	(0.017)	(0.026)
Poultry prices	0.021	0.008	-0.029
	(0.026)	(0.016)	(0.025)
Recession_2001	0.003	-0.002	-0.001
	(0.007)	(0.004)	(0.006)
Recession_2008	-0.04	0.006*	-0.002
	(0.004)	(0.003)	(0.004)
Recession_2020	0.004	-0.005	0.001
	(0.007)	(0.004)	(0.006)
Observations	40	40	40
R-squared	0.70	0.857	-

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Elasticity Estimates

The uncompensated and compensated price and total expenditure elasticities are reported in Table 3. The total expenditure elasticities for all meat categories have the expected positive signs and are statistically significant at the 1% level. This aligns with Chavas (1983), except that his study found the income elasticity for poultry to be insignificant. All expenditure elasticities exceed one, indicating that beef, pork, and chicken are luxury goods, with demand rising more than proportionally to income. However, this contrasts with the findings of Darko Eales, (2013), who reported that disaggregated beef, pork, and chicken products were normal goods both before and after the Great Recession. Notably, the estimated expenditure elasticity for beef is consistent with results reported by Chalfant (1987). According to Dohlman (2025), many consumers with rising incomes find pork to be a very desirable meat. All own-price elasticities have the expected signs and are significantly different from zero (at a 1% level) in both compensated and uncompensated

elasticity estimates. The uncompensated own price elasticity is greater than one for all three meats, indicating that the demand for each meat is price elastic. This suggests that consumers are quite responsive to changes in meat prices, with demand decreasing more than proportionately when prices rise. Moreover, some of the meat products are more elastic than others. For example, pork is more elastic than beef and chicken.

Table 3: Compensated and Uncompensated Demand Elasticities, 1980 - 2021

Uncompensated Elasticities			
	Demand		
Variables	Beef	Pork	Chicken
Expenditure	1.859***	2.403***	1.825***
	(0.156)	(0.173)	(0.312)
Beef Price	-1.276***	0.375***	0.143
	(0.065)	(0.072)	(0.130)
Pork Price	0.163***	-1.399***	0.122
	(0.055)	(0.061)	(0.110)
Chicken Price	0.044	0.027	-1.125***
	(0.052)	(0.058)	(0.105)
Compensated Elasticities			
	Beef	Pork	Chicken
Beef Price	-0.360***	1.559***	1.042***
	(0.115)	(0.127)	(0.229)
Pork price	0.672***	-0.742***	0.622***
	(0.086)	(0.096)	(0.172)
Chicken price	0.479***	0.590***	-0.699***
	(0.062)	(0.069)	(0.124)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The compensated own-price elasticities for beef, pork, and chicken are approximately –0.36, –0.74, and –0.70, respectively, which are comparable to the values reported by (Eales & Unnevehr, 1993; Tonsor et al., 2010). However, the own-price elasticity for chicken in this study differs from that reported by Tonsor et al., (2010), who found a much lower absolute value of 0.099. In contrast, the elasticity estimate for chicken here closely matches Eales & Unnevehr, (1993) finding of about –0.68 for whole birds. This is likely because the chicken data primarily focuses on broilers. The

uncompensated own-price elasticities are larger in magnitude than their compensated counterparts for all three meats. Overall, beef, pork, and chicken exhibit inelastic demand in the compensated elasticities.

The corresponding cross-price elasticities show evidence of substitution between all the meat products. All three meat products show significant cross-price elasticities in the compensated elasticity estimates. Consumers substitute away from beef for pork and chicken. When beef prices rise, pork and chicken demand increases by 1.6 and 1.04, respectively. Pork serves as a stronger substitute for beef than chicken. Chavas, (1983) identified a growing influence of pork prices on beef consumption. Beef and pork also serve as substitutes for chicken; however, pork serves as a stronger substitute than beef. There is a stronger substitutability between chicken and pork than between beef. Chicken emerges as a stronger substitute for the meat product, which may be attributed to its relative affordability, convenience, and perceived health advantages.

Conclusion

Economic shocks and changing consumer preferences can influence demand patterns over time. By applying the Rotterdam model, this study investigated the structural changes in the demand for three meat products. The study specifically analyzed the impact of three different recessions on the demand for beef, pork, and chicken. The study further estimated and compared expenditure, compensated, and uncompensated elasticities.

It was observed that the Great Recession had a positive impact on pork demand and was statistically significant. However, there was a negative effect on beef but no impact on chicken; this result was not significant. All meat products were luxury goods. Beef, pork, and chicken were inelastic in the compensated elasticities but were elastic for the uncompensated elasticities. The results also showed a substitution effect between beef, chicken, and pork. Pork served as a stronger substitute for beef and chicken.

This study centers on pork, chicken, and beef, which represent the most commonly consumed meat products in the United States. Future research could expand the scope to include additional meat categories such as lamb, fish, and others. It is also important to note that the analysis of chicken demand in this study specifically pertains to broilers; examining aggregated chicken data may offer further insights. Finally, employing alternative demand modeling approaches could provide a useful basis for comparison and robustness checks.

References

Andreyeva, T., Long, M. W., & Brownell, K. D. (2010). The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food. *American Journal of Public Health*, *100*(2), 216–222. https://doi.org/10.2105/AJPH.2008.151415

Chalfant, J. A. (1987). A Globally Flexible, Almost Ideal Demand System. *Journal of Business & Economic Statistics*, *5*(2), 233–242. https://doi.org/10.1080/07350015.1987.10509581

Chavas, J.-P. (1983). Structural Change in the Demand for Meat. *American Journal of Agricultural Economics*, *65*(1), 148–153. https://doi.org/10.2307/1240351

Cheney, L. M., Brown, A. B., Yamano, T., & Masterovsky, M. (2001). Issues of Demand Specification and Industry Structure in Turkeys and Broiler Chickens. *Journal of Agricultural and Applied Economics*, *33*(1), 25–34. https://doi.org/10.1017/S1074070800020757

Daniel, C. R., Cross, A. J., Koebnick, C., & Sinha, R. (2011). Trends in meat consumption in the USA. *Public Health Nutrition*, *14*(4), 575–583. https://doi.org/10.1017/S1368980010002077

Darko, F., Addeah, & Eales, J. S. (2013). *Meat Demand in the US During and After the Great Recession*. https://ageconsearch.umn.edu/record/150146/?v=pdf

Dohlman, E. (2025). *USDA Agricultural Projections to 2034*.

Eales, J. S., & Unnevehr, L. J. (1993). Simultaneity and Structural Change in U.S. Meat Demand. *American Journal of Agricultural Economics*, *75*(2), 259–268. https://doi.org/10.2307/1242910

FRED. (2025, April 10). *Consumer Price Index for All Urban Consumers: All Items in U.S. City Average*. https://fred.stlouisfed.org/series/CPIAUCSL

Rodriguez, N., & Eales, J. S. (Eds.). (2012). *Structural Change via Threshold Effects: Estimating U.S. Meat Demand Using Smooth Transition Functions*. https://doi.org/10.22004/ag.econ.124366

Theil, H. (1965). The Information Approach to Demand Analysis. *Econometrica*, *33*(1), 67–87. https://doi.org/10.2307/1911889

Tonsor, G. T., & Lusk, J. L. (2022). U.S. perspective: Meat demand outdoes meat avoidance. *Meat Science*, *190*, 108843. https://doi.org/10.1016/j.meatsci.2022.108843

Tonsor, G. T., Lusk, J. L., & Tonsor, S. L. (2021). Meat Demand Monitor during COVID-19. *Animals*, *11*(4), Article 4. https://doi.org/10.3390/ani11041040

Tonsor, G. T., Mintert, J. R., & Schroeder, T. C. (2010). U.S. Meat Demand: Household Dynamics and Media Information Impacts. *Journal of Agricultural and Resource Economics*, *35*(1), 1–17.

USDA, ERS. (n.d.-a). *Food Availability (Per Capita) Data System | Economic Research Service*. Retrieved April 24, 2025, from https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system

USDA, ERS, W. (n.d.-b). *Beef and Pork Values and Price Spreads Explained*.