American Journal of Agricultural Economics Advance Access published January 20, 2010

MEAT MEETS META: A QUANTITATIVE REVIEW OF THE PRICE ELASTICITY OF MEAT

CRAIG A. GALLET

The price elasticity of meat has been estimated in numerous studies that utilize a variety of disparate modeling procedures. In light of differences in the literature, a meta-analysis is performed to assess the sensitivity of the meat price elasticity to a number of characteristics, including the type of meat, specification of demand, nature of data, estimation method, characteristics of the publication outlet, and location of demand. The results from estimating linear and Box-Cox meta-regressions, coupled with different panel data treatments, reveal that these characteristics have differing influence on the reported price elasticity.

Key words: meat demand, meta-analysis, price elasticity.

JEL codes: D12, Q11.

Few parameters have received as much attention among agricultural economists as the price elasticity of meat demand. Indeed, with hundreds of studies from which to choose, it is easy to find a multitude of elasticity estimates for many types of meat. However, whatever the intended purpose, whether to gauge competitive pressure in the market or to predict the impact on meat consumption of exogenous factors, since studies differ across many dimensions, such as demand specification, nature of data, and estimation technique, it is challenging to select from the numerous elasticity estimates. For example, in light of the increasing attention given to utilizing food price policies to improve health (e.g., Marshall 2000; Kuchler, Tegene, and Harris 2005; Chouinard *et al.* 2007), consider a policymaker wishing to explore the impact of a tax on red meat. Since the literature reports price elasticities for red meat ranging from inelastic to elastic, the decrease in consumption might be small or large, depending on the chosen price elasticity. Furthermore, if the policymaker wishes to compare price responsiveness across meats, the variety of estimates in the literature makes this difficult. With respect to beef and pork, for example, since some studies (e.g., Byrne *et al.* 1995; Mazzocchi 2006) find that beef is more responsive to price than pork, while other studies (e.g., Purcell and Raunikar 1971; Karagiannis, Katranidis, and Velentzas 1996) find the opposite to be the case, a deeper analysis is warranted.

In light of differences in the literature, this article analyzes study characteristics to uncover factors affecting the estimated price elasticities of meat. Similar to meta-analyses of the price elasticities of gasoline (e.g., Espey 1998), water (e.g., Dalhuisen *et al.* 2003), cigarettes (e.g., Gallet and List 2003), and alcohol (e.g., Gallet 2007), we treat the estimated price elasticity of meat as the dependent variable in a series of meta-regressions, with study characteristics serving as explanatory variables. Utilizing linear and Box-Cox specifications of the meta-regression, coupled with panel data treatments, we address the following questions: (1) Are there differences in price elasticities across types of meat? (2) Does the specification of demand affect the price elasticity? (3) To what extent do differences in data influence the price elasticity? (4) Is the price elasticity sensitive to the method used to estimate demand? (5) Do characteristics of the publication outlet affect the reported price elasticity? and (6) Are there regional differences in the price elasticity? The answers to such questions allow us to gauge the sensitivity of meat price elasticities to differences in a variety of factors.

Craig Gallet is a professor in the Department of Economics at California State University, Sacramento. The author would like to thank the editor, as well as three anonymous referees, for providing helpful comments on earlier versions of this paper. The suggestions provided by Smile Dube, Stephan Kroll, and Junsoo Lee are also greatly appreciated.

Amer. J. Agr. Econ. 1–15; doi: 10.1093/ajae/aap008
Received April 2008; accepted August 2009

Briefly, across several meta-regressions we find that the price elasticities of beef, lamb, and fish tend to be highest in absolute value, while the price elasticity of poultry is lowest in absolute value. Also, although the price elasticity of meat is sensitive to a number of specification, estimation, and publication characteristics, data characteristics and the location of demand have noticeably less influence on the price elasticity.

Data

When performing a meta-analysis, a thorough search is needed to compile a list of studies that provide a complete description of the characteristics controlled for in the meta-regressions. To this end, an initial search using EconLit, AgEcon Search, and Google Scholar identified many candidate studies. Several existing qualitative literature reviews (e.g., Kuznets 1953; Reeves and Hayman 1975; Richardson 1976; Tomek 1977; Raunikar and Huang 1987; Smallwood, Haidacher, and Blaylock 1989; Alston and Chalfant 1991; Moschini and Moro 1996; Griffith *et al*. 2001; Asche, Bjorndal, and Gordon 2005), as well as a survey of the reference sections of all studies identified, led to a final set of 419 studies (reporting 4,142 estimated price elasticities) included in this meta-analysis (see online supplementary data for the list of these studies).[1]

Although the median price elasticity across the 4,142 estimates is −0.77, the standard deviation of 1.28 suggests there is much variation in the elasticity estimates to be explained. Consequently, typical of other meta-analyses of demand, information on a variety of study attributes that might influence price elasticity estimates was collected, with the frequencies and median price elasticities for each attribute provided in table 1. To begin, since it is common in the literature to estimate differences in price elasticity across meat products, table 1 reports median price elasticities across six categories of meat (the category "meat" referring to a composite of several different meats), with the greatest number of elasticities corresponding to fish, and the fewest corresponding to lamb.[2] Across these six categories, lamb is most responsive to price, while poultry is least responsive to price.

Concerning the specification of demand, although roughly 25% of the sample comes from linear and double-log specifications, which are attractive in terms of their ease of use, a much larger share of price elasticities come from functional forms that are consistent with consumer theory. For example, by far the most common price elasticity estimate comes from a model based on the linear approximate almost ideal demand system (AIDS-Linear), whereby a price index is used to linearize Deaton and Muellbauer's (1980) AIDS specification. Other less common versions of the AIDS model that have been applied to meat include the traditional nonlinear AIDS model (AIDS-Nonlinear), the quadratic AIDS model (AIDS-Quadratic) of Banks, Blundell, and Lewbel (1997), and the generalized AIDS model (AIDS-Generalized) of Bollino (1990). In addition to these specifications, the price elasticity of meat has been estimated from a variety of other functional forms (i.e., semi-log, Rotterdam, CBS [Central Bureau of Statistics], translog, S-Branch, and Box-Cox). Last, the generalized addilog and quadratic expenditure system models have been adopted sparingly, and so, we collectively account for these specifications using the "Other Form" category. Across all 13 functional form categories the median price elasticity is highest in absolute value for the S-branch form, and lowest for the generalized AIDS form.[3]

[1] Although an initial search of the literature identified more than 419 studies of meat demand, for a few reasons the full sample was reduced to the 4,142 price elasticity estimates reported in the 419 studies. First, several studies (e.g., Huang 1988; Park, Thurman, and Easley 2004) utilize an inverse demand specification (e.g., price on the left side of demand) to estimate price flexibility parameters. However, since price flexibilities are not easily comparable to price elasticities (see Houck 1965; Huang 1994), we chose to drop these studies and instead focus on studies that directly estimate the price elasticity of demand. Second, because a few studies (e.g., Chung *et al*. 2005) estimate price elasticities from a system of disparate equations which cannot be assigned to a particular demand specification, we also excluded these studies from the analysis.

[2] Regarding the composite category, while it is common to find studies that estimate the demand for a specific type of meat, a number of studies (e.g., Chung 1994; Huang and Rozelle 1998) estimate a more broadly defined demand that aggregates a number of different meat products into a composite. The composite category meat in table 1 refers to price elasticities estimated in these studies. Of the 4,142 price elasticities, 7 correspond to goat. Because of this small number, goat is also included in the composite meat category.

[3] There are a number of reasons to expect that functional form may influence the estimated price elasticity of meat. For instance, several studies (e.g., Pashardes 1993; Alston and Chalfant 1993; Barnett and Seck 2008) find that parameter estimates are sensitive to differences in functional form. Accordingly, by comparing results across all studies, meta-analyses of demand take a more global look at the influence of functional form on the price elasticity. Also, although it is beyond the purview of this study to decide which functional form is more appropriate, *ceteris paribus*, we expect theory-based forms on average to yield estimates closer to the population demand, which could lead to differences in price elasticity estimates across functional forms.

Table 1. Frequency of Study Characteristics

Category	Variable	Number of Observations	Median Price Elasticity
Product:	Beef	951	−0.869
	Pork	665	−0.780
	Lamb	191	−0.940
	Poultry	670	−0.650
	Fish	1,042	−0.800
	Meat	623	−0.710
Specification:	Functional form:		
	Linear	437	−0.730
	Double-Log	633	−0.820
	Semi-Log	125	−0.703
	AIDS-Nonlinear	426	−0.690
	AIDS-Linear	1,472	−0.762
	AIDS-Quadratic	175	−0.950
	AIDS-Generalized	68	−0.426
	Rotterdam	242	−0.648
	CBS	88	−0.693
	Translog	235	−0.790
	S-Branch	147	−1.520
	Box-Cox	52	−0.921
	Other Form	42	−0.620
	Other Issues:		
	Compensated	960	−0.598
	Substitute meats	3,599	−0.780
	Two-Step	434	−0.800
	Dynamic	1,567	−0.700
Data:	Time-Series	3,059	−0.740
	Cross-Sectional	879	−0.872
	Panel	204	−0.870
	Aggregation:		
	Multiple countries	42	−0.819
	Country	2,827	−0.720
	Region of country	47	−0.830
	State or province	79	−0.626
	City	35	−1.020
	Firm	154	−1.564
	Individual	958	−0.882
Estimation:	OLS	781	−0.740
	2SLS	110	−1.021
	3SLS	357	−0.899
	FIML	365	−1.175
	MLE	612	−0.703
	SUR	1,744	−0.720
	GMM	31	−0.806
	GLS	114	−0.734
	Other Method	28	−0.618
Publication:	Top 36 Journal	191	−0.640
	AJAE	591	−0.730
	Book	369	−0.750
Region:	Australia	158	−1.070
	North America	1,675	−0.781
	South America	24	−0.463
	North Europe	587	−0.610
	West Europe	162	−1.054
	South Europe	260	−0.679
	East Europe	28	−0.972

Continued

Table 1. Continued

Category	Variable	Number of Observations	Median Price Elasticity
	East Asia	815	−0.770
	South East Asia	133	−0.950
	South Central Asia	72	−0.980
	Middle East	46	−0.806
	South Africa	64	−0.537
	Other Africa	76	−0.604
	Rest of World	42	−0.916
Total observations:		4,142	−0.774

Note: Median price elasticity calculated from all estimates in each respective category. For example, across the 951 beef price elasticity estimates, the median estimate equals −0.869.

In addition to functional form, information on a number of other specification attributes was collected. For instance, roughly 25% of the price elasticity estimates correspond to a compensated demand, which, having a lower median in absolute value compared with all other (i.e., uncompensated) estimates, is consistent with meat being a normal good. Furthermore, although most estimates come from a specification that includes other meats as substitutes, fewer estimates are from a dynamic specification (i.e., inclusion of lags), and even fewer are from models that utilize a two-step methodology, whereby the demand for meat is modeled as: (1) the dichotomous choice of whether or not to consume meat, followed by (2) the continuous choice of how much to consume.

Turning to data and estimation issues, the largest share of price elasticity estimates come from time-series data, with the data aggregated to the country level. Fewer elasticity estimates are from cross-sectional or panel data that are aggregated to the multi-country, region of country, state or province, city, firm, or individual consumer levels.[4] Also, the most common estimates are from equations that are estimated as a seemingly unrelated regression (SUR), compared with ordinary least squares (OLS), two-stage least squares (2SLS), three-stage least squares (3SLS), full information maximum likelihood (FIML), single-equation maximum likelihood (MLE), generalized method of moments (GMM), generalized least squares (GLS), and a few other less common methods (i.e., minimum distance estimator and maximum entropy) collectively labeled "Other Method."

We also note several characteristics of the publication outlet in which the price elasticity appears. For instance, while less than 5% of meat elasticity estimates are published in the top 36 economics journals, as reported by Scott and Mitias (1996), more appear in the *American Journal of Agricultural Economics* (AJAE), prior to 1968 titled the *Journal of Farm Economics,* which is considered to be the top agricultural economics journal. Also, less than 10% of estimates are published in books.[5]

Finally, the demand for meat has been estimated in various parts of the world, and so table 1 reports median price elasticities for different regions (using the Nations Online Project to classify countries by region). Although most of the attention in the literature has been given to the demand for meat in North America, across the fourteen regions the absolute price elasticity in North America is smaller as compared with other regions (e.g., Australia and West Europe).

Meta-Regression Model

Although a perusal of the medians in table 1 indicates variation in price elasticity estimates across study attributes, since the medians do not control for multiple factors influencing

[4] Gardes, Langlois, and Richaudeau (1996) suggest that the use of time-series or cross-sectional data to estimate demand can lead to specification error. For example, if demand is inherently dynamic, then the use of cross-sectional data omits dynamic variables. Concerning aggregation, a number of studies (e.g., Blundell, Pashardes, and Weber 1993; Denton and Mountain 2001) caution that the use of aggregate data may lead to aggregation bias in the estimation of consumer demand (i.e., parameter estimates are sensitive to aggregation). Consequently, it is plausible that the nature of the data used to estimate meat demand may influence the price elasticity.

[5] A number of meta-analyses (e.g., Smith and Huang 1995; Dalhuisen *et al.* 2003; Gallet and List 2003) control for the nature of the publication outlet. In general, papers published in top-ranked journals are subject to a more strenuous review process compared with other outlets, which could lead price elasticity estimates that appear in a top 36 economics journal or the AJAE to differ from those published elsewhere.

the elasticity estimate, common to other meta-analyses (e.g., Smith and Huang 1995; Espey 1998; Dalhuisen *et al.* 2003; Gallet and List 2003; Johnston *et al.* 2006; Gallet 2007), a series of meta-regressions is estimated to more fully explore the variation in meat price elasticities. In particular we begin with the simple linear homogeneous effects model:

$$(1) \qquad E_i = \alpha + \beta' x_i + u_i$$

where E_i is the ith price elasticity estimate, and α is an intercept common across i. The vector β contains the coefficients of the variables contained in vector x_i that might affect E_i. In x_i we account for the study characteristics provided in table 1, using a series of dummy variables (i.e., the dummy variable equals 1 if the respective study characteristic applies to elasticity estimate, 0 if not). In addition to the variables in table 1, as a further control for data issues, we include the median year of the sample used to estimate the respective price elasticities, which, among other factors, could capture changes in consumer preferences over time. Also included in equation (1) is u_i, a normally distributed error term with zero mean and constant variance σ_u^2.

Initially, equation (1) is estimated with the full sample of 4,142 observations. However, included in the full sample are 92 positive price elasticity estimates, which several meta-analyses of demand (e.g., Espey 1998; Dalhuisen *et al.* 2003) drop on the grounds that such observations are unrealistic. Also, 44 price elasticity estimates lie three or more standard deviations from the mean. Accordingly, to see whether or not the results are sensitive to the inclusion of unusual price elasticity estimates, these 136 observations were dropped from the full sample, leading to a restricted sample of 4,006 observations.[6] A convenience of using this restricted sample is that the negative price elasticities are converted into absolute value, and then a Box-Cox counterpart to equation (1) can be estimated, given as:

$$(2) \qquad (|E_i|^{\lambda} - 1)/\lambda = \alpha + \beta' x_i + u_i$$

where the properties of the error term are the same as equation (1), and λ indicates how close the specification is to the linear (λ = 1) or semi-log (λ = 0) version. By estimating equations (1) and (2) with the restricted sample, we can assess the sensitivity of the meta-regression results to functional form.

Since most of the studies in our sample report multiple price elasticity estimates, we follow Rosenberger and Loomis (2000), Gallet and List (2003), and Johnston *et al.* (2006) by also estimating heterogeneous effects counterparts to equations (1) and (2). Specifically, because many study characteristics do not vary within studies, which preclude using a fixed effects approach, we initially consider the following random effects counterpart to equation (1):

$$(3) \qquad E_{ij} = \alpha + \beta' x_{ij} + u_{ij}$$

where E_{ij} is study i's jth price elasticity estimate, and u_{ij} is a composite error equaling $v_i + w_{ij}$. The composite error u_{ij} is normally distributed with each component having a zero mean and constant variance of σ_u^2 and σ_w^2, respectively. Furthermore, the unobserved effect v_i is assumed to be uncorrelated with x_{ij}. Similar to the homogeneous effects models, we not only estimate a linear random effects specification with the full sample, but also use the restricted sample to estimate linear and Box-Cox random effects counterparts to the homogeneous effects models. The homogeneous and heterogeneous effects results for the full and restricted samples are provided in tables 2 and 3, respectively.

Estimation Results

Tables 2 and 3 provide the estimation results for the full sample and the restricted sample with and without adjusting for panel data effects, respectively. Before discussing the results, though, we have to be careful with how they are interpreted. In particular, since we use dummy variables to control for study characteristics, to avoid perfect multicollinearity we must exclude several characteristics in table 1 from each meta-regression. These characteristics then serve as the baseline. For instance, we drop the dummy variable for the meat composite, which then serves as the base meat with which other elasticities are compared. As for the other categories, the baseline

[6] Of the positive price elasticities in the full sample for which the income elasticity is also reported, roughly one-third of the income elasticities are negative. Consequently, although Espey (1998) and Dalhuisen *et al.* (2003) consider positive price elasticities as unrealistic, we cannot rule them out from our sample.

Table 2. Homogeneous Effects Meta-Regression Results

Category	Variable	Full Sample Linear	Restricted Sample Linear	Restricted Sample Box-Cox
Product:	Beef	−0.135 (1.962)**	0.117 (3.339)***	0.134 (3.799)*** [0.110]
	Pork	−0.062 (0.853)	0.062 (1.666)*	0.109 (2.919)*** [0.090]
	Lamb	−0.211 (1.923)*	0.196 (3.500)***	0.206 (3.642)*** [0.169]
	Poultry	0.072 (1.000)	−0.105 (2.849)***	−0.114 (3.072)*** [−0.094]
	Fish	−0.316 (4.630)***	0.118 (3.373)***	0.083 (2.349)** [0.068]
Specification:	Functional form: Double-Log	−0.179 (2.165)**	0.139 (3.261)***	0.130 (3.024)*** [0.107]
	Semi-Log	−0.296 (2.114)**	0.226 (3.177)***	0.209 (2.915)*** [0.172]
	AIDS-Nonlinear	0.075 (0.707)	−0.092 (1.694)*	0.028 (0.512) [0.023]
	AIDS-Linear	−0.024 (0.279)	−0.026 (0.597)	0.054 (1.220) [0.045]
	AIDS-Quadratic	−0.312 (2.143)**	0.095 (1.284)	0.222 (2.997)*** [0.183]
	AIDS-Generalized	−0.016 (0.087)	−0.169 (1.886)*	−0.107 (1.189) [−0.088]
	Rotterdam	−0.208 (1.774)*	0.031 (0.527)	−0.017 (0.287) [−0.014]
	CBS	0.137 (0.871)	−0.174 (2.196)**	−0.102 (1.277) [−0.084]
	Translog	−0.834 (7.162)***	0.101 (1.688)*	0.161 (2.658)*** [0.132]
	S-Branch	−0.945 (5.877)***	0.669 (8.228)***	0.689 (8.421)*** [0.567]
	Box-Cox	−0.113 (0.614)	0.047 (0.506)	0.084 (0.904) [0.069]
	Other form	−0.329 (1.570)	0.152 (1.414)	0.163 (1.504) [0.134]
	Other Issues: Compensated	0.140 (2.867)***	−0.145 (5.820)***	−0.214 (8.502)*** [−0.176]
	Substitute meats	−0.074 (1.132)	0.105 (3.162)***	0.078 (2.354)** [0.064]
Data:	Two-Step	0.225 (2.316)**	−0.063 (1.285)	−0.072 (1.455) [−0.059]
	Dynamic	0.108 (2.026)**	−0.029 (1.072)	−0.020 (0.717) [−0.016]
	Time-Series	0.035 (0.176)	−0.165 (1.625)	−0.051 (0.498) [−0.042]
	Cross-Sectional	0.122 (0.832)	−0.048 (0.650)	−0.080 (1.063) [−0.065]
	Median Year	−0.001 (0.234)	0.001 (0.941)	−0.001 (0.083) [−0.001]
	Aggregation: Multiple countries	0.360 (0.876)	0.369 (1.738)*	0.098 (0.461) [0.081]
	Country	−0.054 (0.220)	0.137 (1.091)	−0.072 (0.571) [−0.059]
	Region of country	0.162 (0.529)	0.088 (0.557)	−0.087 (0.551) [−0.072]
	State or province	0.174 (0.816)	−0.142 (1.286)	−0.310 (2.797)*** [−0.255]

continued

Table 2. Continued

Category	Variable	Full Sample Linear	Restricted Sample Linear	Restricted Sample Box-Cox
	City	−0.198 (0.766)	0.212 (1.629)	0.198 (1.518) [0.163]
Estimation:	Firm	−1.297 (4.844)***	1.074 (7.729)***	0.723 (5.166)*** [0.595]
	2SLS	−0.323 (2.502)**	0.147 (2.205)**	0.144 (2.144)** [0.118]
	3SLS	−0.065 (0.652)	0.220 (4.289)***	0.215 (4.179)*** [0.177]
	FIML	0.206 (1.935)*	0.093 (1.704)*	0.107 (1.948)* [0.088]
	MLE	0.212 (2.677)***	−0.018 (0.434)	−0.007 (0.159) [−0.005]
	SUR	0.239 (3.138)***	0.012 (0.297)	0.015 (0.382) [0.013]
	GMM	0.414 (1.584)	−0.005 (0.039)	0.008 (0.058) [0.006]
	GLS	0.004 (0.031)	0.025 (0.347)	−0.036 (0.494) [−0.029]
	Other Method	−0.168 (0.652)	0.187 (1.439)	0.042 (0.321) [0.035]
Publication:	Top 36 Journal	0.442 (4.150)***	−0.139 (2.545)**	−0.112 (2.043)** [−0.092]
	AJAE	0.193 (2.922)***	−0.064 (1.879)*	−0.054 (1.592) [−0.045]
	Book	0.161 (2.056)**	−0.043 (1.075)	−0.084 (2.096)** [−0.069]
Region:	Australia	0.547 (1.683)*	0.249 (1.443)	0.261(1.504) [0.214]
	North America	0.555 (1.794)*	0.102 (0.620)	0.041 (0.249) [0.034]
	South America	0.338 (0.892)	0.099 (0.496)	−0.116 (0.576) [−0.095]
	North Europe	0.447 (1.435)	0.033 (0.201)	−0.063 (0.379) [−0.054]
	West Europe	0.209 (0.658)	0.476 (2.822)***	0.438 (2.579)*** [0.360]
	South Europe	0.347 (1.097)	0.276 (1.639)	0.125 (0.736) [0.102]
	East Europe	0.104 (0.297)	0.552 (3.022)***	0.473 (2.572)** [0.389]
	East Asia	0.543 (1.756)*	0.115 (0.697)	0.057 (0.345) [0.047]
	South East Asia	0.343 (1.051)	0.375 (2.171)**	0.277 (1.595) [0.228]
	South Central Asia	0.564 (1.647)*	0.162 (0.897)	0.134 (0.738) [0.110]
	Middle East	0.382 (1.073)	0.259 (1.384)	0.217 (1.153) [0.179]
	South Africa	0.629 (1.839)*	0.189 (1.042)	0.013 (0.070) [0.011]
	Other Africa	0.722 (2.167)**	−0.021 (0.116)	−0.128 (0.724) [−0.106]
R^2		0.110	0.191	
N		4142	4006	4006
λ				0.341 (24.437)***

Note: t-Statistics (in absolute value) are provided in parentheses, while marginal effects for Box-Cox (evaluated at means) are provided in brackets. Levels of significance: * = 10%, ** = 5%, and *** = 1%. The dependent variable in the full sample regression corresponds to the price elasticity, whereas the absolute price elasticity is the dependent variable in the restricted sample.

Table 3. Heterogeneous Effects Meta-Regression Results

Category	Variable	Full Sample Linear	Restricted Sample Linear	Restricted Sample Box-Cox
Product:	Beef	−0.142 (1.992)*	0.139 (3.981)***	0.149 (4.198)*** [0.122]
	Pork	−0.030 (0.408)	0.053 (1.469)	0.085 (2.293)** [0.069]
	Lamb	−0.145 (1.316)	0.158 (2.938)***	0.149 (2.712)*** [0.122]
	Poultry	0.093 (1.267)	−0.099 (2.763)***	−0.121 (3.302)*** [−0.099]
	Fish	−0.088 (1.266)	0.026 (0.751)	−0.023 (0.652) [−0.019]
Specification:	Functional form:			
	Double-Log	−0.160 (1.401)	0.101 (1.666)*	0.114 (1.790)* [0.094]
	Semi-Log	−0.025 (0.141)	0.025 (0.268)	0.064 (0.670) [0.052]
	AIDS-Nonlinear	−0.054 (0.365)	0.040 (0.509)	0.183 (2.255)** [0.150]
	AIDS-Linear	−0.030 (0.244)	0.011 (0.166)	0.109 (1.608) [0.089]
	AIDS-Quadratic	−0.244 (0.978)	0.159 (1.143)	0.317 (2.114)** [0.260]
	AIDS-Generalized	−0.008 (0.021)	−0.070 (0.324)	0.045 (0.191) [0.037]
	Rotterdam	−0.078 (0.468)	−0.010 (0.111)	0.017 (0.187) [0.014]
	CBS	0.126 (0.522)	−0.105 (0.786)	−0.010 (0.047) [−0.006]
	Translog	−0.507 (2.786)***	0.109 (1.119)	0.179 (1.748)* [0.146]
	S-Branch	−0.475 (1.302)	0.354 (1.701)*	0.414 (1.839)* [0.339]
	Box-Cox	−0.074 (0.350)	0.030 (0.277)	0.065 (0.594) [0.054]
	Other Form	−0.181 (0.632)	0.094 (0.632)	0.156 (1.003) [0.128]
	Other issues:			
	Compensated	0.162 (3.161)***	−0.169 (6.772)***	−0.250 (9.847)*** [−0.205]
	Substitute meats	−0.055 (0.571)	0.049 (0.948)	0.014 (0.252) [0.011]
	Two-Step	0.098 (0.671)	−0.041 (0.526)	−0.033 (0.406) [−0.027]
	Dynamic	−0.022 (0.285)	0.034 (0.804)	0.040 (0.897) [0.032]
Data:	Time-Series	−0.231 (0.739)	0.040 (0.227)	0.234 (1.224) [0.192]
	Cross-Sectional	0.013 (0.056)	−0.013 (0.109)	−0.010 (0.041) [−0.004]
	Median Year	0.002 (0.455)	0.001 (0.002)	−0.001 (0.493) [−0.001]
	Aggregation:			
	Multiple countries	0.896 (1.626)	0.040 (0.133)	−0.197 (0.621) [−0.161]
	Country	0.263 (0.698)	−0.092 (0.437)	−0.310 (1.376) [−0.254]
	Region of country	0.287 (0.618)	−0.040 (0.257)	−0.253 (0.926) [−0.207]

continued

Table 3. Continued

Category	Variable	Full Sample Linear	Restricted Sample Linear	Restricted Sample Box-Cox
	State or province	0.421 (1.212)	−0.281 (1.417)	−0.472 (2.233)** [−0.386]
	City	−0.147 (0.363)	0.196 (0.892)	0.191 (0.817) [0.157]
	Firm	−0.922 (2.178)**	0.775 (3.245)***	0.439 (1.714)* [0.359]
Estimation:	2SLS	−0.383 (2.479)**	0.218 (2.768)***	0.140 (1.702)* [0.114]
	3SLS	−0.219 (1.525)	0.209 (2.743)***	0.144 (1.794)* [0.118]
	FIML	−0.030 (0.190)	0.123 (1.474)	0.108 (1.228) [0.088]
	MLE	−0.012 (0.103)	0.064 (1.091)	0.073 (1.191) [0.060]
	SUR	0.081 (0.757)	−0.009 (0.148)	−0.052 (0.867) [−0.043]
	GMM	0.146 (0.560)	−0.045 (0.143)	−0.082 (0.240) [−0.067]
	GLS	−0.110 (0.557)	−0.009 (0.081)	−0.066 (0.585) [−0.054]
	Other Method	−0.188 (0.443)	0.196 (0.819)	0.084 (0.327) [0.069]
Publication:	Top 36 journal	0.329 (2.017)**	−0.196 (2.167)**	−0.188 (1.935)* [−0.154]
	AJAE	0.113 (1.014)	−0.019 (0.307)	−0.003 (0.051) [−0.003]
	Book	0.009 (0.058)	0.058 (0.655)	0.054 (0.563) [0.045]
Region:	Australia	1.071 (2.788)***	0.020 (0.097)	0.140 (0.650) [0.114]
	North America	1.128 (3.225)***	−0.133 (0.714)	−0.089 (0.460) [−0.073]
	South America	0.831 (1.853)*	−0.0176 (0.074)	−0.163 (0.658) [−0.133]
	North Europe	0.971 (2.698)***	−0.124 (0.641)	−0.108 (0.540) [−0.089]
	West Europe	0.796 (2.144)**	0.230 (1.160)	0.281 (1.362) [0.230]
	South Europe	1.105 (3.017)***	−0.129 (0.655)	−0.185 (0.902) [−0.151]
	East Europe	0.505 (1.132)	0.357 (1.467)	0.366 (1.421) [0.299]
	East Asia	1.065 (3.020)***	−0.073 (0.385)	−0.024 (0.123) [−0.020]
	South East Asia	0.960 (2.537)**	0.127 (0.630)	0.127 (0.607) [0.104]
	South Central Asia	1.046 (2.552)**	0.020 (0.091)	0.123 (0.539) [0.103]
	Middle East	0.943 (2.143)**	0.064 (0.267)	0.138 (0.550) [0.113]
	South Africa	1.091 (2.554)**	0.062 (0.266)	0.064 (0.260) [0.052]
	Other Africa	1.273 (3.283)***	−0.238 (1.145)	−0.245 (1.129) [−0.200]
N		4142	4006	4006
χ^2(p-value)		1005.01 (0.000)	1253.89 (0.000)	745.98 (0.000)

Note: *t*-Statistics (in absolute value) are provided in parentheses, while marginal effects for Box-Cox (evaluated at means) are provided in brackets. Levels of significance: * = 10%, ** = 5%, and *** = 1%. The dependent variable in the full sample regression corresponds to the price elasticity, whereas the absolute price elasticity is the dependent variable in the restricted sample.

corresponds to the uncompensated price elasticity of an individual consumer, estimated from a linear specification with panel data using OLS. Moreover, the baseline demand neither includes other meats as substitutes, nor is dynamic or two-step. Lastly, the baseline elasticity does not correspond to a particular region (i.e., corresponds to the rest of the world), and is not reported in a top 36 economics journal, AJAE, or a book.

Furthermore, given that we use the price elasticity in the full sample regression (typically negative) and the absolute price elasticity in the restricted sample (never negative), a positive (negative) coefficient of a regressor in the full (restricted) sample implies that the respective study characteristic makes the price elasticity less elastic. A negative (positive) coefficient of a regressor in the full (restricted) sample implies that the respective study characteristic makes the price elasticity more elastic. Accordingly, if the results are similar across the full and restricted samples, then we will find the coefficients are opposite in sign but similar in magnitude.

Homogeneous Effects Results

Beginning with the homogeneous effects results corresponding to the estimation of equations (1) and (2), as indicated at the bottom of table 2, since the *R*-square for the restricted sample linear specification is nearly twice the size of its full sample counterpart, dropping unusual price elasticity estimates improves the overall fit of the linear specification. Nonetheless, the Box-Cox parameter λ (0.341) in the restricted sample does favor a specification between the linear and semi-log forms.

Addressing the general pattern of the individual coefficients across the regressions, for all three meta-regressions we find that the price is significantly more elastic for beef, lamb, and fish (relative to the composite meat category). Also, for the restricted sample, pork is significantly more responsive to price, whereas poultry is significantly less responsive to price.

Concerning demand specification, data, and estimation issues, there are several notable tendencies in the literature. First, compared with the linear form of demand, the double-log, semi-log, AIDS-Quadratic, translog, and S-Branch forms tend to generate greater price elasticities, whereas a number of functional forms (i.e., AIDS-Linear, Box-Cox, and Other Form) do not significantly influence the price elasticity in any of the meta-regressions. Second, the price of meat tends to be less elastic for compensated demand and more elastic when substitute meats are included in demand (although insignificant in the full sample meta-regression). Also, although using a two-step treatment along with a dynamic specification significantly reduces the absolute price elasticity in the full sample meta-regression, the results are insignificant in the restricted sample meta-regressions. Third, given that the coefficients of the time-series and cross-sectional dummy variables, as well as the median year of the sample and most of the coefficients of the aggregation variables, are insignificantly different from zero across the meta-regressions, data issues modestly influence the price elasticity.[7] Fourth, although estimation of meat demand by GMM, GLS, and other less common methods does not significantly influence the reported price elasticity, price tends to be more elastic when demand is estimated with 2SLS, 3SLS, or FIML (although the full sample results suggest that FIML reduces the absolute price elasticity). Also, for the full sample we find that the use of MLE and SUR deflates the absolute price elasticity.

As for the remaining categories, the publication outlet affects the reported price elasticity, since to varying degrees of significance the price elasticity is less elastic when published in a top 36 economics journal, the AJAE, or a book. Also, for the full sample the demand for meat is significantly less elastic in Australia, North America, East Asia, South Central Asia, and the two regions of Africa; however, for the restricted sample, price is significantly more elastic in West Europe, East Europe, and South East Asia (although insignificant in the Box-Cox results).

Lastly, a number of comparisons can be made of the results across the three meta-regressions. For instance, many of the coefficients of the two linear specifications, as well as the corresponding marginal effects of the Box-Cox specification, are similar in sign and magnitude. Nonetheless, although significance of the individual coefficients is most similar across

[7] As for the aggregation variables, a general lack of significance is consistent with studies (e.g., Blundell, Pashardes, and Weber 1993; Denton and Mountain 2001) that find that aggregation bias has a modest influence on the price elasticity. Rather, these studies find that aggregation bias is most pronounced with respect to the income elasticity. Nonetheless, across all three meta-regressions we do find that using firm-level data significantly increases the absolute price elasticity. Such a result could be tied to firm-level elasticities accounting for rivalry among producers.

the two restricted sample meta-regressions, there are noticeable differences between the full and restricted samples. In particular, compared with the full sample, a greater share of the meat product coefficients is significant in the restricted sample, whereas a smaller share of the region coefficients is significant in the restricted sample. Given these differences, this suggests that dropping unusual price elasticities from the sample does influence the results.[8]

Heterogeneous Effects Results

Results for the heterogeneous effects counterparts to table 2 are provided in table 3. At the bottom of the table, across all three meta-regressions the LaGrange Multiplier test rejects homogeneity of the individual effects, and hence, study effects are important determinants of the price elasticity.

Concerning the coefficients, with the exception of those associated with the region dummy variables, all other coefficients that are significant in table 3 are also significant in table 2. However, the number of significant coefficients drops off with the random effects results. In particular the coefficients of several of the previously significant variables controlling for meat products (e.g., fish), specification (e.g., semi-log and substitute meats), estimation method (e.g., FIML), and publication characteristics (e.g., publishing in the AJAE or a book) are now insignificantly different from zero across all three random effects meta-regressions. Nonetheless, similar to table 2, there continues to be a tendency for price to be significantly more elastic for beef and lamb when estimated with firm-level data as a double-log, translog, or S-Branch specification using 2SLS or 3SLS. Alternatively, price tends to be significantly less elastic for the compensated demand for poultry published in a top 36 economics journal. Also, similar to table 2, several functional forms (e.g., AIDS-Linear, Box-Cox, Other Form), data issues (e.g., time-series and cross-sectional data, median year of the sample, many of the aggregation variables), and estimation methods (e.g., GMM, GLS, Other Method) continue to play insignificant roles in determining the price elasticity across all meta-regressions. Interestingly, there is a noticeable difference in the coefficients associated with the region dummy variables between the two samples in table 3, as nearly all of the coefficients of the region dummy variables are significant in the full sample but insignificant in the restricted sample.

Predicted Price Elasticities

Although the individual coefficients in tables 2 and 3 are sensitive to a number of modeling characteristics, it is worthwhile to consider the overall impact of the different meta-regression specifications on the price elasticity. To do so, in table 4 we use the meta-regression results for each of the specifications in tables 2 and 3 to construct the predicted absolute value of the price elasticity for each meat product, holding each study characteristic dummy variable at its mean (with the exception of the dummy variables corresponding to all other meat products, which are set to zero).

Several interesting results regarding the predicted price elasticities are worth mentioning. First, based on the point predictions across all the meta-regressions, there is a tendency for beef, lamb, and fish to be most responsive to price, while poultry and the meat composite are least responsive to price (although the rank ordering of the absolute price elasticities is slightly sensitive to the meta-regression specification). However, since several of the prediction intervals do overlap, we cannot say that the price elasticities significantly differ across all meats (at the 95% level of significance). In particular for the homogeneous effects results in the upper half of table 4, across all three specifications the absolute price elasticity of poultry is significantly lower than that of beef, lamb, and fish. Furthermore, across the two linear specifications, the absolute price elasticity of fish is significantly greater than the meat composite, whereas for the two restricted sample meta-regressions the absolute price elasticities of beef and lamb significantly exceed that of the meat composite. For the heterogeneous effects results, while the absolute price elasticity of poultry continues to be significantly lower than that of beef and fish, the prediction intervals for poultry and lamb do overlap for the full

[8] With respect to the restricted sample linear specification, since observations of the absolute price elasticity are constrained to lie between zero and three standard deviations of the mean (i.e., 4.81), the sample is truncated. To see whether or not this affects the results, single-truncated (with truncation at zero) and double-truncated (with lower truncation at zero and upper truncation at 4.81) regressions were estimated. The maximum likelihood results are provided in table A1 of the supplementary material appendix. Comparing the linear restricted sample results in table 2 with the truncated results in table A1, controlling for truncation has little influence on the results. In particular the sign and significance of the coefficients as well as the marginal effects are similar across both tables. Furthermore, the results are insensitive to whether single- or double-truncated regressions are estimated.

Table 4. Predicted Absolute Price Elasticities

	Product	Full Sample	Restricted Sample	
		Linear	Linear	Box-Cox
Homogeneous effects (table 2)	Beef	0.985	0.968	0.833
		(0.905, 1.065)	(0.927, 1.008)	(0.794, 0.872)
	Pork	0.913	0.913	0.811
		(0.818, 1.007)	(0.865, 0.961)	(0.772, 0.851)
	Lamb	1.062	1.047	0.898
		(0.877, 1.247)	(0.953, 1.141)	(0.859, 0.937)
	Poultry	0.778	0.746	0.632
		(0.684, 0.872)	(0.698, 0.793)	(0.593, 0.671)
	Fish	1.167	0.969	0.789
		(1.085, 1.248)	(0.927, 1.012)	(0.749, 0.828)
	Meat	0.85	0.851	0.719
Heterogeneous effects (table 3)		(0.746, 0.955)	(0.798, 0.904)	(0.681, 0.759)
	Beef	1.025	0.978	0.84
		(0.944, 1.107)	(0.935, 1.018)	(0.802, 0.879)
	Pork	0.913	0.891	0.785
		(0.818, 1.009)	(0.842, 0.940)	(0.746, 0.823)
	Lamb	1.028	0.996	0.841
		(0.841, 1.216)	(0.899, 1.092)	(0.803, 0.880)
	Poultry	0.789	0.739	0.622
		(0.695, 0.885)	(0.690, 0.787)	(0.583, 0.661)
	Fish	0.971	0.864	0.7
		(0.888, 1.054)	(0.820, 0.907)	(0.662, 0.739)
	Meat	0.883	0.838	0.715
		(0.778, 0.989)	(0.783, 0.892)	(0.675, 0.753)

Note: Predicted absolute price elasticities for each product are evaluated at each study characteristic dummy variable set equal to its mean, while the dummy variables for all other meat products are set to zero. Prediction intervals (at 95%) are provided in parentheses below point predictions.

sample. Yet, when we consider 90% prediction intervals, the pattern of significant differences in the predicted price elasticities across meats is more similar between the lower and upper halves of table 4.

Second, when comparing the point predictions of the two linear meta-regressions, although the restricted sample predictions are often minutely lower than the full sample predictions, there is no discernible pattern of difference between the homogeneous and heterogeneous effects results. Hence, the predicted price elasticities are largely insensitive to the choice of sample or the control of panel data issues.

Third, the results are sensitive to the functional form of the meta-regression, with the Box-Cox results yielding absolute price elasticities roughly 10% lower than the linear counterparts. This suggests that it is important to consider the influence of functional form when interpreting meta-regression results.

Lastly, predicted price elasticities for the different regions of the world were also constructed. Evaluated at the means of all dummy variables (with the exception of the other region dummies, which were set to zero), based on the full sample heterogeneous effects results, the following are the predicted absolute price elasticities (in parentheses) for each respective region: Australia (0.915), North America (0.859), South America (1.156), North Europe (1.016), West Europe (1.191), South Europe (0.882), East Europe (1.482), East Asia (0.922), South East Asia (1.026), South Central Asia (0.941), Middle East (1.044), South Africa (0.896), and Other Africa (0.714). Hence, *ceteris paribus*, the price of meat is elastic (inelastic) in South America, North Europe, West Europe, East Europe, South East Asia, and the Middle East (Australia, North America, South Europe, East Asia, South Central Asia, South Africa, and other regions of Africa). Similar predictions hold for the other meta-regression specifications. Nonetheless, although not provided, most of the 95% prediction intervals do overlap, and so there is little significant difference in the price elasticities. In particular, across the regions of the world, we found only the predicted price elasticity for North America to be significantly less elastic compared with West Europe and East

Europe. Accordingly, factors affecting price (e.g., supply shifts) have similar percentage impacts on consumption across most regions of the world.

Concluding Comments

Unlike qualitative literature reviews, which can be sensitive to the reviewer's subjective decision to emphasize particular price elasticity estimates over others, our quantitative literature review statistically analyzes tendencies in the literature to sway meat price elasticity estimates one way or the other. Indeed, across the 419 studies included in the meta-analysis, we find several important results. For instance, the price of beef, lamb, and fish tend to be more elastic compared with poultry. Also, to varying degrees of significance, the price elasticity of meat is particularly sensitive to the specification of demand, chosen estimation method, and publication characteristics.

The results of our meta-analysis are useful in a number of respects. First, by knowing that the price elasticity of meat is sensitive to a number of characteristics, we gain additional insight into the nuances of meat demand. For example, in an effort to improve health outcomes, suppose a policymaker is considering levying a tax on beef and lamb or alternatively a subsidy on poultry and fish. Since the predicted absolute price elasticities of beef and lamb are quite similar, nearly 1 in table 4, a tax on these two meats would have similar effects on consumption, *ceteris paribus*. However, since the predicted absolute price elasticity of fish exceeds that of poultry, a subsidy on fish would promote a greater percentage increase in consumption compared with a similar subsidy on poultry, *ceteris paribus*.

Second, since several model characteristics play an insignificant role in the meta-regressions, the price elasticity of meat is somewhat insulated from these characteristics. In particular with the exception of meat demand at the firm level as well as demand in North America and parts of Europe, the price elasticity of meat is largely insensitive to data issues and the location of demand. Hence, less concern should be given to these issues when choosing a price elasticity.

Finally, as a quantitative summary of the meat demand literature, the results of this meta-analysis are useful in many settings. For example, not only can the results be incorporated into courses that address consumer behavior, but they also suggest avenues for future research, such as exploring in greater depth why some factors influence the price elasticity of meat, whereas other factors do not.

Supplementary Material

Supplementary material is available at the *American Journal of Agricultural Economics* online at www.oxfordjournals.org/our_journals/ajae/.

References

Alston, J. M., and J. A. Chalfant. 1991. Can We Take the Con out of Meat Demand Studies? *Western Journal of Agricultural Economics* 16(1): 36–48.

Alston, J. M., and J. A. Chalfant. 1993. The Silence of the Lambdas: A Test of the Almost Ideal and Rotterdam Models. *American Journal of Agricultural Economics* 75(2): 304–13.

Asche, F., T. Bjorndal, and D. V. Gordon. 2005. Demand Structure for Fish. SNF Working Paper #37/05, Institute for Research in Economics and Business Administration, Bergen, Norway.

Banks, J., R. Blundell, and A. Lewbel. 1997. Quadratic Engel Curves and Consumer Demand. *Review of Economics and Statistics* 79(4): 527–39.

Barnett, W. A., and O. Seck. 2008. Rotterdam Model versus Almost Ideal Demand System: Will the Best Specification Please Stand Up? *Journal of Applied Econometrics* 23(6): 795–824.

Blundell, R., P. Pashardes, and G. Weber. 1993. What Do We Learn about Consumer Demand Patterns from Micro Data? *American Economic Review* 83(3): 570–97.

Bollino, C. A. 1990. GAIDS: A Generalized Version of the Almost Ideal Demand System. *Economics Letters* 34(2): 127–9.

Byrne, P. J., O. Capps Jr., R. Tsai, and G. W. Williams. 1995. Policy Implications of Trade Liberalization: The Case of Meat Products in Taiwan and South Korea. *Agribusiness* 11(4): 297–307.

Chouinard, H. H., D. E. Davis, J. T. LaFrance, and J. M. Perloff. 2007. Fat Taxes: Big Money for Small Change. *Forum for*

Health Economics and Policy 10(2); Available at: http: //www.bepress.com/fhep/10/2/2.

Chung, C. 1994. A Cross-Section Demand Analysis of Spanish Provincial Food Consumption. *American Journal of Agricultural Economics* 76(3): 513–21.

Chung, C., D. Dong, T. M. Schmit, H. M. Kaiser, and B. W. Gould. 2005. Estimation of Price Elasticities from Cross-Sectional Data. *Agribusiness* 21(4): 565–84.

Dalhuisen, J. M., R. J.G. M. Florax, H. L.F. de Groot, and P. Nijkamp. 2003. Price and Income Elasticities of Residential Water Demand: A Meta-Analysis. *Land Economics* 79(2): 292–308.

Deaton, A., and J. Muellbauer. 1980. An Almost Ideal Demand System. *American Economic Review* 70(3): 312–26.

Denton, F. T., and D. C. Mountain. 2001. Income Distribution and Aggregation/Disaggregation Biases in the Measurement of Consumer Demand Elasticities. *Economics Letters* 73(1): 21–8.

Espey, M. 1998. Gasoline Demand Revisited: An International Meta-Analysis of Elasticities. *Energy Economics* 20(3): 273–95.

Gallet, C. A. 2007. The Demand for Alcohol: A Meta-Analysis of Elasticities. *Australian Journal of Agricultural and Resource Economics* 51(2): 121–35.

Gallet, C. A., and J. A. List. 2003. Cigarette Demand: A Meta-Analysis of Elasticities. *Health Economics* 12(10): 821–35.

Gardes, F., S. Langlois, and D. Richaudeau. 1996. Cross-section versus Time-Series Income Elasticities of Canadian Consumption. *Economics Letters* 51(2): 169–75.

Griffith, G., K. I'Anson, D. Hill, R. Lubett, and D. Vere. 2001. Previous Demand Elasticity Estimates for Australian Meat Products. Economic Research Report No. 5, NSW Agriculture, Orange.

Houck, J. P. 1965. The Relationship of Direct Price Flexibilities to Direct Price Elasticities. *Journal of Farm Economics* 47(3): 789–92.

Huang, J., and S. Rozelle. 1998. Market Development and Food Demand in Rural China. *China Economic Review* 9(1): 25–45.

Huang, K. S. 1988. An Inverse Demand System for U. S. Composite Foods. *American Journal of Agricultural Economics* 70(4): 902–9.

Huang, K. S. 1994. A Further Look at Flexibilities and Elasticities. *American Journal of Agricultural Economics* 76(2): 313–17.

Johnston, R. J., M. H. Ranson, E. Y. Besedin, and E. C. Helm. 2006. What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values. *Marine Resource Economics* 21(1): 1–32.

Karagiannis, G., S. Katranidis, and K. Velentzas. 1996. A Quantitative Analysis of Demand for Meat Items in Greece, 1965–1992. *Scottish Agricultural Economics Review* 9: 47–56.

Kuchler, F., A. Tegene, and J. M. Harris. 2005. Taxing Snack Foods: Manipulating Diet Quality or Financing Information Programs? *Review of Agricultural Economics* 27(1): 4–20.

Kuznets, G. M. 1953. Measurement of Market Demand with Particular Reference to Consumer Demand for Food. *Journal of Farm Economics* 35(5): 878–95.

Marshall, T. 2000. Exploring a Fiscal Food Policy: The Case of Diet and Ischaemic Heart Disease. *British Medical Journal* 320(7230): 301–4.

Mazzocchi, M. 2006. No News is Good News: Stochastic Parameters versus Media Coverage Indices in Demand Models after Food Scares. *American Journal of Agricultural Economics* 88(3): 727–41.

Moschini, G., and D. Moro. 1996. Structural Change and Demand Analysis: A Cursory Review. *European Review of Agricultural Economics* 23(3): 239–61.

Park, H., W. N. Thurman, and J. E. Easley Jr. 2004. Modeling Inverse Demands for Fish: Empirical Welfare Measurement in Gulf and South Atlantic Fisheries. *Marine Resource Economics* 19(3): 333–51.

Pashardes, P. 1993. Bias in Estimating the Almost Ideal Demand System with the Stone Index Approximation. *The Economic Journal* 103: 908–15.

Purcell, J. C., and R. Raunikar. 1971. Price Elasticities from Panel Data: Meat, Poultry, and Fish. *American Journal of Agricultural Economics* 53(2): 216–21.

Raunikar, R., and C. Huang. 1987. *Food Demand Analysis: Problems, Issues, and Empirical Evidence*. Ames: Iowa State University Press.

Reeves, G. W., and A. H. Hayman. 1975. Demand and Supply Forces in the World Beef Market. *Quarterly Review of Agricultural Economics* 28(3): 121–51.

Richardson, R. A. 1976. Structural Estimates of Domestic Demand for Agricultural Products in Australia: A Review. *Review of Marketing and Agricultural Economics* 44(3): 71–100.

Rosenberger, R. S., and J. B. Loomis. 2000. Panel Stratification in Meta-Analysis of Economic Studies: An Investigation of its Effects in the Recreation Valuation Literature. *Journal of Agricultural and Applied Economics* 32(3): 459–70.

Scott, L. C., and P. M. Mitias. 1996. Trends in Rankings of Economics Departments in the U. S.: An Update. *Economic Inquiry* 34(2): 378–400.

Smallwood, D. M., R. C. Haidacher, and J. R. Blaylock. 1989. A Review of the Research Literature on Meat Demand. In R. Buse, ed., *The Economics of Meat Demand*. Madison: Department of Agricultural Economics, University of Wisconsin, pp. 93–124.

Smith, V. K., and J. Huang. 1995. Can Markets Value Air Quality? A Meta-Analysis of Hedonic Property Value Models. *Journal of Political Economy* 103(1): 209–27.

Tomek, W. G. 1977. Empirical Analysis of the Demand for Food: A Review. In R. Raunikar, ed., *Food Demand and Consumption Behavior: Selected Research Topics*. Athens GA: The S-119 Southern Regional Research Committee and the Farm Foundation, pp. 1–30.