Resolving the Conflicts between Previous Meat Generic Advertising Studies

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Paper prepared for the AAEA Conference

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Abstract

United States producer organizations spend millions of dollars on generic advertising of both beef and pork and other promotion programs designed to stimulate consumers' demand for meat. Producers need to know if the money allocated to generic advertising and these promotion programs is effective in increasing the demand for meat. Past research disagreed about the effectiveness of generic advertising. Models of Ward and Lambert and Brester and Schroeder are reestimated and tested for misspecification. The 5:1 return on beef generic advertising found by Ward and Lambert has been widely quoted and has been used to justify spending on generic advertising. The conflicting findings about generic advertising effectiveness are shown to be primarily due to the data transformation used by Ward and Lambert. Results indicate that generic advertising does not substantially increase meat demand. However, the advertising elasticities are estimated inaccurately enough that we can also not reject that advertising is a breakeven investment.

Key Words: beef, confirmation, demand, generic and branded advertising, misspecification testing, pork, Rotterdam model.

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Expenditures on generic beef and pork advertising were over 200 and 70 million dollars for the 1970-1993 period, respectively. These advertising programs are designed to stimulate consumers' demand for beef and pork. Producers need to know if the money allocated to advertising increases the demand for meat. Past research disagreed about the effectiveness of generic advertising. Ward and Lambert found that generic advertising has substantially increased beef demand. The 5:1 return found by Ward and Lambert has been widely quoted by the beef industry and by academic researchers. Their results have been and still are being used to support additional funding on generic advertising. In contrast, Brester and Schroeder and Kinnucan et al. found that generic beef and pork advertising has little effect on demand. The question that arises from these contradictory findings is what should be believed about the effectiveness of generic meat advertising? Industry groups apparently believe that generic advertising is a wise investment. If advertising is not effective then the money should be spent elsewhere.

The econometric models used to estimate the advertising response equations differ from one study to another. For example, Brester and Schroeder, Kinnucan et al., and Ward and Lambert all used different functional forms. Different functional forms may lead to different conclusions about the effectiveness of generic advertising (see e.g., Green et al.). Other factors that may lead to different inferences about the effectiveness of generic advertising are the use of different data and the variables included in the demand model. Kinnucan et al. also found that advertising parameters are sensitive to the sample periods used.

Of the studies evaluating the effectiveness of U.S. generic meat advertising only Kinnucan and Venkateswaran included misspecification testing. Reliable elasticity estimates can only be obtained if the models used are correctly specified (McGuirk et al., 1993; 1995). McGuirk et al. (1993; 1995) misspecification test procedures can be used to test if all of the underlying assumptions of the models hold. The test procedures help identify possible problems with parameter stability, omitted relevant variables, and functional form, for example. Importantly, these misspecification tests can be used to guide model respecification.

This paper aims to determine why previous studies on the effectiveness of U.S. generic meat advertising have reached conflicting conclusions. Demand models of Brester and Schroeder and Ward and Lambert that have led to different conclusions about the effectiveness of U.S. generic meat advertising are reestimated and tested for misspecification. McGuirk et al. (1993; 1995) misspecification test procedures are used. Brester and Schroeder used generic advertising expenditures (i.e. leading national advertisers' (LNA) data) while Ward and Lambert used beef checkoff expenditures data. In this paper, each model is estimated using both data series. Specific problems related to the modeling approach used by Brester and Schroeder and Ward and Lambert are discussed. Correctly specified models are developed and used to reassess the effectiveness of generic meat advertising.

The Models

To achieve our objective, the studies conducted by Brester and Schroeder and by Ward and Lambert are considered. The data used by Brester and Schroeder were requested and obtained from Brester. The beef checkoff expenditures data used by Ward and Lambert were obtained from Lambert. Ward declined to provide any additional data. Contrary to Brester and Schroeder who used a Rotterdam demand system, Ward and Lambert used an ad hoc single-equation price-dependent model. As mentioned earlier, these two studies reached conflicting conclusions about the effectiveness of generic beef advertising.

Ward and Lambert's Study

Ward and Lambert estimated three models to determine the economic impact of U.S. beef checkoff efforts on demand. The first model was at the liveweight level and the second and third were at the boxed beef and retail market levels, respectively. The retail market model is the one considered here. The model estimated by Ward and Lambert is:

$$(1) \quad \ln P_{bt} = \alpha_0 + \alpha_1 \ln Q_{bt} + \alpha_2 \ln Q_{kt} + \alpha_3 \ln Q_{pt} + \alpha_4 \ln I_t + \alpha_5 T_{1t} + \alpha_6 T_{2t} + \alpha_7 S_{1t}$$

$$+ \alpha_8 S_{2t} + \alpha_9 S_{3t} + \alpha_{10} FR_t + \delta_1 \ln[1 + \exp(-\beta/E_t)] + \delta_2 \ln[1 + \exp(-\beta/E_{t-1})] + \epsilon_t,$$

here P_{bt} is the real price of beef at the retail level, Q_{bt}, Q_{kt}, and Q_{pt} are the per capita disappearances of beef, pork, and poultry, respectively, I_t is real per capita income, the S_{it} are quarterly dummy variables, E_t and E_{t-1} are the current and lagged beef checkoff expenditures (used as proxies for current and lagged generic beef advertising expenditures), T_{1t} and T_{2t} are time trends, Ward and Lambert call FR_t the feeder steer ratio, and ϵ_t is the error term. The variable T_1 increases one unit each quarter, starting with $T_1 = 58$ in 1979:2. T_2 equals one before 1990:1 and increases in units of one thereafter.

Application of Ward and Lambert's Model to Pork Data

The effectiveness of generic pork advertising was determined in Brester and Schroeder's study but not in Ward and Lambert's. For comparison, a pork response function is estimated here using Ward and Lambert's model. The demand equation used is:

$$(2) \quad lnP_{kt} = \alpha_0 + \alpha_1 lnQ_{bt} + \alpha_2 lnQ_{kt} + \alpha_3 lnQ_{pt} + \alpha_4 lnI_t + \alpha_5 T_1 + \alpha_6 S_{1t} + \alpha_7 S_{2t}$$

$$+ \alpha_8 S_{3t} + \delta_1 \ln[1 + \exp(-\beta/A_t)] + \delta_2 \ln[1 + \exp(-\beta/A_{t-1})] + \epsilon_t,$$

where P_{kt} is the real price of pork, A_t and A_{t-1} are current and one-period lagged per capita generic pork expenditures, and all other variables are defined as before. Here, T_1 starts at 1 in 1970:1 and increases in units of one until 1993:4. T_2 is not used. It was used in (2) as an additional variable to account for intercept parameter instability (see Ward and Lambert, p. 458).

Brester and Schroeder's Study

Brester and Schroeder's study estimated the effects of both branded and generic advertising on consumer demand for beef, pork, and poultry. Using a Rotterdam model with scaling, all of the advertising expenditures were incorporated in the form of a stock of investment. The stock variable was obtained using a procedure proposed by Cox. This procedure accounts for advertising carry-over effects with little restriction on the shape of the advertising response function (see Cox). While a Rotterdam demand system is also ad hoc since it is not derived from a utility function, it is theoretically more appealing to demand theorists since it allows imposing symmetry and adding up restrictions.

The Rotterdam model with scaling is nonlinear in the parameters. The specification of the advertising stock variable makes this model even more nonlinear. Although Cox explains how end point restrictions can make the model easier to estimate, it is still very intractable in the context of system misspecification testing. Brester and Schroeder indicated that they estimated a linear Rotterdam model without scaling effects. The price elasticities were similar to those obtained with the nonlinear model, suggesting that the scaling effects are negligible.

To simplify matters and given that the linear model yields similar results to the nonlinear model, the linear Rotterdam model is used here to conduct the misspecification tests. The specific model is formulated as:

$$(3) \quad w_i d\ln q_i = \alpha_i d\ln Q + \sum_j \beta_{ij} d\ln p_j + \sum_j \gamma_{ij} d\ln A_j + \sum_j \sum_{m=1}^{3} \delta_{ijm} d \ln A_{jm} + \sum_{k=1}^{3} \phi_{ik} D_k + e_i,$$

where w_i is the budget share of the i^{th} good, q_i is per capita consumption of good i, p_j is the nominal price of good j, A_j is real advertising expenditures on good j, $d\ln Q = \sum_i w_i \, d\ln q_i$ is the DIVISIA volume index, A_{jm} is the m-period lagged advertising expenditures, the D_k's are quarterly dummy variables, and e_i is the error term. Note that, here, the contemporaneous advertising variables include both brand and generic advertising. The lagged advertising variables, however, only include generic advertising expenditures. This is done to be consistent with the fact that no lagged branded advertising variable was used in Brester and Schroeder. As in Brester and Schroeder, the demand system in (3) has four equations. The fourth equation represents other consumption goods.

Procedures

This section discusses the estimation procedures and the general approach used to determine if the conflicting conclusions about the effectiveness of generic meat advertising are due to different data, different variables, or different functional forms. In each case, specific econometric issues that need to be addressed before a definitive conclusion can be drawn are also discussed.

Estimation, Confirmation, and Misspecification Testing

Ward and Lambert's Model. Ward and Lambert's model is estimated using the checkoff and LNA data over the 1979:2-1991:2 sample period. Since only the checkoff expenditures used by Ward and Lambert are available to us, the prices, quantities, and income data are taken from Brester and Schroeder's data set. The feeder steer ratio is computed from 1990 revised cattle slaughter data (USDA). Ward and Lambert are not clear about how it is computed. We computed it as the ratio of feeder steer slaughter to total cattle slaughter times one hundred.

Following Ward and Lambert, the model is estimated using ordinary least squares holding the checkoff coefficient β fixed. The value of β used is the one for which the sum of squared errors are minimized. This procedure does not bias the parameter estimates, but it does bias the standard errors. The parameter estimates of our beef checkoff model are compared with those of Ward and Lambert to see how closely we replicate their results. The model is also estimated over the 1970-1993 period to determine if the use of different sample periods substantially affects the estimated advertising effects.

McGuirk et al.'s (1993) approach to misspecification testing in single linear regression equations is used to determined if Ward and Lambert's model is misspecified. This approach consists of carrying out a set of individual and joint misspecification tests. The joint misspecification tests are conditional mean and variance tests. While the conditional mean test simultaneously tests parameter stability, functional form, and independence, the conditional variance test simultaneously tests variance stability, and static and dynamic heteroskedasticity.

Rotterdam Model. The linear Rotterdam model is estimated with the “other consumption goods” equation included. As in Brester and Schroeder, the 1970:1-1993:4 sample period is used. McGuirk et al.’s (1995) misspecification test procedures for systems of linear regression equations are used to test the model for misspecification. If the model is misspecified, efforts are made to respecificy it. If it cannot be correctly respecified, an alternative linear Rotterdam model is considered. The misspecification tests are repeated until a correctly specified model is found.

The correctly specified Rotterdam model is estimated using seemingly unrelated regressions. As in Brester and Schroeder, the price symmetry and homogeneity conditions are imposed. Since branded advertising for beef, pork, and poultry are included in the model, advertising homogeneity is imposed for these variables (see Kinnucan et al.). Advertising homogeneity is not imposed for the generic advertising variables since poultry advertising is branded advertising.

Different Data

The checkoff and LNA advertising expenditures for 1970:1-1993:4 are shown in figure 1. This figure shows only minor differences in the two data series. However, the presence of many zero observations in the checkoff expenditures data does lead to differences in results.

With Ward and Lambert's model, the transformed checkoff variable is zero when the checkoff expenditures are zero and is greater than zero but less than one otherwise. The checkoff variable has a dummy variable-type of effect because checkoff expenditures are either zero or very large. This is not the case for the generic advertising expenditures variable as shown in figure 2. Brester and Schroeder's data show small amounts of generic advertising before the beef checkoff program began. With Ward and Lambert's transformation these small amounts make a lot of difference.

Zero advertising expenditures also creates a problem in the Rotterdam model since logarithms of the data are used for estimation. The problem is generally addressed by adding a small number to each observation in the advertising data set (see, e.g., Brester and Schroeder). As in Brester and Schroeder, here, 100 is added to all observations (zero and nonzero advertising expenditures). The same number is added to the checkoff expenditures data to estimate the Rotterdam model. Looking at the checkoff expenditures data, it appears that when the first differences are taken, one observation will be an outlier. This is due to the fact that there are many consecutive zeros in the data and the first non-zero observation is much greater than zero. Since the number added to the observations is the same, the first differences of the logarithms yield zeros for all observations where the original numbers were zeros. Note that this does not occur with the LNA data (see figure 3).

Functional Forms and Advertising Effects

To determine if different functional forms lead to different conclusions, the effects of advertising must be compared across functional forms. Brester and Schroeder measured the effects of advertising with price flexibilities. This approach was criticized by Huang who recommended using directly estimated flexibilities or elasticities "in agricultural policy and program analysis" (p. 313). Huang's approach is used here.

Results

Estimation and Misspecification Test Results

Ward and Lambert's Model. The parameter estimates of the Ward and Lambert model for beef are reported in table 1 for each type of advertising data. Our attempt to replicate Ward and Lambert's model is not perfect, but their estimates are generally confirmed. The parameter estimates of the quantity and income variables are similar to those of Ward and Lambert. Our estimates, however, suggest an even larger effect of the checkoff program than was found by Ward and Lambert.[1] This fragility in results is probably due to the fact that the feeder steer ratio used here may not be the same as the one used by Ward and Lambert.

The misspecification test results are reported in table 2. All figures are p-values. For the overall F tests (joint tests only), the critical significance level is 0.15 (Sidak criterion; see McGuirk et al. (1993)). For the individual tests, the critical significance levels are 0.05 and 0.10. Consider the beef response function estimated using the checkoff data. The results of the overall misspecification tests indicate that the conditional mean and variance are misspecified. For the conditional mean, the problem is due to the functional form while for the conditional variance the likely problem is dynamic heteroskedasticity. The results of the individual tests show that the

[1]The 5:1 return reported by Ward and Lambert was calculated using the positive coefficient on lagged advertising and ignoring thenegative coefficient on current advertising. The net effect of advertising fromtheir model would be roughtly 2:1 and likely statistically insignificant.

problem is due to the functional form misspecification only. Similarly, the beef response function estimated using the LNA data is misspecified; functional form is the source of the misspecification. For pork, the assumptions of functional form linearity and no autocorrelation do not hold.

Autocorrelation is generally a sign of functional form misspecification (Thursby and Thursby). Thus, to respecify the pork equation, one would start by finding an appropriate functional form. Results also suggest respecifying the functional form of the beef equation. Additional explanatory variables were included in each equation. The functional forms of the two equations were still misspecified. We were unable to change Ward and Lambert's model so that it would be correctly specified.

The Rotterdam Model. The Rotterdam model including the other-good equation was severely misspecified. All of the underlying assumptions of the model did not hold, except dynamic homoskedasticity and independence. The model was respecified using women labor force participation and cholesterol information index as additional explanatory variables.[2] It has been argued that the increased participation of women in the labor force may have caused structural change in meat demand (McGuirk et al., 1995). Health information has also been found to be a significant factor in explaining structural change in meat demand in the United States (e.g., McGuirk et al., 1995; Kinnucan et al.). The women labor force participation variable used here is different from the one used by McGuirk et al. (1995). Here, this variable is the ratio of civilian women in the labor force who are married or who maintain a family to the total civilian labor

[2]These variables were also included in Ward and Lambert's model. The respecified model was then tested for misspecification. The functional form of the model was still misspecified.

force (Bureau of Labor Statistics: gopher://stats.bls.gov/). Contrary to the ratio used in previous studies, the one used here is not highly correlated with a linear time trend (the correlation here is 0.57 compared to the 0.98 of past studies). The cholesterol information index used here is the same as the one used by Kinnucan et al. These data were requested and obtained from Kinnucan. Including the additional variables did not correct the misspecification problems. An alternative linear Rotterdam model was considered. This model simply does not include the “other goods” equation and thus an incomplete demand system is used. A similar model specification was used by Kinnucan et al. Kinnucan et al., however, do not include branded advertising in their model although they recognize that this may lead to an upward bias in the parameter estimates.

Table 3 and 4 report the misspecification test results of the alternative Rotterdam model. Consider the Rotterdam model without the additional explanatory variables included. The p-values of the full-system joint tests indicate that the conditional mean and variance are misspecified. The equation-by-equation system tests in table 4 indicate that the problems may be due to nonnormality, dynamic heteroskedasticity, parameter stability, and/or functional form. When the additional explanatory variables are used more of the underlying assumptions of the model hold. The equation-by-equation tests in table 4 indicate that the variance-covariance may not be stable. McGuirk et al. (1995) indicated that the full-system tests can point to a misspecification problem simply because the variance-covariance is often inflated with those tests, or because the “cross-equation residual covariances may not be stable” (p. 15). In the present case, an alternative explanation of unstable variance-covariances is that the advertising parameters may vary randomly over time.

The parameter estimates of the preferred Rotterdam model are reported in tables 5 and 6 for the 1970:1-1993:4 and 1979:2-1991:2 sample periods, respectively. For the entire sample period, most of the parameter estimates of the economic variables are significantly different from zero. The coefficients of the women labor force participation and cholesterol information index variables are generally significant at the 5 or 10 per cent level. For the 1979:2-1991:2 sample period, all of the parameter estimates of the economic variables are significantly different from zero. The parameter estimate of the women labor force participation variable is significant in the pork equation only. The coefficient of the cholesterol information index variable is not significantly different from zero.

Many of the parameter estimates for generic advertising as reported in tables 5 and 6 are statistically significant. Some of the beef advertising coefficients in the beef equation are negative and the same is true for pork. The net effects of advertising are reported in table 7. These elasticities are small and statistically insignificant, but are at least positive except for pork with the beef checkoff data included. But, as shown in figure 3, the checkoff data may not work well with this functional form.

Different Data

Ward and Lambert's Model. The results in table 1 show that the maximum percentage impacts that beef advertising can have on prices is 5.1% with the checkoff data and 0.502% with the generic advertising data, suggesting that different data lead to different conclusions about advertising effectiveness. As discussed in the procedures section, this difference may simply be due to the way zero advertising expenditures are treated in this model (see also figure 2). One odd thing about Ward and Lambert's advertising variable is that since it is essentially a dummy variable, the optimal level of advertising would only be a fraction of current levels. Therefore, even if it were accepted, it would imply that spending on generic advertising should be cut.

The Rotterdam Model. The advertising elasticities are reported in table 7 for the 1970:1-1993:4 and 1979:2-1991:2 sample periods, respectively. These advertising elasticities are lower than those obtained by Brester and Schroeder. They are generally similar to those calculated by Kinnucan et al. The advertising elasticities differ depending on the advertising data used. The first differences of the logarithm of these two data series plotted in figure 3 show an outlying observation in the checkoff expenditures. This might cause substantial differences in the estimation results.

Marginal Advertising Effects

The results with the Rotterdam model indicate that generic advertising does not significantly increase meat demand. To determine if advertising is a good investment, marginal returns to advertising can be calculated as $p\frac{\partial q}{\partial A}$, where p, q, and A are the price, quantity, and advertising expenditures of the good of interest (Piggot et al.). "Minimum necessary conditions" for advertising to be profitable are that marginal returns be greater than one (Piggot et al., p. 276). Here, $p\frac{\partial q}{\partial A}$ is approximated as $p\frac{\triangle q}{\triangle A}$. The marginal returns are calculated at the mean of the data. For beef, the marginal returns to generic advertising are \$2.29 and \$0.73 with the 1970-1993 and 1979:2-1991:2 data, respectively. Similarly, the marginal returns to pork advertising are \$33.74 and nearly zero dollars. These results indicate that while advertising may have not been statistically significant, coefficient values which could justify advertising are likely inside the confidence intervals.

Different Sample Periods

Here, we determine if the use of different sample periods changes the conclusions about advertising effectiveness. The parameter estimates of Ward and Lambert's price dependent model are reported in table 8 for the 1970:1-1993:4 sample period. For beef, the net effects (the sum of the current and lagged advertising coefficients) of advertising on prices is negative with both the checkoff and generic advertising data. These results indicate that with Ward and Lambert's model the effect of advertising on meat demand differ depending on the sample period used. With the Rotterdam model, the advertising elasticities are generally low, irrespective of the sample period used. This indicates that, with the Rotterdam model, the finding that generic advertising does not significantly increase meat demand is unchanged whether the entire sample period is used or not.

Summary and Implications

Past studies on generic meat advertising used different functional forms, different data on advertising, different observation periods, and different variables. Two past models are evaluated to determine why the past studies reached different conclusions about the effectiveness of generic advertising. The primary factor causing the differing conclusions was Ward and Lambert's transformation of the advertising variable. Every model estimated without this transformation yielded low advertising elasticities. When more recent data were used with Ward and Lambert's specification, the estimated effects of beef advertising turned negative. Furthermore, Ward and

Lambert's transformation yielded very different conclusions with Brester and Schroeder's data. Ward and Lambert's advertising variable was essentially a dummy variable. Slight differences in Brester and Schroeder's data caused the conclusions to be totally changed. Given the fragility of Ward and Lambert's results, their model does not seem appropriate. The widely quoted 5:1 return on generic beef advertising should not be believed. Ward and Lambert's and Brester and Schroeder's models were both misspecified. A revision of Brester and Schroeder's model which was correctly specified did not yield materially different conclusions.

The generic advertising elasticities estimated from the Rotterdam model are generally very small and statistically insignificant. Similar results were obtained by Brester and Schroeder and Kinnucan et al. These advertising elasticity estimates suggest that advertising does not substantially increase meat demand. Nevertheless, because the estimates are imprecise we cannot reject that advertising is a breakeven proposition.

The findings of this paper have important implications. Since there is now some evidence that generic meat advertising has not had a substantial effect on demand, industry groups should tightly monitor and perhaps reduce the money they allocate to generic advertising. Certainly, some of the early beef advertisements appeared directed more toward beef producers than toward beef consumers. Time series models like those considered are always subject to the criticism that advertising may be positively correlated with some omitted factor which has reduced meat demand. One way around such a criticism is to use designed experiments. The one such study available by Jensen and Schroeter used split-cable data and also found little effect of advertising on beef demand. Thus, while the effect of generic meat advertising is likely not zero, its effect appears to be too small to measure accurately.

Table 1. Parameter Estimates of the Ward and Lambert Model For Beef, 1979:2-1991:2 Data

Variable	Checkoff Data Coef.	Checkoff Data t-Ratio	LNA Data Coef.	LNA Data t-Ratio	W&L Estimates Coef.	W&L Estimates t-Ratio
Constant	8.0206**	3.1250	7.6785**	2.7110	9.7346**	15.0130
$\ln Q_k$	-0.0708	-0.8005	0.0181	0.2063	-0.0567	-0.7716
$\ln Q_b$	-0.8066**	-5.0250	-0.9370**	-5.3770	-0.9220**	-7.6033
$\ln Q_p$	-0.2558	-1.3320	-0.0622	-0.3074	-0.2766 *	-1.8557
lnI	0.2874	0.6076	0.2124	0.3981	-0.2975	1.7432
T1	-0.0049	-0.4736	-0.0023	-0.2013	-0.8817**	-9.4674
T2	0.0187**	3.8070	0.0137**	2.6450	0.0495**	3.7769
Current Adv.	0.0210	0.5567	-0.0335	-1.1570	-0.0305	-1.2742
Lag Adv.	0.0718*	1.7770	0.0072	0.2409	0.0535**	2.2547
S1	-0.0509**	-1.9250	-0.0277	-0.9833	-0.0389**	-3.1033
S2	-0.0193	-1.0790	-0.0012	-0.0608	0.0083	0.5908
S3	0.0063	0.3575	0.0351**	2.0700	0.0201	1.4253
FR	1.1923	1.7580	0.0188**	2.7300	1.7669**	3.9913
R-Square	0.97		0.96		0.98	
R-Square Adj.	0.96		0.95		0.98	

Note: Single and double asterisks denote significant at the 10% and 5%, respectively.
The W&L estimates are the parameter estimates reported in Ward and Lambert's paper.

Table 2. P-Values of the Misspecification Tests, Ward and Lambert's Model for Beef (1979:2-1991:2) and Pork (1970:1-1993:4)

Assumptions	Test	Checkoff Data	LNA data Beef	LNA data Pork
Individual Tests				
Normality	Skewness	0.300	0.995	0.845
	Kurtosis	0.703	0.415	0.749
Functional Form	RESET 2	0.050	0.084	0.005
Static Homoskedasticity	RESET 2	0.953	0.471	0.000
Dynamic Homoskedasticity	ARCH 1	0.459	0.190	0.000
Parameter Stability		-	-	0.009
Independence		0.191	0.193	0.000
Joint Tests				
Conditional Mean	Overall F-test	0.088	0.152	0.000
Parameter Stability	Parameter Shifts	-	-	0.981
Functional Form	RESET 2	0.077	0.150	0.023
Independence		0.333	0.306	0.000
Conditional Variance	Overall F-test	0.108	0.258	0.441
Parameter Stability	Variance Shifts	-	-	0.127
Static Homoskedasticity	RESET 2	0.144	0.683	0.594
Dynamic Homoskedasticity	ARCH 1	0.102	0.109	0.603

Note: The parameter stability test is conducted using a dummy variable. The Chow and CUSUMSQ tests were not reliable when the beef model and the 1979:2-1991:2 sample were used. Also in this case, the parameter stability test cannot be conducted using a time trend or a dummy variable because of the use of T_1 and T_2 in the model.

Table 3. P-values of the Misspecification Tests for the Beef, Pork, and Poultry Equations, Full System Tests, 1970:1-1993:4

Assumption	Without Additional Variable	With Additional Variable
Individual Tests		
Normality		
Skewness	0.0000	0.1865
Kurtosis	0.0000	0.0000
Functional Form		
RESET2	0.0014	0.18461
Heteroskedasticity		
Static: RESET	0.1005	0.4325
Dynamic	0.0264	0.7538
Autocorrelation	0.0046	0.5965
Parameter Stability		
Variance	0.0000	0.0000
Mean	0.0006	0.0029
Joint Tests		
Overall Mean Test	0.0001	0.4195
Parameter Stability	0.1192	0.8050
Functional Form	0.0006	0.1492
Autocorrelation	0.0114	0.5152
Overall Variance Test	0.0000	0.0147
Parameter Stability	0.3491	0.3172
Static Heteroskedasticity	0.0291	0.1524
Dynamic Heteroskedasticity	0.0039	0.7537

Notes: For the individual tests, the significance levels are 5 and 10 percent, respectively. For the overall tests, Sidak criterion is used (see McGuirk et al., 1995).

Table 4. P-values of the Misspecification Tests for the Beef, Pork, and Poultry Equations, Equation-by-Equation System Tests, 1970:1-1993:4

		Without Additional Variable			With Additional Variable		
		Beef	Pork	Poultry	Beef	Pork	Poultry
Individual Tests							
Normality							
Skewness		0.7194	0.0625	0.6692	0.1967	0.0762	0.1274
Kurtosis		0.3801	0.7873	0.6889	0.8070	0.2775	0.9172
Functional Form							
RESET2		0.0000	0.0004	0.0000	0.4284	0.0541	0.2284
Heteroskedasticity							
Static	Beef	0.8395	0.8104	0.6281	0.8729	0.5794	0.9054
RESET2	Pork		0.5659	0.6578		0.0381	0.7180
	Poultry			0.3385			0.8629
Dynamic	Beef	0.0532	0.3944	0.0367	0.1735	0.5000	0.2947
	Pork		0.6493	0.2459		0.7064	0.3824
	Poultry			0.0512			0.7685
Autocorrelation		0.4581	0.2260	0.1598	0.6788	0.8349	0.1121
Parameter Stability							
Variance		0.9097	0.2821	0.9985	0.9845	0.7771	0.8058
Mean		0.0163	0.0266	0.0128	0.1057	0.0042	0.5169
Joint Tests							
Overall Mean Test		0.0000	0.0192	0.0000	0.6462	0.5658	0.1609
Parameter Stability		0.9630	0.5466	0.7092	0.5909	0.3768	0.6586
Functional Form		0.0000	0.0228	0.0000	0.3171	0.2051	0.2686
Autocorrelation		0.4581	0.2260	0.1598	0.6442	0.5275	0.1373

Table 4. Continued

Overall Variance Test						
Beef	0.0000	0.0000	0.0000	0.0000	0.0000	0.0282
Pork		0.0017	0.0315		0.0000	0.5315
Poultry			0.0000			0.0015
Parameter Stability						
Beef	0.1214	0.2184	0.3022	0.3493	0.2122	0.8860
Pork		0.2584	0.6615		0.4935	0.1720
Poultry			0.4257			0.2012
Static Heteroskedasticity						
Beef	0.2932	0.3389	0.2873	0.1098	0.0039	0.9393
Pork		0.3485	0.4554		0.0002	0.8071
Poultry			0.1639			0.1170
Dynamic Heteroskedasticity						
Beef	0.0118	0.3100	0.0063	0.0953	0.6137	0.0734
Pork		0.5333	0.2376		0.9626	0.4897
Poultry			0.0052			0.2577

Notes: For the individual tests, the significance levels are 5 and 10 percent, respectively. For the overall tests, Sidak criterion is used (see McGuirk et al., 1995).

Table 5. Parameter Estimates of the Rotterdam Model for Beef, Pork, and Poultry, 1970:1-1993:4

	Checkoff Data			LNA Data		
Variable	Beef	Pork	Poultry	Beef	Pork	Poultry
Prices:						
Beef	-0.188868*			-0.179816*		
	(-9.611)			(-9.580)		
Pork	0.195048*	-0.132642*		0.191956*	-0.137951*	
	(12.291)	(-8.408)		(12.902)	(-9.261)	
Poult.	-0.006180	-0.062406*	0.068586*	-0.012140	-0.054005*	0.066145*
	(-0.659)	(-7.800)	(5.561)	(-1.280)	(-6.787)	(3.749)
Exp.	0.236903*	0.082030*	0.681067*	0.239316*	0.078869*	0.681815*
	(17.048)	(6.886)	(37.209)	(18.196)	(7.131)	(39.677)
Cholesterol Index	-0.001965**	0.000842	0.001251	-0.003295*	0.001159	-0.002136
	(-1.558)	(0.780)	(0.754)	(-2.785)	(1.168)	(-1.384)
W. Labor Force	0.005832*	-0.005243*	-0.000589	0.007891*	-0.005598*	-0.002293
	(2.415)	(-2.536)	(-0.185)	(3.462)	(-2.925)	(-0.770)
Generic Adv.:						
Beef	0.000041*	0.000004	-0.000045**	0.000018*	-0.000004	-0.000014
	(2.179)	(0.221)	(-1.833)	(2.122)	(-0.514)	(-1.257)
Pork	-0.000009	-0.000019	0.000028	-0.000033	0.000002	0.000031
	(-0.303)	(-0.744)	(0.707)	(-0.860)	(0.062)	(0.618)
Lag Gen. Adv.:						
Beef 1	-0.000016**	0.000003	0.000013	-0.000009**	0.000011*	-0.000002
	(-1.521)	(0.388)	(0.953)	(-1.537)	(2.446)	(-0.274)
Beef 2	0.000013	-0.000001	-0.000012	-0.000019*	-0.000001	0.000020
	(1.221)	(-0.161)	(-0.875)	(-3.209)	(-0.358)	(2.688)
Beef 3	-0.000027*	0.00001	0.000026**	0.000022*	-0.000017*	-0.000005
	(-2.601)	(1.109)	(1.913)	(4.016)	(-3.556)	(-0.687)
Pork 1	-0.000009	0.000018	-0.000009	0.000005	-0.000021	0.000016
	(-0.441)	(0.985)	(0.324)	(0.163)	(-0.828)	(0.414)
Pork 2	0.000031	-0.000008	-0.000023	0.001210*	-0.000004	-0.001206*
	(1.468)	(-0.425)	(-0.820)	(4.033)	(-0.174)	(-3.719)
Pork 3	0.000025	-0.000008	-0.000017	-0.000077*	0.000064*	0.000013
	(1.209)	(-0.418)	(-0.606)	(-2.582)	(2.578)	(0.335)

Note: Single and double asterisks denote significance at the 5 and 10 percent level, respectively. The parameter estimates of the branded advertising and seasonality variables are not reported.

Table 6. Parameter Estimates of the Rotterdam Model for Beef, Pork, and Poultry, 1979:2-1991:2

Independent Variable	Checkoff Data			LNA Data		
	Beef	Pork	Poultry	Beef	Pork	Poultry
Prices:						
Beef	-0.289173*					-0.278497*
	(-8.566)					(-7.761)
Pork	0.114072*	-0.085168*			0.103006*	-0.080627*
	(4.409)	(-3.556)			(3.905)	(-3.475)
Poult.	0.175101*	-0.028904*	-0.146197*	0.175492*	-0.022379*	-0.153113*
	(11.062)	(-2.369)	(-7.315)	(10.520)	(-1.863)	(-7.448)
Exp.	0.304043*	0.132128*	0.563829*	0.302271*	0.134949*	0.562780*
	(12.210)	(6.528)	(17.570)	(11.410)	(6.603)	(16.820)
Cholesterol Index	-0.001478	0.003095	-0.001617	-0.001694	0.003489	-0.001795
	(-0.417)	(1.057)	(-0.352)	(-0.458)	(1.205)	(-0.382)
W. Labor Force	0.005340	-0.010115**	0.004775	0.005809	-0.010864*	0.005055
	(0.772)	(-1.772)	(0.532)	(0.807)	(-1.931)	(0.553)
Generic Adv.:						
Beef	0.000123*	-0.000024	-0.000099**	0.000030	-0.000001	-0.000029
	(2.911)	(-0.701)	(-1.832)	(1.392)	(-0.073)	(-1.043)
Pork	-0.000110**	-0.000027	0.000137**	-0.000070	-0.000053	0.000123
	(-1.848)	(-0.554)	(1.769)	(-0.820)	(-0.807)	(1.143)
Lag Gen. Adv.:						
Beef 1	0.000015	0.000002	-0.000017	-0.000013*	-0.000004	0.000017*
	(1.599)	(0.282)	(-1.328)	(-1.999)	(-0.742)	(2.177)
Beef 2	0.000041*	-0.000007	-0.000034*	-0.000029*	0.000006	-0.000023*
	(4.111)	(-0.873)	(-2.655)	(-4.660)	(1.274)	(-2.945)
Beef 3	-0.000024*	0.000024*	0.000000	0.000018*	-0.000015*	-0.000003
	(-2.448)	(2.998)	(0.004)	(2.928)	(-3.044)	(-0.384)
Pork 1	-0.000052*	0.000033*	-0.000019	0.000009	0.000050*	-0.000059
	(-3.028)	(2.374)	(-0.863)	(0.293)	(2.085)	(-1.505)
Pork 2	-0.000025	-0.000015	-0.000040**	0.000122*	-0.000047*	-0.000075**
	(-1.451)	(-1.070)	(-1.816)	(3.888)	(-1.941)	(-1.913)
Pork 3	0.000030**	-0.000029	-0.000001	-0.000065*	0.000050*	0.000015
	(1.734)	(-2.008)	(-0.044)	(-2.030)	(1.990)	(0.369)

Note: Single and double asterisks denote significance at the 5 and 10 percent level, respectively. The parameter estimates of the branded advertising and seasonality variables are not reported.

Table 7. Elasticity Estimates, Rotterdam Model for Beef, Pork, and Poultry

	Checkoff Data			LNA Data		
Variable	Beef	Pork	Poultry	Beef	Pork	Poultry
Prices						
Beef	-0.251415	0.768753	-0.374082	-0.254268	0.753810	-0.335527
	-0.507321	0.422489	1.094381	-0.488591	0.381504	1.096825
Pork	0.343985	-0.688568	-0.144993	0.337298	-0.666292	-0.158253
	0.200126	-0.315437	-0.180650	0.180712	-0.298619	-0.139869
Poultry	-0.092569	-0.080186	0.519075	-0.083029	-0.087519	0.493781
	-0.307195	-0.107052	-0.913731	0.307881	-0.082885	-0.956956
Meat Expend.	0.398910	0.294450	4.704849	0.403247	0.286894	4.700986
	0.533409	0.489363	3.523931	0.530300	0.499816	3.517375
Generic Advertising						
Beef	0.000007	0.000106	-0.000219	0.000027	-0.000053	-0.000068
	0.000272	-0.000019	-0.000938	0.000011	-0.000052	-0.000238
Pork	0.000017	-0.000106	-0.000219	0.001920	0.000205	-0.008130
	-0.000275	-0.000141	0.000481	-0.000007	0.000000	0.000025
Branded Advertising						
Beef	0.000039	-0.000227	-0.000411	-0.000142	0.000057	0.000473
	0.000318	0.000200	-0.001469	-0.000296	0.000415	0.000356
Pork	-0.000019	-0.000167	0.000301	0.000125	-0.000042	-0.000432
	-0.000265	-0.000219	0.001313	0.000254	-0.000404	-0.000225
Poultry	-0.000020	0.000061	0.000110	0.000017	-0.000011	-0.000048
	-0.000051	0.000163	-0.000094	0.000042	-0.000011	-0.000131

Note: Price and meat expenditures elasticities are compensated elasticities. For each equation, elasticities are calculated as the ratio of the parameter estimates to the budget share. For the generic advertising variables, the coefficient of the lagged variables are added to those of the contemporaneous variables before calculating the ratio.

The elasticities are for the 1970:1-1993:4 and 1979:2-1991:2, respectively.

Table 8. Parameter Estimates of the Ward Model for Beef and Pork, 1970:1-1993:4 Data

	Checkoff Data		LNA Data			
	Beef		Beef		Pork	
Variable	Coefficient	t-Ratio	Coefficient	t-Ratio	Coefficient	t-Ratio
Constant	4.0286*	2.1840	3.9559*	2.1840	6.6577*	4.8050
$\ln Q_k$	-0.3644*	-3.3840	-0.3617*	-3.2160	-1.1626*	-12.0800
$\ln Q_b$	-1.2457*	-7.5690	-1.2228*	-7.3770	-0.4453*	-3.3090
$\ln Q_c$	-0.0283	-0.1374	-0.0983	-0.4702	0.0460	0.2453
lnI	1.4241*	7.9150	1.4741*	9.2990	0.8077*	5.9630
T1	-0.0263*	-6.0530	-0.0027*	-6.9330	-0.0128*	-3.7080
Current Adv.	-0.1385**	-1.5660	-0.0197	-0.4251	-0.0027	-0.0670
Lag Adv.	0.1087	1.2160	-0.0156	-0.3329	0.0551	1.3340
S1	-0.0483	-1.3960	-0.0604**	-1.7090	-0.0810*	-2.4510
S2	-0.0356	-1.4070	-0.0461**	-1.7310	-0.1058*	-4.4950
S3	0.0094	0.4562	0.0421	0.2013	-0.0775*	-3.7980
FR	0.0263	1.4000	0.0264	1.4010	--	--
R-Square	0.98		0.96		0.97	
R-Square Adjusted	0.97		0.95		0.97	

Note: Single and double asterisks denote significant at the 5% and 10%, respectively.

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