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Revealed Demand for Country-of-Origin Labeling of Meat in the United States

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Proponents of the U.S. mandatory country-of-origin labeling (MCOOL) law have argued that consumers prefer domestic meat and value labels confirming domestic origin. Following legislation enacted in March 2009, an *ex post* analysis of demand is possible to evaluate relative costs and benefits of MCOOL. This study uses retail grocery-store scanner data to estimate a Rotterdam demand model of meat products. The model results failed to detect changes in consumer meat demand post-MCOOL. Given the costs of compliance incurred by meat processors and no evidence of increased demand, our results suggest that producers and consumers have experienced a welfare loss.

Key words: country of origin, MCOOL, meat demand, Rotterdam, separability

Introduction

Imposing mandatory country-of-origin labeling (MCOOL) in the United States was anticipated to affect demand by providing customers with additional, valuable information. Advocacy groups for MCOOL pointed to studies suggesting that consumers would prefer U.S. meat products and would be willing to pay premiums for confirmation of U.S. origin. MCOOL detractors, including Canada and Mexico, argued that the increased burden from record keeping would favor domestic meat. The subsequent lawsuits and WTO hearings have called into question the relative value of MCOOL to consumers as compared to costs faced by both domestic meat processors and North American trading partners.

Most existing research on MCOOL was conducted prior to the law's implementation, but now that MCOOL has been in place for over three years, an *ex post* analysis of the impacts on realized consumer demand is possible. This study attempts to determine whether MCOOL has altered U.S. demand for covered meat products since the implementation of the law.

The 2002 Farm Bill amended the Agricultural Marketing Act of 1946 to require retailers to notify customers of the country of origin of muscle-cut and ground meats from several different species. On January 15, 2009, the U.S. Department of Agriculture's Agricultural Marketing Service published a final rule, which became effective on March 16, 2009 (U.S. Department of Agriculture, Agricultural Marketing Service, 2009b). Commodities covered in this MCOOL final rule include muscle cuts of beef, chicken, pork, and several other species and products (Link, 2009). Processed meat products, meat purchased at restaurants, and certain commodity meats (e.g., turkey) are exempt from MCOOL (U.S. Department of Agriculture, Agricultural Marketing Service, 2009a). Examples of the MCOOL labels now appearing on covered meat products include "Product of the U.S.;" "Product of Canada;" and "Product of the U.S., Canada, Mexico."

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The length of time from the 2002 Farm Bill amendment to its implementation in 2009 resulted largely from notable contention over the proposed MCOOL rule. Segments of the U.S. meat industry supported the rule on the grounds that consumers placed value on origin labeling, while other parties suggested that the costs of implementing MCOOL would exceed expected benefits and disputed the need for MCOOL. Beyond delaying MCOOL implementation, this debate triggered a host of economic research, including estimating implementation costs and estimates of what U.S. consumers may be willing to pay for meat produced domestically, the meat demand increase needed to offset expected costs, and direct impacts on major trading partners. Nearly all of this research was conducted prior to implementation and knowledge of specific details of the final rule.

Another notable development was an assessment of MCOOL made by the World Trade Organization (WTO) and expanding political pressure on domestic policy makers. Six U.S. senators called for MCOOL labeling rules to be revised in order to address "loopholes" (Gabbett, 2009a). Led by Canada, several countries filed formal complaints with the WTO over MCOOL (Gabbett, 2009b). The WTO ruled in November 2011, supporting several aspects of the grievance filed. In response, the United States elected to appeal the WTO ruling. In June 2012, the WTO Appellate Body upheld components of the March ruling, including the finding that MCOOL results in less favorable treatment of imported Canadian cattle and hogs than domestic counterparts. The United States had until May 23, 2013, to implement the recommendations and rulings of the WTO Dispute Settlement Board (World Trade Organization, 2012).

An *ex post* evaluation of MCOOL's economic impacts meets the need for additional information to improve U.S. policy response to continued developments in the WTO process and the broader need to understand how consumers react to origin labeling. We use grocery-store scanner data of meat-product purchases covered by MCOOL and consider multiple demand approaches varying in imposed separability and MCOOL impact specifications. Our use of multiple modeling approaches and grocery-store scanner data, rather than the more common style of estimating a sole model using aggregate disappearance data, add robustness to our findings.

Background Literature

The existing literature can be categorized into four main approaches: exploring what U.S. consumers may be willing to pay for meat produced domestically, estimating implementation costs, identifying the meat demand increase needed to offset expected costs, and examining direct impacts on trading partners.

Proponents of MCOOL have argued that consumers would prefer meats from domestically raised animals, and numerous willingness-to-pay studies suggest these preferences would drive premiums for U.S. meat over products from other countries (e.g., Gao and Schroeder, 2009; Link, 2009; Loureiro and Umberger, 2007; Mennecke et al., 2007; Miranda and Kónya, 2006; Umberger et al., 2003; Ward, Bailey, and Jensen, 2005). While assessing willingness-to-pay for U.S. over foreign meat is relevant, existing studies fail to assess labels that indicate a mixture of origins—such as "U.S., Canada" or "U.S., Canada, Mexico"—which are central to the MCOOL debate and prevalent in the current marketplace. Moreover, this existing literature was conducted prior to specific details of the MCOOL final rule being known, explored only a subset of products actually covered by the law, and largely relied on stated preference techniques, making hypothetical bias a possible concern (Lusk, 2003; Tonsor and Shupp, 2011).

Major resistance to MCOOL stems mostly from industry segments concerned about implementation costs. The changes required for successfully tracking, segmenting, and labeling country of origin are believed to be most substantial for beef and least onerous for chicken, with pork falling in between. This situation follows from structural differences in livestock industries as well as differences in cross-border integration with Canada and Mexico. These industry differences lead to notably different implementation cost estimates. In 2010, Informa Economics (2010) conducted an updated assessment of implementation costs derived in 2003 (Sparks Companies, Inc., 2003). This update includes reduced cost estimates reflecting adjustments to the documentation and reporting requirements that developed between the releases of the two reports. Example cost estimates provided in this updated report include total supply chain costs of $1.50/head for cattle and $0.25-$0.35/head for hogs solely of U.S. origin. Animals of mixed origin are estimated to present notably larger total supply chain costs ($45.50–$59/head for cattle; $6.90–$8.50/head for hogs).

After the 2002 Farm Bill was amended, a few studies sought to estimate the net impact MCOOL would have on various segments of the U.S. meat and livestock industry. Brester, Marsh, and Atwood (2004) and Lusk and Anderson (2004) use equilibrium displacement models to explore these impacts and how they would be distributed across market levels. These studies were conducted prior to knowledge of MCOOL's final rules (for instance, chicken went from exempt to covered) and relied on preliminary cost estimates. In the absence of more precise demand impact assessments, both studies identify the enhancement of aggregate beef and pork demand (estimates varied from 2% to 5%) necessary to offset implementation costs and maintain pre-MCOOL industry economic welfare.

The economic impacts on U.S. livestock and meat trading partners have also been studied. This interest mainly follows from the expectation that increased cost of tracking and segregating animals and meat from other countries would reduce derived demand for items not solely of U.S. origin (Rude, Iqbal, and Brewin, 2006). As some expected, this situation also led to the aforementioned WTO dispute. While we are unaware of a comprehensive impact study, several projects have examined key segments of impact. Schulz, Schroeder, and Ward (2011) estimate that MCOOL increased the price differential between Canadian and U.S. fed cattle by $6.04/cwt. Twine and Rude (2012) estimate that MCOOL was more harmful to Canadian cattle producers than appreciation of the Canadian dollar and the recent global economic recession. Additional research suggests that MCOOL has reduced the competitiveness of Canada's hog and pork industry (Rude, Gervais, and Felt, 2010).

Data

The data used to conduct this study were collected by the Fresh Look Marketing Group, which tracks grocery-store sales. The point-of-sale data are comprised of purchases made between February 2007 and March 2011, providing two years of sale observations before and two years after the introduction of MCOOL. The data are aggregated across retail grocery stores, with purchases recorded monthly.

The majority of U.S. meat-demand assessments rely on disappearance data to estimate aggregate meat-demand systems. For instance, Tonsor, Mintert, and Schroeder (2010) provide a recent example and list of several comparable applications in the literature. However, given that the MCOOL policy mainly affects grocery-store sales and exempts restaurant sales, applying aggregate disappearance data (comprised of both covered and exempt products) is not an attractive option. Fortunately, grocery-store scanner data collected by The Fresh Look Marketing Group is available. The data include monthly totals of quantity purchased and expenditures on fresh beef, pork, chicken, and turkey products. Prices are represented by unit values and were obtained by dividing total expenditures by total quantity purchased.

The scanner data allow more flexibility in model specification because they are less aggregated over time, geographical space, and products. While USDA disappearance data are only available for each quarter, the scanner data are measured monthly. The greater frequency of observations allows for more accuracy in matching policy implementation dates and subsequent tests of structural change parameters in the demand models. Volume-weighted prices provided by scanner data also reflect what consumers actually pay for fresh meat more accurately than the more commonly used BLS summaries of posted prices (Lensing and Purcell, 2006).

Access to national scanner data and its composition of products covered by MCOOL (e.g., grocery-store sales) makes these data very appealing for this analysis. Our approach also fits within the increasingly common use of scanner data in food-demand studies (Capps, 1989; Capps and

Table 1. Summary Statistics of Monthly U.S. Scanner Data Used for Models 1–4

Description	Mean	Std Dev	Min	Max
Beef consumption (lbs per capita)	1.2152	0.1444	0.9725	1.5254
Pork consumption (lbs per capita)	0.6773	0.1722	0.5019	1.2126
Chicken consumption (lbs per capita)	0.9663	0.1139	0.7429	1.2343
Turkey consumption (lbs per capita)	0.2818	0.3837	0.0850	1.6818
Beef retail price ($/lb)	3.6190	0.1435	3.3364	3.8800
Pork retail price ($/lb)	2.4706	0.1860	2.0117	2.7984
Chicken retail price ($/lb)	2.0212	0.0497	1.8898	2.1140
Turkey retail price ($/lb)	2.2030	0.4973	0.9771	2.7936
Beef loin consumption (lbs per capita)	0.1489	0.0234	0.1113	0.2021
Ground beef consumption (lbs per capita)	0.5717	0.0628	0.4576	0.7339
Other beef consumption (lbs per capita)	0.4765	0.0553	0.3951	0.5899
Other meat & poultry consumption (lbs per capita)	1.9254	0.4827	1.3963	3.1913
Beef loin retail price ($/lb)	6.4139	0.3229	5.7082	7.3050
Ground beef retail price ($/lb)	2.9363	0.1135	2.7495	3.2586
Other beef retail price ($/lb)	3.8411	0.1742	3.4719	4.2206
Other meat & poultry retail price ($/lb)	2.1913	0.1532	1.7834	2.3963

Notes: The dataset contains fifty monthly observations spanning from February 2007 to March 2011.

Love, 2002; Nayga and Capps, 1994; Schulz, Schroeder, and White, 2012; Schulz, Schroeder, and Xia, 2012).

Approach and Results

The aggregation options provided by scanner data facilitate multiple demand model specifications, which ensure a more comprehensive investigation of the MCOOL impact on meat demand. Specifically, by exploiting separability assumptions for meat and food products, as well as subcategories of beef products, the models allow for a wide range of potential substitution patterns to emerge. The ability of individuals to substitute between products covered and not covered by MCOOL will provide evidence of the impact of country-of-origin labeling on consumer behavior.

Previous work by Moschini, Moro, and Green (1994) specifically tested whether weak separability holds within the Rotterdam framework. They failed to reject the weak separability restriction for food versus nonfood purchases and meat versus other food. Related work by Nayga and Capps (1994) used parametric tests of weak separability between twenty-one disaggregate meat products. The tests were conducted using scanner data to estimate the absolute price version of the Rotterdam model. Four separate partitions of meat products were analyzed and, in all cases, tests of weak separability were rejected. Their results suggest that, while meat can be separated from food within a demand system, individual meat products are not separable from the full meat category. These studies support our use of the weak separability assumption for Rotterdam models of meat and food products. This separability assumption is also common in existing meat-demand studies.

Meat Separable Model

Model 1 is specified to allow for substitution between beef, pork, and chicken products (which are covered under MCOOL labeling regulations) and turkey products (which are not covered by MCOOL). If country-of-origin labels impact consumers' perceptions of food safety or quality, they may change the proportion of MCOOL-labeled meat they buy relative to unlabeled turkey products. Summary statistics of the national scanner data on monthly prices and quantities of beef, pork, chicken, and turkey used to estimate Model 1 are given in table 1.

Table 2. Expenditure Shares for Models 1–4

Description	Mean	Std Dev	Min	Max
Model 1: Meat Separable				
Beef expenditure share	0.5214	0.0311	0.4192	0.5541
Pork expenditure share	0.1946	0.0175	0.1776	0.2439
Chicken expenditure share	0.2321	0.0185	0.1818	0.2473
Turkey expenditure share	0.0518	0.0387	0.0278	0.2026
Model 2: Food Separable				
Beef expenditure share	0.0024	0.0003	0.0019	0.0029
Pork expenditure share	0.0009	0.0002	0.0007	0.0014
Chicken expenditure share	0.0011	0.0001	0.0008	0.0013
Other non-meat & poultry food expenditure share	0.9957	0.0005	0.9948	0.9963
Model 3: Meat Separable-Beef Cuts				
Beef loin expenditure share	0.1142	0.0159	0.0842	0.1395
Ground beef expenditure share	0.1932	0.0121	0.1551	0.2106
Other beef expenditure share	0.2114	0.0105	0.1763	0.2275
Other meat & poultry expenditure share	0.4813	0.0309	0.4469	0.5823
Model 4: Food Separable-Beef Cuts				
Beef loin expenditure share	0.0005	0.0001	0.0004	0.0007
Ground beef expenditure share	0.0009	0.0001	0.0007	0.0011
Other beef expenditure share	0.0010	0.0001	0.0008	0.0012
Other non-beef food expenditure share	0.9977	0.0003	0.9971	0.9981

For the meat separable model (Model 1) and each of the subsequent model specifications considered, the absolute price version of the Rotterdam model was estimated. The models are specified as follows:

$$(1) \qquad \overline{w}_{it}\Delta\ln(x_{it}) = a_i + \beta_i\Delta\ln(\overline{q}_t) + \sum_{j=1}^{n} c_{ij}\Delta\ln(p_{jt}) + \sum_{k=1}^{3} d_{ik}D_k + \mu_i Z_{it} + v_i,$$

where $\overline{w}_{it} = 0.5(w_{i,t} - w_{i,t-1})$ is the average budget share of the ith good ($i = 1,\ldots,n$); Δ is the first difference operator; x_{it} is the per capita consumption of good i in time t; $\Delta\ln(\overline{q}_t)$ is the Divisia volume index where $\Delta\ln(\overline{q}_t) = \sum_{j=1}^{n}\overline{w}_{it}\Delta\ln(x_{it})$; p_{jt} is the price of the jth good in time t; D_k is a quarterly dummy variable; Z_{it} is a binary variable equal to 1 for observations occurring after MCOOL was implemented in March 2009 and 0 for observations occurring prior to MCOOL; v_i is a random error term; and α_i, β_i, c_{ij}, d_{ik}, and μ_i are coefficients to be estimated. Expenditure shares for Model 1 are presented in table 2.

The Rotterdam model is estimated using SAS 9.2 statistical software. The jth equation was dropped due to singularity of the covariance matrix. The coefficients of the jth equation can be recovered by imposing restrictions on the model. The adding-up restrictions are $\sum_{i=1}^{n}\beta_i = 1$, $\sum_{j=1}^{n} c_{ij} = 0$, $\sum_{i=1}^{n} d_{ik} = 0$, and $\sum_{i=1}^{n}\mu_i = 0$. The homogeneity restriction is $\sum_{i=1}^{n} c_{ij} = 0$, and symmetry is imposed by $c_{ij} = c_{ji}$. Following several previous studies examining structural change in demand models, the intercept term (a_i) represents a linear time trend and is included to account for structural changes not captured by other included variables (Marsh, Schroeder, and Mintert, 2004; Piggott et al., 1996; Burton and Young, 1996).

The estimated coefficients for Model 1 are reported in table 3. Goodness of fit, as measured by R^2 values, indicates that the model captured the in-sample variation of beef, pork, and chicken

Table 3. Estimated Rotterdam Demand Models 1 and 2

Model 1: Meat Separable			Model 2: Food Separable		
Variable	**Coefficient**	**Std Err**	**Variable**	**Coefficient**	**Std Err**
α_{Bf}	−0.00816*	0.00473	α_{Bf}	−0.00004	0.00003
α_{Pk}	−0.00056	0.00209	α_{Pk}	0.00001	0.00003
α_{Ch}	−0.00331	0.00272	α_{Ch}	−0.00003	0.00002
β_{Bf}	0.55158***	0.03320	β_{Bf}	−0.00352***	0.00101
β_{Pk}	0.21152***	0.00971	β_{Pk}	−0.00184***	0.00062
β_{Ch}	0.20867***	0.01430	β_{Ch}	−0.00075	0.00046
c_{Bf}	−0.37696***	0.05110	c_{Bf}	−0.00225***	0.00062
$c_{Bf,Pk}$	0.26286***	0.01370	$c_{Bf,Pk}$	0.00130***	0.00027
$c_{Bf,Ch}$	−0.01846	0.04660	$c_{Bf,Ch}$	−0.00042	0.00031
c_{Pk}	−0.46397***	0.02460	c_{Pk}	−0.00220***	0.00017
$c_{Pk,Ch}$	0.16392***	0.02020	$c_{Pk,Ch}$	0.00081***	0.00014
c_{Ch}	−0.20804***	0.04770	c_{Ch}	−0.00150***	0.00032
d_{Bf1}	0.01087	0.00997	d_{Bf1}	0.00005	0.00004
d_{Bf2}	0.00758	0.00773	d_{Bf2}	0.00006	0.00004
d_{Bf3}	0.00702	0.01270	d_{Bf3}	0.00000	0.00002
d_{Pk1}	−0.00480*	0.00283	d_{Pk1}	−0.00005	0.00004
d_{Pk2}	0.00052	0.00256	d_{Pk2}	0.00000	0.00004
d_{Pk3}	0.00023	0.00440	d_{Pk3}	−0.00002	0.00003
d_{Ch1}	0.00531	0.00463	d_{Ch1}	0.00005*	0.00003
d_{Ch2}	0.00139	0.00369	d_{Ch2}	0.00003*	0.00002
d_{Ch3}	0.00644	0.00518	d_{Ch3}	0.00002	0.00002
μ_{Bf}	0.00039	0.00518	μ_{Bf}	0.00002	0.00002
μ_{Pk}	0.00133	0.00184	μ_{Pk}	0.00002	0.00001
μ_{Ch}	−0.00076	0.00239	μ_{Ch}	0.00000	0.00001
rho	−0.60237***	0.11920	*rho*	−0.49411***	0.15110
LL	506.13		*LL*	1,291.18	
R^2_{Bf}	0.98		R^2_{Bf}	0.99	
R^2_{Pk}	0.99		R^2_{Pk}	0.98	
R^2_{Ch}	0.97		R^2_{Ch}	0.97	
Wald test:	0.84			2.41	

Notes: Bf is beef, Pk is pork, and Ch is chicken. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively. A restricted diagonal matrix autocorrelation correction was made to all models (preferred by LR tests). The omitted equation for Model 1 is turkey and for Model 2 is all other food. The null hypothesis tested by the Wald statistic is: $\mu_{Bf} = \mu_{Pk} = \mu_{Ch} = 0$. The 95% χ^2 critical value of the Wald test statistic is 7.81 with 3 degrees of freedom.

similarly to those of previous meat-demand studies.[1] Curvature restrictions are satisfied (at the data means), as the estimated price coefficient matrix is negative semidefinite.

Table 4 provides point estimates of the elasticity measures. Own-price compensated elasticity estimates are -0.723, -2.384, -0.896, and -3.506, for beef, pork, chicken, and turkey, respectively. Our finding that pork is more elastic than beef and chicken is consistent with results reported by Brester and Schroeder (1995); Tonsor and Marsh (2007); and Tonsor, Mintert, and Schroeder (2010). Past studies, which have commonly used disappearance data, have typically found demand for poultry products to be the most inelastic of examined meats. In our scanner-data-based evaluation we

[1] The results presented for all of the models are estimated using a diagonal element correction matrix for autocorrelation (Berndt and Savin, 1975). Likelihood-ratio tests were conducted to compare the diagonal matrix-autocorrelation correction to the no-autocorrelation and full matrix-autocorrelation corrections. The diagonal correction, with all diagonal elements restricted to be equal, was the preferred autocorrelation correction. Estimates using the other autocorrelation corrections and test results are available upon request from the authors.

Table 4. Compensated, Uncompensated, and Expenditure Elasticities from Models 1 and 2

	Beef	Pork	Chicken	Turkey
Model 1: Meat Separable	*Uncompensated Elasticities*			
Beef	−1.274	0.298	−0.281	0.199
Pork	0.784	−2.595	0.590	0.135
Chicken	−0.548	0.531	−1.105	0.223
Turkey	2.273	0.611	1.081	−3.534
	Compensated Elasticities			
Beef	−0.723	0.504	−0.035	0.254
Pork	1.351	−2.384	0.842	0.191
Chicken	−0.080	0.706	−0.896	0.270
Turkey	2.557	0.717	1.207	−3.506
	Expenditure Elasticities			
Beef	1.058	-	-	-
Pork	1.087	-	-	-
Chicken	0.899	-	-	-
Turkey	0.544	-	-	-

	Beef	Pork	Chicken	Other Food
Model 2: Food Separable	*Uncompensated Elasticities*			
Beef	−0.944	0.547	−0.175	2.055
Pork	1.450	−2.468	0.910	−0.802
Chicken	−0.397	0.771	−1.422	1.759
Other Food	−0.001	−0.001	0.000	−1.007
	Compensated Elasticities			
Beef	−0.947	0.545	−0.177	0.579
Pork	1.452	−2.467	0.910	0.104
Chicken	−0.398	0.770	−1.423	1.051
Other Food	0.001	0.000	0.001	−0.004
	Expenditure Elasticities			
Beef	−1.482	-	-	-
Pork	0.910	-	-	-
Chicken	−0.711	-	-	-
Other Food	1.008	-	-	-

Notes: The elasticities are point estimates calculated using the mean expenditure share.

alternatively find similar own-price elasticity estimates for beef and chicken and substantially more elastic estimates for turkey. It is further worth highlighting that each own-price elasticity estimate we have derived is larger than most found in the current literature. These differences may stem not only from differences in data sources, as established by Rojas, Andino, and Purcell (2008) but also from variations in time periods considered (we evaluate a comparatively shorter period) and model specifications employed.

Parameter estimates for Model 1 do not provide support for any changes in consumption or substitution patterns between beef, pork, chicken, and turkey for the period following implementation of MCOOL regulations. The individual coefficients for the MCOOL parameter, Z_{it}, are individually and jointly not different from zero at a statistically significant level. While these results support a conclusion of no impact from MCOOL, further investigation is warranted to determine whether certain assumptions of the specification of Model 1 are affecting the results.

Food Separable Model

The partitioning of the meat and poultry products in Model 1 and the assumption of a weakly separable meat-demand system limit our analysis of consumer behavior with regard to MCOOL. It is possible that information provided by MCOOL has caused consumers to increase or decrease expenditures on meat and poultry products, a possibility not examined in Model 1. Weak separability assumptions for a food-demand system, however, will allow us to explore this possible change in consumption. Model 2 is estimated by partitioning consumer purchases into the following categories: beef, pork, chicken, and all other food (including turkey). As with turkey in Model 1, the fourth category is exempt from MCOOL.

Estimating this model requires data on food purchases not contained in the Fresh Look Marketing Group dataset. Following Tonsor and Olynk (2011), a proxy for all food purchases was created using national data on food expenditures and consumer price indices. Other food expenditures were obtained from the Bureau of Economic Analysis (BEA), and consumer price indices were collected from the Bureau of Labor Statistics (BLS). Expenditures on all other food were obtained by subtracting beef, pork, and chicken expenditures, as measured by the scanner data, from total food expenditures, as measured by the BLS. Other food quantity is the total food quantity (BLS total food expenditures divided by the consumer price index for food) less the sum of beef, pork, and poultry quantities from the scanner data. Prices for the other food categories are the ratio of other food expenditures to other food quantity. Summary statistics of the data used to estimate Model 2 are given in table 1 and expenditure shares are presented in table 2.

As with Model 1, the estimated parameters of Model 2 fail to support a systematic change in consumer behavior in the period following MCOOL implementation (see table 3). The MCOOL parameters are not statistically different from zero in both individual and joint tests. Failure to find evidence of any alteration in consumer behavior as a result of MCOOL regulations using a model that accounts for a greater diversity of product choice lends support to the results of Model 1.

Beef Product-Level Models

The final model specification presented here appeals to the work of Nayga and Capps (1994), who found that the weak separability assumption does not extend to cuts of meat. Models 3 and 4 are estimated using the following partition: beef loin, ground beef, all other beef products, and an "other" category that varies depending on the separability assumption employed. Our interest in estimating a model where beef cuts are estimated individually stems from the nature of beef processing.

Beef-packing plants typically operate on slim margins, making efficiency a core driver of production practices. Ground beef is a product made largely from carcass trimmings, not whole muscle cuts. As a result, beef is mixed together from many different carcasses prior to grinding. This grinding process likely makes tracking the carcasses used and their country of origin more costly than other beef products. Whole muscle cuts like the loin do not get mixed in the same manner. This difference reduces the cost of tracking and labeling country of origin, as compared to ground beef. Moreover, the processing industry has historically imported beef trimmings to increase leanness in ground products and has not traditionally imported much in the form of whole muscle products such as loin.

Models 3 and 4 are specified to test whether there have been impacts on the consumption patterns of different beef products. Model 3 assumes a meat separable partition containing beef loin, ground beef, all other beef, and all other meat (the total of pork, chicken, and turkey). The summary statistics and expenditure shares for the variables in Models 3 and 4 are given in tables 1 and 2, respectively. For Model 4, a food separable assumption is made and the partition of categories includes beef loin,

Table 5. Estimated Rotterdam Demand Models 3 and 4

Model 3: Meat Separable - Beef Cuts			Model 4: Food Separable - Beef Cuts		
Variable	**Coefficient**	**Std Err**	**Variable**	**Coefficient**	**Std Err**
α_{Ln}	-0.00873^{***}	0.00224	α_{Ln}	-0.00005^{***}	0.00001
α_{GB}	-0.00036	0.00186	α_{GB}	-0.00002^{*}	0.00001
α_{OB}	0.00491	0.00368	α_{OB}	0.00003^{*}	0.00002
β_{Ln}	0.12702^{***}	0.00773	β_{Ln}	-0.00280^{***}	0.00040
β_{GB}	0.18982^{***}	0.00664	β_{GB}	-0.00432^{***}	0.00047
β_{OB}	0.22797^{***}	0.01730	β_{OB}	-0.00567^{***}	0.00062
c_{Ln}	-0.21490^{***}	0.03760	c_{Ln}	-0.00093^{***}	0.00015
$c_{Ln,GB}$	0.00903	0.02270	$c_{Ln,GB}$	0.00005	0.00016
$c_{Ln,OB}$	0.01308	0.02820	$c_{Ln,OB}$	0.00033^{*}	0.00020
c_{GB}	-0.20333^{***}	0.04640	c_{GB}	-0.00054	0.00041
$c_{GB,OB}$	-0.10794^{***}	0.03780	$c_{GB,OB}$	-0.00028	0.00021
c_{OB}	-0.21732^{***}	0.05740	c_{OB}	-0.00035	0.00033
d_{Ln1}	0.01231^{***}	0.00355	d_{Ln1}	0.00006^{***}	0.00002
d_{Ln2}	0.01672^{***}	0.00268	d_{Ln2}	0.00009^{***}	0.00001
d_{Ln3}	0.00376	0.00281	d_{Ln3}	0.00002	0.00002
d_{GB1}	0.00022	0.00206	d_{GB1}	0.00001	0.00002
d_{GB2}	-0.00032	0.00248	d_{GB2}	0.00002^{*}	0.00001
d_{GB3}	0.00116	0.00213	d_{GB3}	0.00000	0.00003
d_{OB1}	-0.00895	0.00779	d_{OB1}	-0.00005^{**}	0.00002
d_{OB2}	-0.00854^{*}	0.00426	d_{OB2}	-0.00004^{*}	0.00002
d_{OB3}	-0.00467	0.00637	d_{OB3}	-0.00003	0.00003
μ_{Ln}	0.00056	0.00125	μ_{Ln}	0.00001	0.00001
μ_{GB}	0.00052	0.00095	μ_{GB}	0.00002	0.00001
μ_{OB}	0.00021	0.00244	μ_{OB}	0.00002	0.00002
rho	-0.55875^{***}	0.11470	*rho*	-0.41191^{***}	0.12690
LL	570.93		*LL*	1,330.31	
R^2_{Ln}	0.96		R^2_{Ln}	0.93	
R^2_{GB}	0.99		R^2_{GB}	0.95	
R^2_{OB}	0.95		R^2_{OB}	0.93	
Wald test:	0.50			2.96	

Notes: Ln is loin, GB is ground beef, and OB is all other beef. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively. A restricted diagonal autocorrelation correction was made to all models (preferred by LR tests). The omitted equation for Model 3 is other meat and for Model 4 is other food. The null hypothesis tested by the Wald statistic is: $\mu_{Ln} = \mu_{GB} = \mu_{OB} = 0$. The 95% χ^2 critical value of the Wald test statistic is 7.81 with 3 degrees of freedom.

ground beef, all other beef, and all other food. As with Model 2, the other food category is calculated using BEA food expenditures and BLS price indices to estimate the model parameters.

The parameter estimates for Models 3 and 4 are presented in table 5, and the elasticities of Models 3 and 4 are shown in table 6. As with the previous models, there appears to be no statistically significant impact from MCOOL on purchases of individual beef products or the aggregated categories of meat and other food.

Model Specification Sensitivity

By appealing to previous work on the validity of weak separability holding for both meat and food separable demand systems, we have expanded the analysis to allow for multiple possible manifestations of MCOOL impacts on consumer demand for meat. However, other assumptions in the estimated models may affect the results. For example, the variable representing the imposition

Table 6. Compensated, Uncompensated, and Expenditure Elasticities from Models 3 and 4

	Beef Loin	Ground Beef	Other Beef	Other Meat
Model 3: Meat Separable-Beef Cuts		*Uncompensated Elasticities*		
Beef Loin	−2.011	−0.136	−0.121	1.155
Ground Beef	−0.065	−1.242	−0.766	1.091
Other Beef	−0.061	−0.718	−1.254	0.956
Other Meat	0.293	0.446	0.449	−1.493
		Compensated Elasticities		
Beef Loin	−1.884	0.079	0.115	1.690
Ground Beef	0.047	−1.052	−0.558	1.564
Other Beef	0.062	−0.510	−1.026	1.474
Other Meat	0.401	0.629	0.649	−1.038
		Expenditure Elasticities		
Beef Loin	1.114	-	-	-
Ground Beef	0.982	-	-	-
Other Beef	1.076	-	-	-
Other Meat	0.947	-	-	-
Model 4: Food Separable-Beef Cuts		*Uncompensated Elasticities*		
Beef Loin	−0.510	−1.026	1.474	0.000
Ground Beef	0.629	0.649	−1.038	0.000
Other Beef	0.000	0.000	0.000	0.000
Other Food	-	-	-	0.000
		Compensated Elasticities		
Beef Loin	0.000	0.000	0.000	0.000
Ground Beef	0.000	0.000	0.000	0.000
Other Beef	0.000	0.000	0.000	0.000
Other Food	0.000	0.000	0.000	0.000
		Expenditure Elasticities		
Beef Loin	−1.242	-	-	-
Ground Beef	−0.718	-	-	-
Other Beef	0.446	-	-	-
Other Food	0.000	-	-	-

Notes: The elasticities are point estimates calculated using the mean expenditure share.

of MCOOL is defined as a binary variable that "switches on" for observations occurring after March 2009. This specification represents an immediate and permanent change in consumer behavior at that point in time. Recognizing that it is possible for an MCOOL effect to be temporary or change over time, we follow the assessment of consumer response to MCOOL for seafood by Kuchler, Krissoff, and Harvey (2010). We specify the variable Z_{it} as a binary variable equal to 1 for the six-month period following MCOOL implementation (and 0 otherwise) to reflect temporary changes in consumer behavior that may result from unfamiliarity with the label changes from policy implementation. We also test a specification of the variable Z_{it} set equal to 0 for the months prior to March 2009 and equal to a linear trend starting in March 2009 to reflect changing behavior over time. These changes may be due to increased awareness as consumers begin to learn more about the policy and the meanings of the new labels. Models 1 to 4 were estimated using these alternate specifications for the MCOOL variable. As with the previous models, impacts on consumer behavior from MCOOL were not statistically different from zero, either individually or jointly.

Another element of the analysis that may be sensitive to modeling specifications was the choice to estimate all the models using data aggregated to a national level. It is possible that consumers in some parts of the country are more or less sensitive to the information provided by MCOOL, but these effects either offset each other or are not large enough to detect using national-level data. The scanner data were available disaggregated into eight regions of the United States: California, Great Lakes, Midsouth, Northeast, Plains, South Central, Southeast, and West. Models 1 and 2 were re-estimated for each region to determine whether MCOOL impacted consumption of meat across different regions of the country.[2] As with the national-level models, no statistically significant effect was found in any of the individual regions, providing further evidence that consumers did not make a measurable change in their consumption behavior with regard to beef, pork, or chicken as a result of MCOOL regulations.

Implications

If MCOOL implementation created benefits for U.S. consumers by filling an information gap with valued information that the market was not voluntarily providing to consumers, then one would expect to observe a response in the demand for covered products. This study used retail grocery-store scanner data of covered products to examine consumer response to the implementation of MCOOL. We applied multiple approaches varying in imposed separability, geographic region considered, and time paths of possible impacts. Across a multitude of evaluations, no evidence of a change in demand following implementation of MCOOL was found.

Perhaps more importantly to industry stakeholders, our finding of no identifiable increase in demand suggests a net economic welfare loss has followed implementation of MCOOL. While estimates of implementation costs vary, they are certainly non-zero. Coupling this situation with no evidence of an increase in demand for covered products suggests producers and consumers have experienced a welfare loss. Going further, existing studies indicate that implementation costs have been lower for the chicken industry, suggesting that stakeholders in the beef and pork industries are comparatively worse off.

Our findings are in line with a variety of studies suggesting MCOOL impacts are unlikely to be significant. The warning offered by Plain and Grimes (2003) notes that a lack of demand response is less surprising when one appreciates the predominance of domestic sourcing for most covered products that has characterized the U.S. meat market for decades. Other studies suggest that U.S. consumers are either generally unaware of MCOOL (Allen et al., 2011; Tonsor, Schroeder, and Lusk, forthcoming) or report that origin information is not as important as other issues such as safety and price (e.g., Lusk and Briggeman, 2009). More narrowly, the finding of no impact is consistent with the argument that voluntary labeling by country of origin would have occurred if it were economically beneficial to do so (Lusk and Anderson, 2004; Lusk et al., 2006).

In addition to these domestic welfare implications, this study is important in the realm of international trade. These results provide useful information in the ongoing process of resolving the multiyear WTO dispute over MCOOL. The absence of an increase in demand by U.S. consumers for covered products suggests that any attempt to maintain MCOOL would result in aggregate welfare loss not only within the United States but also with key trading partners.

It is our desire that future discussions specific to origin labeling—and mandatory labeling of food products more broadly–take note of our findings. Careful consideration of possible implications is needed prior to implementation to reduce the probability of negative economic welfare outcomes.

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[2] Models 3 and 4 could not be estimated at the regional level, because the data from BEA and BLS are not available for the corresponding regions.

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