Impact of Changes in Dietary Preferences on U.S. Retail Demand for Beef: Health Concerns and the Role of Media

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Abstract

The goal of this study is twofold: to determine if in the long run health concerns affect, via changes in consumer dietary preferences, the retail demand for beef in the United States and to establish if media coverage of popular diets (media frenzy) causes the change in retail demand for beef, or if it simply reports the facts about the changes in consumer dietary preferences. Data used in the analysis are the quarterly retail demand index for beef and the number of newspaper articles and magazine features on low-fat, low-cholesterol and low-carb diets published in the United States between 1990:I and 2004:IV. Johansen's cointegration method and vector error correction (VEC) model based Granger causality test were used in the long-run and short-run analysis respectively. The results indicate that health concerns are an important demand shifter for beef in the long run. In the short run, media serves as a trigger that will swing people to become followers of a certain diet.

Key words: Health concerns, media, demand for beef, cointegration, VEC, Granger causality

JEL: D12, Q13

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1. Introduction

U.S. beef producers have faced significant and serious decline in the domestic

demand for beef products between 1980 and 1998. According to Schroeder (2000) and

Marsh (2003), per capita retail beef demand declined by almost 50 percent between 1980

and 1998. In 1998 a Beef Demand Study Group (BDSG) was formed in an attempt to

stabilize or increase consumer demand for beef. Since a measure of demand was needed,

BDSG economists developed an annual retail beef demand index with the series starting

in 1980 (Genho, 1998). The index measures yearly shifts in retail beef demand. Its

purpose was to be used for planning and budgeting in accomplishing the BDSG goal.

This index showed a steady decline in the retail demand for beef. Similar results can be

found in the publications by the Virginia Tech's Research Institute on Livestock Pricing

(RILP) (www.aaec.vt.edu/rilp/demandtop.html). Several studies have documented

negative structural shifts in retail beef demand (*e.g.*, Eales and Unneveher, 1988, 1993;

Moschini and Meilke, 1989; Purcell, 1989; Purcell and Lusk, 2003; Schroeder, 2000).

These negative structural shifts were attributed to a number of factors including changing

demographics, changing consumer preferences (*e.g.*, food safety, health, or inconsistent

quality), or relative meat prices.

A different phenomenon became observable in the late 1990s and during the first

four years of this decade. According to BSDG or RILP (2004), retail demand index for

beef increased rather significantly during that period of time. While this positive

structural shift has not been formally analyzed yet, it has been speculated that the

popularity of so called low-carb diets is responsible for it (*e.g.*, Plain, 2004). Considering

the fact that the majority of Americans (61 percent) today are either overweight or obese

[Center for Disease Control (CDC) Behavioral Risk Survey, 2003], it comes as no

surprise that many of them are on a weight-reducing diet program of some sort. While

the early 1990s brought a low-fat, low-cholesterol bonanza, the New Diet Revolution of

Dr. Robert Atkins has certainly been the most popular diet in the United States during the

last 5-6 years. This diet is one of the so called low-carb diets. More than 17 percent of

Americans were on the Atkins or some other low-carb diet in 2004

http://www.acnielsen.com). The low-carb diet limits the intake of carbohydrates

(primarily grains and vegetables) while promoting the increase in consumption of other

foods (primarily meat and dairy).

The goal of this study is twofold. First, we are to determine if in the long run

health concerns affect, via changes in consumer dietary preferences, the retail demand for

beef in the United States. Second, it is stipulated that popular diets (such as low-fat, low-

cholesterol or low-carb diets) reflect the popular perception about the "healthy life style."

The related goal, therefore, is to establish if media coverage of popular diets (media

frenzy) causes the change in retail demand for beef, or if it simply reports the facts about

the changes in consumer dietary preferences.

The paper is organized as follows. Section 2 discusses the causes of the increase

in obesity in the United States and some of its social and economic implications. The

long-run link between consumer health concerns and demand for beef is established in

section 3. Section 4 determines the causality between the media coverage of specific diet types and the demand for beef. Finally, section 5 concludes.

2. Obesity in the United States – Social and Economic Implications

According to the Surgeon General's report (2001), 61 percent of adults in the United States were overweight or obese. Obesity is measured commonly by the body mass index (BMI) which is weight in kilograms divided by height in meters squared. The convention is that overweight people have s BMI above 25, while obese people have a BMI above 30. Thirteen percent of children aged 6 to 11 years and 14 percent of adolescents aged 12 to 19 years were overweight in 1999. This prevalence has nearly tripled for adolescents in the past 2 decades. The increases in overweight and obesity cut across all ages, racial and ethnic groups, and both genders. Approximately 300,000 deaths each year in the United States are associated with obesity. Obesity and being overweight are associated with heart disease, certain types of cancer, type 2 diabetes, stroke, arthritis, breathing problems, and psychological disorders, such as depression.

According to a few estimates, economic cost of obesity in the United States was about $117 billion in 2000 alone (*e.g.,* Lakadawalla and Philipson, 2002; Anderson, Butcher, and Levine, 2003; Cutler, Glaeser, and Shapiro, 2003). The direct cost of obesity-related disease was estimated at $61 billion, while indirect costs were estimated at $56 billion. Direct costs, for instance, are healthcare costs associated with physician visits and hospitalizations. Indirect costs are the value of lost wages by those who cannot work due to sickness or disability and foregone earnings due to premature death. Furthermore, overweight and obese people receive lower wages than those without

weight problems. This may be because obesity-related illness reduces productivity or because of employer discrimination (Averet and Korenman, 1996; Cawley, 2000). Next, Cutler, Glaeser, and Shapiro (2003) argue that there might be 'internalities,' the costs borne by individuals themselves because of their higher weights. These internalities exist in the presence of self-control or addiction problems: people would like to eat less than they do, but have difficulty limiting their consumption. They are similar to externalities because they result from individuals who are consuming food and not internalizing the impact on their future happiness.

Cutler, Glaeser, and Shapiro (2003) further argue that people are willing to spend large amounts of money to try to lose weight. They present survey evidence that desired BMI rises much more slowly than actual BMI, indicating that most overweight people would like to weigh less than what they do. If their finding is correct, there are two ways to accomplish the goal of losing weight. Considering the basic relationship of calories in versus calories out, people get heavier if they consume more calories or expend fewer calories. But many people are unwilling or unable to make the sacrifice of eating less and/or exercising more, and the actual question they are asking is: How can I lose weight without eating less and/or exercising more? This is the point where many dietary wizards come into place with proposed diets, often based on questionable scientific studies, which will supposedly resolve the problem of obese and overweight people. The solution they often propose is to change the diet. The same foods have often been "healthy" at one time and "unhealthy" at a different time. Beef is one of the prime examples: it has been the main culprit in the low-fat, low-cholesterol boom during the early and mid 1990s, and the food of choice during the low-carb diet domination in the late 1990s and early 2000s.

In this rollercoaster process, individual agricultural industries, including the beef industry, went through both major adversity and prosperity periods.

3. *The Health Concerns and Demand for Beef: Long-run Link*

We will first define time frame and the variables representing retail demand for beef in the United States and consumers' dietary health concerns. The time span considered in the study is the period between 1990:I and 2004:IV. The beginning of the period is chosen because it represents the time when obesity was noticed as a potential health issue in the United States (CDC National Center for Chronic Disease Prevention and Health Promotion, http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/index.htm) and the low-fat, low-cholesterol diet became the most popular diet to promote healthy eating habits and to fight obesity.

The quarterly retail demand index for beef developed by RILP (www.aaec.vt.edu/rilp/demandtop.html) is used in this study. RILP used per-capita consumption and retail beef price data from the Livestock Marketing Information Center website (http://lmic1.co.nrcs.usda.gov/) in order to calculate the index. The index calculation is based on demand constant prices compared to 1980 (base year) using an elasticity of -0.67. Notice that the index values are a function of the -0.67 retail level demand elasticity, but the index does not change drastically for elasticity parameters of -0.5 to -0.8 which represents the range of own-price elasticities estimated in a number of influential studies on retail demand for beef (*e.g.*, Marsh, 2003; Eales and Unneveher, 1988, 1993). The index is also rescaled to 1998=100 so that the improvements since demand bottomed in 1998 can be easily monitored. For example, an index of 121.962 for 2004:I

would mean that demand in the first quarter of 2004 has increased by 21.962 percent since 1998. The index values show how demand is changing but give no information on why it is changing.

Consumers' dietary health concerns and in turn related dietary preferences are difficult to measure. Ideally, one would like to have access to the number of individuals who were on low-fat, low-cholesterol and low-carb diets during the time period under consideration. Unfortunately, there are no reliable sources which would provide the time series we need for the analysis. A good approximation for the number of people on these diets would be the number of newspaper articles and magazine features on low-fat, low-cholesterol and low-carb diets published in the United States between 1990:I and 2004:IV. The assumption here is that the newspapers and magazines will report and inform about these diets only if that represents news defined as current information and happenings or new information about specific and timely events (*Merriam-Webster's Collegiate Dictionary*, 2004). The source of this information is NewsLibrary.com (http://nl.newsbank.com), considered the world's largest news archive. Approximately 600 major newspapers and magazines published in the United States were searched for articles and features related to low-fat, low-cholesterol and low-carb diets published between 1990:I and 2004:IV. The frequencies of articles published related to these two types of diets are, therefore, considered to be two variables measuring or approximating the consumers' dietary health concerns and in turn preferences.

The underlying concept in testing for the existence of a long-run relationship between the variables representing consumers' dietary health concerns and their demand for beef is fairly straightforward. It has been long recognized that many time series

variables are non-stationary. Any equilibrium relationship among a set of non-stationary

variables implies that their stochastic trends must be linked. After all, the equilibrium

relationship means that the variables cannot move independently of each other.

Therefore, the linkage among the stochastic trends necessitates that the variables are

cointegrated (Enders, 1995; Engle and Granger, 1987; Hamilton, 1994).

Johansen's (1991, 1995) methodology is used to determine whether the group of

non-stationary series (retail demand beef index, low-carb diet number of newspaper

articles, and low-fat low-cholesterol diet number of newspaper articles) are cointegrated

or not. The presence of a cointegrating relation forms the basis of the Vector Error

Correction (VEC) specification. These are VAR-based cointegration tests. Consider a

VAR of order p:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B\, x_t + \varepsilon_t \qquad (1)$$

where y_t is a k-vector of non-stationary I(1) variables, x_t is a d-vector of deterministic

variables, and ε_t is a vector of innovations. We may rewrite this VAR as,

$$\Delta y_t = \Pi y_{t-1} + \ldots + \sum_{i=1}^{p-1} \Gamma_i\, \Delta y_{t-i} + B\, x_t + \varepsilon_t \qquad (2)$$

where:

$$\Pi = \sum_{i=1}^{p} A_i - I, \qquad\qquad \Gamma_I = -\sum_{j=i+1}^{p} A_j \qquad (3)$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist k x r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. The elements of α are the adjustment parameters in the VEC model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π.

Augmented Dickey-Fuller test (Dickey and Fuller, 1979) is used in order to test if the time series under consideration are stationary or not. The null hypothesis is one of non-stationarity or the variable having a unit root. We were unable to reject the null hypothesis for any of the three variables when tested at the levels at 5 percent significance level. After first differencing, each of the variables the null hypothesis was rejected at 1 percent significance level for all three of them. Thus, each variable is I(1). Notice that in all three cases exogenous variables were constant and linear trend. The lag length based on both SIC or AIC criteria were 6 for the Beef Index, 1 for the Low-fat, Low-cholesterol variable, and 9 for the Low-carb variable.

After establishing that all three time series under consideration are I(1), we could pursue the cointegration analysis. The results of the cointegration analysis are reported in Table 1.

(INSERT TABLE 1 HERE)

The multivariate cointegration test was carried out with one lag in differences (two lags in levels). Based on the results of both trace statistics and maximum eigenvalue statistics, we can conclude that the three variables representing consumers' dietary health concerns

and their demand for beef are cointegrated with p-values being below 0.01 considering one cointegrating vector and below 0.05 considering two cointegrating vectors.

When finding more than one cointegration vector in a multivariate system, the estimated cointegration vectors are often hard to interpret. According to Johansen and Juselius (1994), restrictions motivated by economic theory can be used to detect structural relationships in the cointegration vectors. In this case, however, there is no economic theory that would direct us towards looking more deeply into structural relationships. The lack of more precisely defined structural relationship does not represent a problem in this case since the main purpose of this portion of the analysis was to determine that these three variables are not moving independently of each other. To summarize, the two variables approximating the health-dietary concerns (*i.e.*, newspaper and magazine articles published concerning low-fat, low-cholesterol and low-carb diets) and retail demand for beef in the United States follow the same stochastic trend and are not moving independently of each other. This indicates that U.S. consumers are health concerned. They perceive how changing their dietary habit and reducing their weight is one way of improving their health. In turn, this change in dietary habits leads to a change in demand for beef.

4. The Causality between the Media Coverage of Specific Diet Types and Demand for Beef – Short-run Link

While we established the long-run link between consumers' health concerns and dietary preferences for beef, it is not clear what mechanism triggered people to change their diet from the low-fat, low-cholesterol diet scarce in beef to the low-carb diet rich in

beef. Some will argue that more frequent media reporting on these diets changed their perception about certain foods, including beef, which in turn caused a change in the amounts of beef consumed. In other words, frequent newspapers writings about low-fat, low-cholesterol diets during the early to mid 1990s induced consumers to lower their intake of all red meats and especially beef. In the late 1990s, the number of articles on low-fat, low-cholesterol diets decreased while the number of articles on low-carb diets increased. That, many believe, led to an increase in the consumption of beef. Some research pointed out how it is important to distinguish between "positive, neutral, and negative articles" when it comes to using media reports as a measure of representation or frequency of a certain phenomenon (Kalaitzandonakes, Marks, and Vickner, 2004; Marks *et al.*, 2003). We argue that unless the reporting about a certain diet is extremely negative in terms of either its effectiveness or negative health side-effects it may have, many among the 61 percent or over 150 million overweight or obese people in the United States today are willing to change their diet (*e.g.*, increase or decrease their consumption of beef or any other food) in the hope of reducing their weight and thus improving their health.

An alternative line of reasoning may suggest that media do not create the news but only report what they observe. This would mean that consumers get the dietary and health information about the latest research from medical professionals and dieticians. Consumers further follow the medical and dietary advice and change their diet accordingly. Media picks up the change at this point only. This line of reasoning would imply that the decrease in beef consumption was followed by an increase in the number of articles on low-fat, low-cholesterol diets while the increase in beef consumption was followed by an increase in the number of articles on low-carb diets.

The causality between the media coverage of specific diet types and demand for beef can be tested using the Granger approach (Granger, 1969; Hamilton, 1983, 1994). In general, the Granger approach to the question of whether x causes y is to determine how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. Y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case: x Granger causes y and y Granger causes x. This bivariate causality is exactly what we will try to determine in this case: Does the causality run: (a) from the change in the number of articles published to the change in demand for beef, (b) from the change in demand for beef to the change in the number of articles published, or (c) both ways.

Our previous results, however, prevent us from using the standard version of the Granger causality test. That is, it would be inappropriate to test for causality in levels with nonstationary series that are known to be cointegrated. The Vector Error Correction (VEC) model is appropriate in this case because it has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is called the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. We will consider here a simple case of a two variable (y_1 and y_2) system with one cointegrating equation and lagged difference terms.

$$\Delta y_{1,t} = \alpha_{1,0} + \alpha_1 (y_{2,t-1} - \beta y_{1,t-1}) + \sum \alpha_{1,1} (i) \Delta y_{1,t-i} + \sum \alpha_{1,2} (i) \Delta y_{2,t-i} + \varepsilon_{1,t} \qquad (4)$$

$$\Delta y_{2,t} = \alpha_{2,0} - \alpha_2 (y_{2,t-1} - \beta y_{1,t-1}) + \sum \alpha_{2,1} (i) \Delta y_{1,t-i} + \sum \alpha_{2,2} (i) \Delta y_{2,t-i} + \varepsilon_{2,t}. \qquad (5)$$

Again, $\varepsilon_{1,t}$, $\varepsilon_{2,t}$, and all terms involving $\Delta y_{1,t-i}$ and $\Delta y_{2,t-1}$ are stationary. Thus, the linear

combination of two variables ($y_{2,t-1} - \beta y_{1,t-1}$) must also be stationary. In this simple

model, the only right-hand side variable is the error correction term. In long run

equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long run

equilibrium, the error correction term will be nonzero and each variable adjusts to

partially restore the equilibrium relation. Finally, the coefficient α_i measures the speed of

adjustment of the i-th endogenous variable towards the equilibrium.

After estimating VEC model, one can do the Pairwise Granger causality tests. In

the context of a cointegrated system Granger causality test must be reinterpreted (Enders,

p.371). For instance, in a cointegrated system y_2 does not Granger cause y_1 if lagged

values $\Delta y_{2,t-i}$ do not enter the $\Delta y_{1,t}$ equation and if $y_{1,t}$ does not respond to the deviation

from long-run equilibrium. The appropriate test statistic is Wald (χ^2) statistic for the joint

significance of each of the other lagged endogenous variables in that equation.

The results of the Granger causality tests are provided in Table 2.

(INSERT TABLE 2 HERE)

Two sets of results that are of interest are Pairwise Grainger causality tests

between LFLC (number of newspaper articles published on the low-fat, low-cholesterol

diet) and BEEFINDEX, and LC (number of newspaper articles published on the low-carb

diet) and BEEFINDEX. The third set of results related to the Granger causality test

between LFLC and LC is not something we originally intended to do, but it turned out to

be interesting and worthy of our attention. The lag length was set at 9 to match the highest number of lags selected according to AIC or SIC criteria.

In the first case, the causality between LFLC and BEEFINDEX is examined. The presence of bivariate causality is determined. Based on the test results, we reject at 5 percent significance level the hypothesis that BEEFINDEX does not Granger cause LFLC. The hypothesis that LFLC does not Granger cause BEEFINDEX cannot be rejected at any standard significance level. These results seem to be intuitive. The low-fat, low-cholesterol diet has been around for many years. Most medical professionals will routinely advise their patients to decrease the intake of high cholesterol foods such as beef. And most patients will comply, at least to some extent. However, a steady but large number of people who follow this type of diet represent an information that media cannot ignore and therefore that is being reported by the media. Reverse causality on the other hand, running from news reports on the low-fat, low-cholesterol diet to beef demand, is not statistically significant. This result is intuitive because most people are likely to have been exposed multiple times to the information on medical benefits of the low-fat, low-cholesterol diet through either continuous coverage in the media over an extended period of time or their medical and dietary advisors. Given that this information does not represent anything new to most consumers, they may be willing to acknowledge the information but not to change their dietary habits, *i.e.*, to decrease beef consumption, because of that.

The causality between LC and BEEFINDEX is examined next. Bivariate causality is determined to exist. In other words, based on the test results we reject at 1 percent significance the hypothesis that LC does not Granger cause BEEFINDEX. This

result confirms what many have suspected: more frequent writings in newspapers about low-carb diets led to an increase in beef consumption. The writings about the Atkins diet or similar low-carb diets are a typical case of herding behavior by media. Once the news on low-carb diets was picked up by media leaders, no newspaper could afford to ignore the information. This type of herding behavior may be classified as either information or reputation-based herding (*e.g.*, Bikhchandani and Sharma, 2000). Once the media overwhelmed the public with the information on low-carb diets, many people responded by entering one of the formal low-carb diet programs or by trying to adjust their diet on their own. Low-carb diets are unorthodox and have a great deal of appeal to many of the most affected segments of the population (very overweight and obese people): they can lose weight while not eating less overall and by eating even more of the foods such as meats and dairy. While medical researchers have some doubts about long-term viability, success, and health consequences of this diet, many among more than 150 million overweight and obese Americans are not willing to wait for the "jury verdict." Ultimately, the demand for meats, and beef in particular, soared to levels higher than in years. That in turn did no go unnoticed by media. Higher consumption and demand for beef and other "healthy foods" led to more newspapers articles and media reports about low carb diet. This conclusion is supported with rejecting at 1 percent significance the hypothesis that LC does not Granger cause BEEFINDEX.

Finally, bivariate causality is determined to exist, at 1 percent significance, between LC and LFLC. This result is an interesting by-product of our investigation. Newspapers reports on low-carb diets are often coupled with writings (often

comparisons) about competing diets including low-fat, low-cholesterol diet. Thus this contemporaneous bivariate causality is a logical consequence of the newspapers writings.

5. Conclusion

Obesity became one of the main health and social concerns in the United States during the last 15 years. One of the most commonly chosen ways to fight obesity is changing dietary habits and preferences. This change is sometimes guided by medical professionals based on knowledge in medical research accumulated over many decades. Sometimes, however, people who are most endangered, *i.e.*, the most overweight and obese people, do not have the will and ability to follow medical advice and make a certain sacrifice. As an alternative to more exercising and less eating, there are many special diets that emphasize changing dietary preferences rather than decreasing the amount of food consumed. Two of the most popular and competing diets during the last 15 years have been first the low-fat, low-cholesterol diet and later the low-carb diet. As a large number of Americans adopted these diets, the consumption of different foods changed. In this research, we focused on beef and showed that it represents one of those foods whose demand fluctuated as the perception about its healthiness changed. In other words, we showed that many Americans are health concerned and have changed their diet from "healthy" low-fat, low-cholesterol (which implies low-beef consumption) to "healthier" low-carb (which implies high-beef consumption).

We determined that media reports over time, including newspaper articles and magazine features on low-carb diets, have been the trigger of change in consumers' dietary preferences. It was determined that media frenzy induces consumers to change

their diet. This led to an increase in demand for beef when the low-carb diet became

trendy.

The implications of these findings are twofold. First, health concerns are an

important demand shifter for beef (and likely some other food products) in the long run.

We showed that demand for beef first decreased and then increased due to the same

reason, *i.e.*, due to health concerns. Thus, maintaining currently existing positive image

of beef as a healthy food may be very beneficial for the beef industry. It is even more

critical for the beef industry to create this image if one knows the dependence of the beef

industry on domestic markets: less than 8 percent of beef produced in the United States is

exported (Miljkovic, Brester, and Marsh, 2003). Second, most overweight and obese

people represent a group whose health is most eroded. These people are generally more

vulnerable and likely to be influenced by various dietary or other programs that offer a

quick fix for their problem. Media serves as a trigger that will swing people to become

followers of a certain diet. Given the number of people in the United States affected with

obesity, it is irrelevant if media reports about diets such as the low-carb diet in a positive,

neutral, or moderately negative way (for as long as it is not very negative reporting).

Many people are willing to try these diets and an increase in publicity will surely lead to

the higher adoption rate of a potentially beneficial diet.

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Table 1 Cointegration Analysis - Multivariate Johansen Test

H_0: rank = p	Trace Test Statistic	0.05 Critical Value	p-value**	Max. Eigenvalue Statistic	0.05 Critical Value	p-value**
p = 0*	67.17430	35.01090	0.0000	37.62279	24.25202	0.0005
p ≤ 1*	29.55124	18.39771	0.0009	25.42513	17.14769	0.0025
p ≤ 2*	4.126115	3.841466	0.0422	4.126115	3.841466	0.0422

Both Trace and Max. Eigenvalue Tests indicate 3 cointegrating equations at the 0.05 level.

* Denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon, Haug, and Michelis (1999) p-values.

Table 2 Pairwise Granger Causality Tests

Null Hypothesis	χ^2-Statistic	p-value	d.f.
LFLC[1] does not Granger Cause BEEFINDEX[3]	5.807	0.76	9
BEEFINDEX does not Granger Cause LFLC	18.097**	0.03	9
LC[2] does not Granger Cause BEEFINDEX	23.153*	0.01	9
BEEFINDEX does not Granger Cause LC	36.667*	0.00	9
LC does not Granger Cause LFLC	29.559*	0.00	9
LFLC does not Granger Cause LC	29.007*	0.00	9

* and ** Denote statistical significance at 1 percent and 5 percent, respectively.

[1] LFLC - Number of newspaper articles published on the low-fat, low-cholesterol diet.

[2] LC - Number of newspaper articles published on the low-carb diet.

[3] BEEFINDEX – Index for retail demand for beef in the United States.