Meat and Muscle Biology™

Price Determinants of Graded Brisket

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Abstract: In 2004, beef briskets were the lowest valued primal cut on a carcass, but in recent years, briskets have been ranked as high as the 3rd most valuable cut on a carcass. In this study, we determined factors associated with wholesale graded brisket prices with a novel estimated national graded brisket supply. We used a multivariate price determination model for Prime, Choice, Select, and Ungraded brisket using monthly data from 2004 to 2019. We found that all graded brisket prices increased after Arby's introduced their brisket sandwich nationwide. Additionally, we used Google Trends data for brisket searches and found that consumer interest is also increasing brisket prices over time ($P < 0.01$). Own- and cross-price flexibilities were estimated using the quantity grade data. Choice briskets were found to have a significant own-price flexibility ($P < 0.01$) and cross-product flexibility ($P < 0.01$), which indicates that as the supply of Choice briskets changes, the price of Choice and other graded briskets changes. Cross-quantity flexibilities showed substitutes across brisket quality grades and pork shoulders ($P < 0.05$). Our results expand the BBQ literature and provide insights that are useful for market participants.

Introduction

The "low and slow" cooking method, which we refer to as BBQ-ing, is typically the preferred cooking style for primal cuts of inexpensive and undesirable meat due to their toughness (Jeremiah et al., 2003; Harris et al., 2017). Low and slow cooking can transform these cuts from being tough to a tender finished product (Jeremiah et al., 2003; Harris et al., 2017; Fletcher et al., 2021). Using a sensory panel, Harris et al. (2017) showed that BBQ-ing beef brisket increases consumer palatability in terms of juiciness and tenderness when the meat is cooked low and slow. This cooking methods adds value to underutilized muscle of the beef carcass (Jeremiah et al., 2003; Harris et al., 2017; Nyquist et al., 2018; Fletcher et al., 2021).

In recent years, there has been growing enthusiasm over "craft" BBQ at restaurants and backyard/home BBQ-ing (Goldwyn and Blonder, 2016).

Some of this interest might be explained by books and television shows, which have helped popularize this style of cooking in recent years. Texas Monthly magazine, which is famous for their quadrennial ranking of the Texas top 50 BBQ restaurants, heralded 2017 as the "golden age" in BBQ (Texas Monthly, 2018). In 2018, the National Restaurant Association surveyed nearly 700 professional chefs and asked them to forecast new culinary trends, and 27% of the respondents classified BBQ as a hot trend (National Restaurant Association, 2018). Additionally, hardware used for BBQ-ing, typically called a smoker, has helped make backyard/home BBQ-ing more convenient and doable. Another source of growing BBQ enthusiasm is restaurants and chefs including BBQ meats on menus (Harris et al., 2017). Along with these venues, quick service restaurants such as Arby's and Subway have introduced a slow-smoked brisket sandwich to their menu in recent years (Harris et al., 2017).

The introduction of a slow-smoked sandwich by Arby's in 2014 was a unique product to the quick service food industry and alternative to a traditional roast beef sandwich.

As BBQ popularity has grown, there have been some interesting changes in wholesale brisket prices. In 2004, beef briskets were the lowest valued primal cut on a carcass (Clark, 2017). By 2019, briskets reached as high as the third highest valued cut, after only the rib and loin (Clark, 2017). The increasing popularity of BBQ-ing and relative values of briskets raise interesting and important questions about drivers of brisket price changes and how different quality graded brisket prices are affected by these changes.

Studies have examined the impact of advertising, Checkoff programs, new market entrants, animal disease, and food safety on price changes of various proteins such as beef, chicken, pork, and lamb (Marion and Walker, 1978; Wohlgenant and Mullen, 1987; Capps et al., 1994; Lusk et al., 2001; Tonsor et al., 2010). These studies were informative in understanding drivers of meat demand, but a common limitation of these studies is the aggregation of beef cuts from the carcass and quality grade (Marion and Walker, 1978; Wohlgenant and Mullen, 1987; Capps et al., 1994). For example, Capps et al. (1994) estimated wholesale level elasticities for cuts of beef, chicken, and pork; however, this study did not consider price differentiation and supplies by quality grade (i.e., Prime, Choice, Select) of beef.

Unlike other wholesale primal cuts that are further broken down into many retail cuts during fabrication, briskets are a primal cut that is commonly sold as the whole primal cut. Therefore, knowing the number of head slaughter and their respective grade yields the supply of briskets by quality. Analyzing changes in wholesale graded brisket prices and using an estimated graded brisket supply are unique contributions to the meat demand literature, particularly the wholesale meat demand literature.

The objective of this study is to determine factors that have impacted wholesale graded brisket prices. We estimate a multivariate price determination model for Prime, Choice, Select, and Ungraded brisket using monthly data from 2004 to 2019. A unique contribution of this paper is the development of a graded brisket supply as an explanatory variable. Additionally, we include Google Trends data as a proxy for consumer interest in briskets, and a variable for the impact of a quick service restaurant chain offering brisket on their menu. We hypothesize that the introduction of a brisket in the quick service restaurant chain increased brisket prices. Also, we hypothesize that

consumer interest is also increasing brisket prices. This study utilizes a novel estimate of national graded brisket supply as well as focuses on a unique cut of meat that is growing in popularity.

Materials and Methods

Data

Nominal monthly graded brisket prices ($/tonne) were collected from January 2004 to February 2019 from United States Department of Agriculture (USDA) Agricultural Marketing Service (2019) and compiled by the Livestock Marketing Information Center. Figure 1 displays the monthly choice beef primal prices during this period. Most prices across the cattle and beef complex peaked in 2014 following the 2010–2012 drought, which is reflected in the increase seen in the primal cuts. Coming off the peak prices, the rib and loin cuts maintained their presence as the top 2 valued primal cuts. However, the pre-2014 pattern of brisket being a low valued cut did not hold. Brisket prices continued to increase relative to other cuts and the carcass cutout. We hypothesize that Arby's entrance into the brisket market influenced prices; therefore, we utilize an Arby's dummy variable in our estimation.

As mentioned, a past limitation of analyzing price determinates of quality grade beef is not having a disaggregated supply by quality grade and cuts of meat. That is, it is hard to estimate exact pounds of Prime, Choice, and Select graded loins and ribeyes due to how these primals are fabricated into steaks and other retail cuts. However, briskets are a unique cut to analyze since there are 2 per beef animal slaughtered and they are sold at the retail level with very little fabrication relative to other beef cuts between wholesale
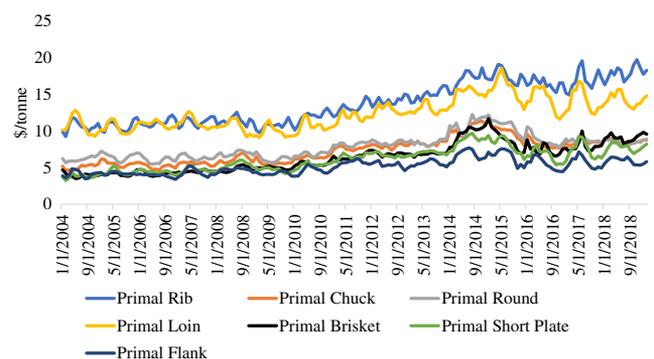
Figure 1. Monthly choice primal cut price ($/tonne) from January 2004 to February 2019.
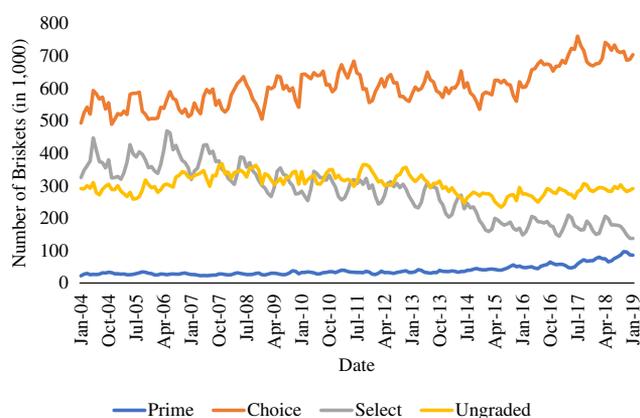
Figure 2. Monthly quantity of (number of briskets in 1,000) for beef briskets from January 2004 to February 2019 by grade.

and retail. In this study, we attempt to quantify brisket supply by quality grade by estimating the total number of briskets. The brisket supply estimation multiplies the total number of monthly head slaughtered by 2 for each quality grade. The monthly number of head slaughtered, and the percentage of quality graded carcasses, was collected from January 2004 to February 2019 from the monthly slaughter report provided by the USDA National Agricultural Statistical Service (2019). Figure 2 shows quantities of briskets by quality grade during the study period. Brisket supplies by quality grade have shifted over time along with the normal seasonal and cyclical changes. Over time, the number of cattle grading Choice and Prime have increased, while cattle grading Select have declined. Choice still makes up most of all brisket supply, and Prime makes up the least of all briskets. However, in 2014 the quantity of Select grade briskets were less than the Ungraded briskets.

Pork is an important BBQ alternative to briskets. Pork shoulders, for example, also benefit from low and slow BBQ-ing techniques and have been regarded as a predominant cut to be BBQ-ed (Goldwyn and Blonder, 2016) and are a popular BBQ meat in other regions of the country. Like beef, every pork carcass has 2 shoulders, which are primal cuts. We include pork shoulder quantity in our model as a BBQ alternative to briskets. We recognize other cuts, such as pork ribs, could be substitutes to briskets. However, ribs, for example, are processed into various cuts (e.g., baby back, St. Louis, and spare) between fabrication and retailer. Thus, while they are possible substitutes for a brisket, we only considered pork shoulders as a substitute to brisket because it is a primal cut. The same assumption of pork shoulder quantity supply is made for pork shoulders as beef briskets. That is, the number of pork shoulders is determined by multiplying

the number of hogs slaughtered by 2. The monthly number of head slaughtered was collected from January 2004 to February 2019 from the monthly slaughter report provided by the USDA National Agricultural Statistical Service (2019) compiled by the Livestock Marketing Information Center. An aspect of the hog industry that differs from the beef industry is that there is no quality grade system in place for pork carcasses; therefore, we assume that pork shoulders are homogenous in nature.

Others have considered that media attention around health or food safety can impact meat demand (Tonsor et al., 2010; Yadavalli and Jones, 2014). These studies typically use the number of times a word or phrase was mentioned in a news article as a variable affecting prices or demand. In our case, instead of news mentions, the number of times the word "brisket" is searched in Google is used as an explanatory variable. We use Google Trends data to arrive at the number of searches for brisket. Google Trends data represent search interest relative to the highest point in each period or region. Mccallum and Bury (2013) showed that search behavior by the public is closely related to their interests. A value of 100 represents peak interest, and zero represents no interest. Figure 3 displays the Google Trends data during the period analyzed in this study. The figure shows the search for brisket has increased over time, suggesting growing interest in eating and preparing briskets. By using the "brisket" search variable, it captures anything related (bad and good) to briskets. By keeping it broad, we avoid bias issues and aggregation of search terms issues. Summary statistics for dependent and independent variables used in this analysis are shown in Table 1. As anticipated, Prime graded briskets had the highest average price followed by Choice, then Select, and finally Ungraded.
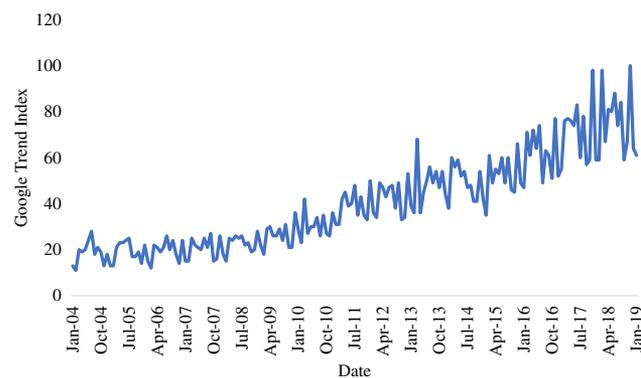
Figure 3. Google trends index data for search "Brisket" from January 2004 to February 2019 across the United States.

Table 1. Dependent and independent variables definition and summary statistics for brisket quantities and prices

Variable	Definition	Mean	Standard Deviation
	Dependent Variable		
P^P	Prime Grade Brisket Price ($/tonne)	6.37	1.97
P^C	Choice Grade Brisket Price ($/tonne)	6.36	1.96
P^S	Select Grade Brisket Price ($/tonne)	6.32	1.95
P^{UG}	Ungraded Grade Brisket Price ($/tonne)	6.31	1.91
	Independent Variables		
q^P	Number of Prime Grade Briskets (in 1,000)	38.75	15.71
q^C	Number of Choice Grade Briskets (in 1,000)	605.68	59.02
q^S	Number of Select Grade Briskets (in 1,000)	281.32	83.03
q^{UG}	Number of Ungraded Grade Briskets (in 1,000)	303.92	29.34
q^k	Number of Pork Shoulder (in 1,000)	9,284.85	778.94
δ_t	Arby's introduction of their Brisket Sandwich	0.34	0.48
G	Index value ranging from 0 to 100 representing search interest for "brisket" in the United States from January 2004 to February 2019	40.03	20.43
T	Time Trend		
T^2	Time Trend Squared		

Estimation

A common challenge in estimating meat demand or price differentiation by beef products is finding appropriate price and quantity data (Wohlgenant and Mullen, 1987; Capps et al., 1994; Lusk et al., 2001; Hahn and Mathews, 2007; Tonsor et al., 2010). This has resulted in several different methods being used to explore demand for beef products that conform to the available data (Hahn and Mathews, 2007). Some studies have attempted to recognize the quality variation of beef in their model (Capps et al., 1994; Lusk et al., 2001; Hahn and Mathews, 2007). Quality variation has been considered in forms of meat products such as ground beef and table cuts, but this approach assumes that demand across quality grades is homogeneous (Capps et al., 1994). Conversely, others have considered quality variations using quality grades such as Choice and Select, but this approach assumes homogeneous demand across cuts (Lusk et al., 2001; Hahn and Mathews, 2007). Additionally, when quality grade is considered in these demand models, the quantity or supply is not disaggregated by quality grade, causing data aggregation issues for modeling demand.

Like Capps et al. (1994), we are interested in production and price impacts of quality grade on a specific cut of meat (brisket). Therefore, we used a multivariate price-determination model like Capps et al. (1994); however, unlike past demand studies, we can disaggregate quantity by quality grade. Also, we estimate 4 equations simultaneously considering correlation in the error terms for Prime, Choice, Select, and Ungraded brisket prices as the dependent variables.

Additionally, the quantity of briskets by quality grade are independent variables for each equation, as are the quantity of pork shoulders. One assumption of our model is that the brisket substitute will be pork shoulders.

Mathematically, our model is defined as $\ln(P_t^G) = \beta_0^G + \beta_1^G \ln(q_t^P) + \beta_2^G \ln(q_t^C) + \beta_3^G \ln(q_t^S) + \beta_4^G \ln(q_t^{UG}) + \beta_5^G \ln(q_t^k) + \beta_6^G \ln(G_t) + \beta_7^G \delta_t + \sum_{m=1}^{11} \beta_{7+m}^G \gamma_{mt} + \beta_{19}^G \ln(T_k) + \beta_{20}^G \ln(T_k^2) + \varepsilon_t^G$, where P_t^G is the price per hundredweight for quality grade G (G = Prime, Choice, Select, and Ungraded) in time period t ($t = 1, \ldots, N$); q_t^P, q_t^C, q_t^S, q_t^{UG}, and q_t^k are quantity (total number available) produced of Prime grade brisket, Choice grade brisket, Select grade brisket, Ungraded brisket, and pork shoulder, respectively; G_t is Google Trends index data for brisket searches in the United States; δ_t is an indicator variable equal to 1 if date is post 2014; γ_{mt} are indicator variables for months; T_k are year time trend variables for year k ($k = 1, \ldots, K$); ε_t^G is the error term; and $\beta_0^G, \ldots, \beta_{20}^G$ are coefficients to be estimated. The errors are assumed multivariate normal (Greene, 2016). The introduction of the Arby's brisket sandwich in 2014 was included in our model (δ_t) as well as dummy variables for each month to consider season variability. We tested for heteroskedasticity using White's test (Greene, 2016), and results were presented using heteroskedasticity-consistent errors. The mvreg command in STATA 16 was used to estimate the model. We also perform pairwise comparisons across models to determine whether estimated coefficients are different.

By taking the natural log transformation of prices and quantities, we can determine flexibilities (Capps et al., 1994). For example, the estimated coefficient

for brisket quantity indicates a percentage change in brisket price when quantity changes. Indicator variables can be transformed to indicate the percentage change in wholesale price relative to the base (Capps et al., 1994). For example, the seasonal indicator variable can describe the percentage change in brisket price by grade relative to December. Google Trends data are an index as described in the data section, and the interpretation of a magnitude effect of a percentage change in graded brisket prices based on this index is not straightforward. However, an understanding the directional impact is of interest. Therefore, a positive (negative) coefficient will indicate an increase (decrease) in graded brisket prices with an increase in Google searches for brisket.

Results and Discussion

Table 2 shows the correlation coefficient for the error terms across the models as well as the R-squared and number of observations. Correlation was positive and significant across the error terms, which was anticipated and validates the need for the multivariate model.

The results from the estimated econometric model are contained in Table 3. Own-quantity flexibilities for each grade are shown by the quality grade supply coefficients, which are the same as the quality grade price in the equation. For example, the own-price flexibility of Choice grade briskets is −0.9860. This means that a 1% increase in the supply of Choice grade briskets decreases Choice brisket price by 0.986%. Unlike Capps et al. (1994), we found own-quantity flexibility to be significant for Choice briskets. Choice graded briskets were the only grade to be found significant. Choice quantity was also the only graded brisket supply to have a significant impact on other quality grades. The majority of briskets grade Choice, and these findings suggest that prices (regardless of grade) are

impacted by and responsive to the large supply of Choice briskets in the supply chain. Buyers in the brisket market inherently have a budget constraint, and our results indicate that when Choice brisket quantity increases by 1%, Prime prices decrease by 0.97%, Select Prices decrease by 0.93%, and Ungraded prices drop by 0.91%. Prime, Select, and Ungraded briskets were found to not be statistically impacted by graded brisket prices. This could be a function of low supply numbers for each grade and that brisket buying is contingent on Choice price and quantity.

Shoulder quantity had a significant negative impact on all grades of brisket prices. This supported the hypothesis that shoulders and briskets are substitutes. Capps et al. (1994) did not find any cross-product flexibility in their estimation between pork and briskets. The effect of pork shoulder quantities on brisket prices ranged from −0.366 (Prime brisket price) to −0.438 (Ungraded brisket price). This means a 1% increase in the quantity of pork shoulders results in a decrease of 0.44% in Ungraded brisket price. We tested parameter estimates across the equations to determine whether they were equal and failed to reject the null hypothesis. We can observe that, as grade quality decreases from Prime to Ungraded, the impact of pork shoulder supply on brisket prices increases on average. Perhaps this means that pork shoulders are more of a substitute for Ungraded briskets than Prime briskets.

Google Trends and Arby's had significant positive impacts on the price of all grades of brisket. The Google Trends variable revealed that, as interest increases, brisket prices increase as well. Therefore, it seems like increasing consumer interest in brisket could explain some of the recent increase in brisket prices. This could indicate that, as more marketing efforts are put toward briskets and/or graded briskets, demand can increase, which increases price.

Similarly, we tested for differences in parameter estimates for the indicator variable when Arby's

Table 2. Correlation coefficients for error term across models and goodness of fit the wholesale graded brisket model

Variable	Prime Grade Brisket Price ε^P	Choice Grade Brisket Price ε^C	Select Grade Brisket Price ε^S	Ungraded Grade Brisket Price ε^{UG}
Prime Grade Brisket Price ε^P	1.000	-	-	-
Choice Grade Brisket Price ε^C	0.999***	1.000	-	-
Select Grade Brisket Price ε^S	0.9950***	0.9951***	1.000	-
Ungraded Grade Brisket Price ε^{UG}	0.9917***	0.9917***	0.9952***	1.000
R^2	0.907	0.906	0.905	0.900
Number of Observations	181	181	181	181

***, **, * indicate statistical significance at the 0.01, 0.05, 0.1 levels.

Table 3. Parameter estimates for factors impacting wholesale graded brisket from January 2004 to February 2019

Independent Variables	Prime Grade Brisket Price P^P	Choice Grade Brisket Price P^C	Select Grade Brisket Price P^S	Ungraded Grade Brisket Price P^{UG}
Intercept	8.9046***	9.0284***	9.2051***	9.4315***
q^P	0.0599	0.0586	0.0249	0.0156
q^C	−0.9769***	−0.9860***	−0.9300***	−0.9182***
q^S	0.2493	0.2487	0.2024	0.1787
q^{UG}	−0.2448	−0.2460	−0.2069	−0.1888
q^k	−0.3666**	−0.3720**	−0.4140***	−0.4382***
G	0.1507***	0.1506***	0.1562***	0.1552***
δ	0.1210***	0.1194***	0.1234***	0.1115***
January	0.1622***	0.1626***	0.1535***	0.1510***
February	0.1344**	0.1346**	0.1187**	0.1161**
March	0.1003**	0.1007**	0.0912**	0.1033**
April	0.0450	0.0453	0.0449	0.0492
May	0.0494	0.0499	0.0453	0.0482
June	0.0858	0.0859	0.0787	0.0856
July	0.0251	0.0249	0.0166	0.0200
August	0.1137***	0.1142**	0.1063**	0.1070**
September	0.0398	0.0400	0.0323	0.0305
October	0.0944**	0.0954**	0.0924	0.0931
November	0.0623	0.0626	0.0593	0.0575
Log Time trend	−0.3420***	−0.3418***	−0.3193***	−0.3095***
Log Time trend squared	0.0913***	0.0914***	0.0871***	0.0850***

***, **, * indicate statistical significance at the 0.01, 0.05, 0.1 levels, respectively. $q^{P,C,UG}$ refer to quantity of graded briskets, q^k refers to quantity of graded briskets, δ_k refers to Arby's introduction of their Brisket Sandwich, and G refers to Google Trends.

introduced their brisket sandwich, and we rejected the null. This shows that Arby's entrance into the market increased all graded brisket prices. While the quality grade and quantity of brisket that Arby's was sourcing is unknown, the effect of a large retail chain entering the brisket market affected all graded prices. There is little research on effects of a large business market entrance with regard to specific meats, but the results from this dummy variable and the Google Trends variable could be useful for understanding market responses by retailers, grocers, and the Beef Checkoff.

For seasonal effects, January, February, March, and August were significantly different from the December base month for all grades. These months were found to increase all prices of graded briskets. October was found to be significant for only Prime and Choice brisket prices. The significance of the August month having impact on prices agrees with what Capps et al. (1994) found. However, Capps et al. (1994) did not find higher seasonal prices for briskets (relative to December) in the months of January, February, March, and October. They also found that August could have a 7% price increase on brisket, whereas our results indicate a smaller impact on price. The largest price increase for all grades occurred in

January. The smallest increase was in March for Select and Ungraded and was in October for Prime and Choice briskets. Nonetheless, the seasonality effects could still present an opportunity for participants in the brisket market to know when prices are seasonally lower or higher. Marketing campaigns by retailers and/or programs such as The Beef Checkoff program could capitalize on known seasonality trends. Finally, the time trend variables were significant for all grades of briskets, which confirms the quadratic nature of brisket prices. This variable accounts for cyclical changes such as the drought and other shocks to the market over this time. It is worth noting that while controlling for time trends in prices, we did find a shift in brisket prices post 2014.

Conclusions

This research explores the hypothesis that there has been a changing demand for briskets due to BBQ trends and major retailer entrance into this market. We used a multivariate price determination model for Prime, Choice, Select, and Ungraded brisket using monthly data from 2004 to 2019. This analysis of brisket price

determinants adds to the limited literature on wholesale meat price studies. More specifically, it is an important contribution to the BBQ demand literature. Additionally, we extend previous literature by developing and using a graded brisket supply as an explanatory variable.

Choice briskets were found to have a significant own-price flexibility and cross-product flexibility. This suggests that the large supply of Choice briskets in the supply chain has a large impact on other graded brisket prices. Cross-quantity flexibilities showed substitutes across brisket quality grades and pork shoulders. Understanding these relationships may aid market participants in formulating special features or alternative menu options when prices are not favorable. The Google Trends variable revealed that, as interest (defined as more internet searches) increased, the brisket prices increased over time. The Google Trends data suggest that there is growing interest in briskets and this interest might be impacting prices for all grades of briskets. Also, we found that the impact of Arby's entrance into the brisket market had a positive impact on graded and ungraded brisket prices.

Future research that would benefit this literature would be a survey to investigate changes in individuals' demand for BBQ at home or at restaurants. For example, it would be interesting to determine how advances in smokers have influenced the demand for at-home BBQ-ing and at-home demand for primal cuts of meat.

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